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MOOSE

Mary V. Hicks, Editor

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Grants W-27-1 and W-27-2
Study 1.0
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STATE OF ALASKA
Tony Knowles, Governor

DEPARTMENT OF FISH AND GAME
Frank Rue, Commissioner

DIVISION OF WILDLIFE CONSERVATION
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Cover photo

Gerhard Kraus is a travel writer and photographer, specializing in northern countries of the world. He has spent much time hiking Alaska's major trails and canoeing Alaska's rivers. Gerhard has written books about Scandinavia and over 100 articles about trekking, mountaineering, canoeing, cycling, and cross-country skiing. He currently writes for Nordis Magazine.

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LOCATION

GAME MANAGEMENT UNIT: 1A (5300 mi^2)

GEOGRAPHIC DESCRIPTION: Ketchikan area including mainland areas draining into Behm and Portland Canals

GAME MANAGEMENT UNIT: Unit 2 (3600 mi^2)

GEOGRAPHIC DESCRIPTION: Prince of Wales Island and adjacent islands south of Sumner Strait and west of Kashevarof Passage

BACKGROUND

Most of the Unit 1A moose population is localized in the Unuk River drainage and appears stable. Good habitat is limited and moose numbers are low. The harvest is sporadic, ranging from 0–8 per year. The Chickamin River supported a few moose before a supplemental transplant in the early 1960s. A short-term increase followed the release, but moose populations have declined and we have had no reports of moose on the Chickamin in recent years. Moose are occasionally reported from other parts of Unit 1A.

Although present-day rumors indicate that moose occurred sporadically on Prince of Wales Island as far back as the 1940s, ADF&G received its first plausible report in 1987 when the U.S. Forest Service reported a cow and calf sighting near Snakey Lakes. During fall 1991 a pickup truck struck a cow moose near Control Lake. In June 1993 a Forest Service employee photographed a cow moose walking along the 30 Road, located roughly 0.5 miles south of Ratz Harbor. One bull moose was poached near Hollis in the fall of 1996. Additional reports indicate that a population of moose, the size and composition of which is unknown, inhabits the Snakey Lakes/Thorne River, Twelvemile Arm, Control Junction, and Staney Creek areas of Prince of Wales Island. Currently there is no open hunting season in Unit 2.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

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

	Plan Objective	1997	1998
Posthunt numbers	35	--	--
Annual hunter kill	3	4	3
Number of hunters	20	32	29
Hunter-days of effort	90	131	189
Hunter success	15%	13%	10%

Unit 2: No objectives have been developed.

METHODS

No moose surveys were flown during the 1997–98 seasons.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Data are insufficient to make a quantitative determination of Unit 1A moose population trends during the past 5 years. Moose populations appeared stable at a low density. Carrying capacity is estimated to be very low and predation pressure high.

Increasing reports of moose in Unit 2 may indicate a growing moose population, or be a function of increased human access into once remote areas. No population data are available for the unit.

Population Composition

No surveys were completed during this report period due to weather. Hunters reported observing about the same number and composition of moose as in years past.

Distribution and Movements

Moose frequently move between the Canadian and US sides of the Unit 1A mainland drainages.

MORTALITY

Harvest

Season and Bag Limit	Resident and nonresident hunters
Unit 1A 1 bull by registration permit only.	Sep 15–Oct. 15
Unit 2	No open season

Board of Game Actions and Emergency Orders. No regulatory changes were made through the Board of Game during this report period.

Hunter Harvest. During 1997/98, 59 individuals obtained moose registration permits for Unit 1A, of which 32 actually hunted. Four moose were reported harvested and antler spreads for bulls measured 25.5, 27.0, 33.5 and 36.0 inches for an overall average of 30.5 inches.

During 1998/99, 53 individuals obtained registration permits, 29 actually hunted, and 3 moose were harvested (Table 1). Antler spreads for bulls measured 28.0, 31.0, and 35.0 inches for an overall average of 31.0 inches.

Permit Hunts. Fifty-nine registration permits were issued for fall 1997 and 53 for the 1998 season.

Hunter Residency and Success. Unit 1A moose hunters continue to be primarily Ketchikan and Metlakatla residents. Several local hunters own cabins on the Unuk River. With the exception of 2 nonlocal hunters, all other participants were from the local area during the past 2 seasons. During 1997/98 3 local and 1 nonlocal hunter harvested 4 bulls. During 1998/99, 3 local residents harvested 3 bulls (Table 2).

Harvest Chronology. During the 2 years of the report period, 3 moose were killed during the first week of the season, and the remaining 4 were taken in the last 2 weeks of the season.

Transport Methods. Typically most hunters use boats to access the Unuk River hunting area. The 1998 season was different with 2 of 3 successful moose hunters using airplanes (Table 4).

Other Mortality

The extent of mortality on adult and calf moose caused by predators such as wolf, black bear, and brown bear in Unit 1A is unknown.

CONCLUSIONS AND RECOMMENDATIONS

The small Unit 1A Unuk River moose population attracts very few hunters other than local residents. Access is difficult and moose populations are low. Suitable habitat is limited, and carrying capacity is likely very low. Most moose harvested are young bulls with relatively small antlers, which have historically averaged 30 inches in width. Winter weather and snow conditions are probably limiting factors. We do not expect moose numbers to exceed current levels.

The Unit 1A registration permit provides accurate hunt-based data. Both the harvest and hunter effort have remained consistent recently, indicating a stable moose population in Unit 1A.

We recommend that Unit 2 remain closed to moose hunting.

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Table 1 Unit 1A moose harvest, 1993–98

Regulatory year	Permits issued	Did not hunt	Hunter harvest reported M	(%)	F	(%)	Unk	Total
1993/94	37	0	3	(100)	0	(0)	0	3
1994/95	62	17	6	(100)	0	(0)	0	6
1995/96	81	33	2	(67)	1[a]	(33)	0	3
1996/97	63	27	4	(100)	0	(0)	0	4
1997/98	59	27	4	(100)	0	(0)	0	4
1998/99	53	24	3	(100)	0	(0)	0	3

[a] Illegal cow kill.

Table 2 Unit 1A moose hunter residency and success, 1993–98

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[a] resident	Nonlocal resident	Non-resident	Total	(%)	Local[a] resident	Nonlocal resident	Non-resident	Total	(%)	
1993/94	3	0	0	3	7	39	3	0	42	93	45
1994/95	4	0	0	6	13	39	2	0	41	87	47
1995/96	2	2	0	2	4	36	6	1	43	96	45
1996/97	4	0	0	4	11	27	5	0	32	89	36
1997/98	3	1	0	4	13	27	1	0	28	87	32
1998/99	3	0	0	3	10	24	2	0	26	90	29

[a] Local resident hunters reside in Unit 1A.

Table 3 Unit 1A moose harvest chronology 1993–1998

Regulatory year	15–21 Sep	22–28 Sep	29 Sep–5 Oct	6–15 Oct
1993/94	0	0	1	2
1994/95	1	1	0	4
1995/96	1	0	1	0
1996/97	2	0	0	2
1997/98	1	0	2	1
1998/99	2	0	0	1

Table 4 Unit 1A successful moose hunter transport methods, 1993–98

Regulatory year	Airplane	Boat	Highway vehicle	3- and 4-Wheeler	Horse	Unknown	Total
1993/94	1	2	0	0	0	0	3
1994/95	1	5	0	0	0	0	6
1995/96	0	3	0	0	0	0	3
1996/97	1	3	0	0	0	0	4
1997/98	0	4	0	0	0	0	4
1998/99	2	1	0	0	0	0	3

LOCATION

GAME MANAGEMENT UNIT: Unit 1B (3000 mi^2)

GEOGRAPHIC DESCRIPTION: The Southeast Mainland from Cape Fanshaw to Lemesurier Point

BACKGROUND

Isolated populations of moose (*Alces alces*) occur in Unit 1B and are believed to be the *andersonii* subspecies. They emigrated from interior British Columbia via the Coast Range and the Stikine River Valley around the turn of the 20th century.

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

The moose population in Thomas Bay is isolated from populations in Canada by the Coast Mountains. These moose occupy an area that was heavily logged from the late 1950s through the early 1970s. The Thomas Bay moose population may decline significantly as conifer re-growth in clearcuts matures and reduces forage production. The average annual harvest of Thomas Bay moose during the 1950s, 1960s, 1970s, and 1980s was 5, 8, 10, and 18, respectively. A scarcity of calves prompted closure of the season in 1982 and 1983.

Moose inhabiting the Alaska portion of the Stikine drainage represent the westernmost tip of a mainland population emanating from Canada. The Alaska portion of this population was estimated at 300 animals in 1983 (Craighead et al. 1984). Since 1983 most winters have been mild and the moose population, based on harvest records and subjective impressions, appeared 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.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

The following moose management objectives for Unit 1B are based on biological data and input from the public.

Unit 1B:

Stikine River

	Plan Objective	1997	1998
Posthunt numbers	300	N/A	N/A
Annual hunter kill	30	17	24
Number of hunters	250	149	194

Hunter-days of effort	1,750	1,089	1,236
Hunter success	12%	11%	12%

Thomas Bay:

	Plan Objective	1997	1998
Posthunt numbers	200	N/A	N/A
Annual hunter kill	20	18	24
Number of hunters	160	146	127
Hunter-days of effort	675	946	819
Hunter success	12%	12%	19%

METHODS

Late winter surveys were flown along the Stikine River valley. Hunters and harvested moose were checked in the field during the Stikine River and Thomas Bay hunts. Field data was used to reconcile written hunter reports. Public meetings in Wrangell and Petersburg were attended where moose management was discussed. Hunters in Unit 1B were asked to report on their registration permit 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

The Thomas Bay population in northern Unit 1B appeared to be stable at a high density. The Stikine River population in Unit 1B, at a moderate density, appeared to be increasing.

The Stikine River population was estimated at 300 moose and increasing in 1983 (Craighead, op. cit.). Post-1983 harvest levels and subjective impressions 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 remained low until 1994. In 1995, 1996, and 1998 the percentage of calves surviving to late winter increased to 18%, 22%, and 24%, respectively (Table 1). Hunters took 57 bulls in 1988 and the kill dropped each succeeding year to a low of 3 in 1994 (taken under a Federal permit; the State season was closed by emergency order in 1994).

The Thomas Bay population was estimated at 180 moose the late 1970s (ADF&G files, Petersburg). Based on increased harvest and observed habitat utilization the current population is probably larger.

Population Composition

Table 1 shows the results of all Stikine River valley surveys since 1989/90. Dense coniferous forest and inclement weather make adequate surveys difficult. No attempt was made to differentiate between bulls and cows, but adults and calves were differentiated during late winter aerial surveys.

Distribution and Movements

Moose have been observed 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 move in both directions. Radio telemetry of Stikine moose found no evidence of extensive seasonal migration (Craighead et. al., 1984). Rutting surveys in 1995 and 1996 identified Dry Wash, Andrew Island, and Barnes Lake as important rutting areas on the Stikine River. Moose appear to be well distributed in the Alaska portion of the Stikine River valley and Thomas and Farragut bays. Moose seem to be absent from the Bradfield Canal area although several river valleys appear to have suitable habitat.

MORTALITY

Harvest

Season and Bag Limit	Resident and nonresident hunters
Unit 1B	Sep 15–Oct 15
1 bull with spike/fork-50"/3 brow tine antlers, by registration permit only.	

Board of Game Actions and Emergency Orders. Action by the Board of Game effective July 1, 1995 put all of Units 1B and 3 and that portion of Unit 1C south of Point Hobart under 1 registration permit hunt (RM038). A legal moose for this registration permit hunt is a bull with a spike/fork or 50-inch antlers or 3 brow tines on at least one side. No emergency orders were issued during this report period.

Hunter Harvest. In 1997, 149 hunters harvested 17 moose on the Stikine portion of Unit 1B. In 1998, 194 hunters harvest 24 moose on the Stikine (Table 2).

In 1997, 146 hunters (Table 3) harvested 18 moose at Thomas Bay. In 1998, 127 hunters harvested 24 Thomas Bay moose.

Hunter Residency and Success. In 1997 and 1998 almost all successful hunters on the Stikine River were Petersburg or Wrangell residents (Table 4). The success rate was 11% and 12% for 1997 and 1998, respectively.

Petersburg residents continued to dominate the Thomas Bay hunt (Table 5). The success rate was 12% in 1997 and 19% in 1998.

Harvest Chronology. Harvest chronology for Unit 1B moose has varied. In general, most bulls are killed during the first half of the season and the success rate declines throughout the season (Table 6). Most hunters are in the field early in the season, and except for weekends, effort tends to drop off as the season progresses. Inclement weather does not appear to slow hunting effort early in the season.

Transport Methods. There were no apparent changes in the type of transportation used by moose hunters in Unit 1B. The majority of hunters used boats and one or 2 hunters used airplanes (Table 7). Motorized land vehicles are prohibited for moose hunting in the Thomas Bay hunt and the Stikine Wilderness. Motorized land vehicles may be used in Thomas Bay for any purpose except moose hunting.

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 some years few calves are recruited into the Stikine herd. Hunters reported increased signs of wolf activity at Thomas Bay during the 1999 season.

HABITAT

Moose populations at Thomas Bay responded favorably to the initial increase in available browse resulting from extensive clearcut logging between 1958 and 1975. Since that time the dense, closed-canopy forests resulting from natural regeneration of second growth stands has reduced available understory browse vegetation.

In 1991 the U.S. Forest Service cleared a 100-acre plot along the Patterson River to investigate the feasibility of improve moose habitat. Regrowth has been browsed heavily during the summer leaving little winter forage in this area.

It is estimated that pre-commercial thinning of second growth stands will extend the habitat value of clearcuts for an estimated 20–30 years. In March 1997 the Alaska Department of Fish and Game developed a plan to enhance moose habitat on State land at Thomas Bay. Phase one of the plan called for reopening 10 miles of State logging roads that were impassable due to dense vegetative growth and downed trees. Road clearing operations were completed in June of 1998. Phase two of the plan called for treating 380 acres of dense second growth primarily by pre-commercial thinning and partial strip clearing. The thinning of 4, second growth units totaling 380 acres was completed in October of 1998.

Stikine moose range lies mostly within the USFS Stikine/LeConte Wilderness area and the Stikine River drainage. Moose habitat in this area, identified by Craighead (1984), is designated wilderness and cannot be artificially manipulated to improve moose habitat. Nineteen transects were surveyed in 1984 to determine the condition and availability of moose winter browse in the Stikine River corridor (Craighead op.cit.). The transects were revisited in June 1991 and in June 1997. Preferred browse species were identified as willow (*Salix* spp.) and red osier dogwood (*Cornus stolonifera*). The total percent of available browse that was heavily utilized included 62.2% *Salix* spp. and 63.9% *Cornus* spp. in June 1997 (Elze, 1997). In 1991 the percentage in the heavy use category was 15.8% for *Salix* spp. and 13.8% for *Cornus* spp. (Stoneman 1992). In 1997 the majority of plants recorded were in the heavily used category compared to 1991 when most plants were in the zero to moderate use categories (Stoneman, 1992).

CONCLUSIONS AND RECOMMENDATIONS

In 1997 none of the Stikine hunt management objectives were met and in 1998 only the percent of successful hunters was met. We believe the herd has been increasing in size since 1994.

In Thomas Bay the moose harvest exceeded the management objective for 1998. Although the number of hunters did not meet the management objectives in 1997 or 1998, the percent of successful hunters and days hunted did meet or exceed objectives in both years. The moose herd currently appears stable.

We recommend that Units 1B and 3 remain unified under one registration permit hunt with season dates from September 15–October 15 and a bag limit of one bull with spike/fork or 50" antlers or at least 3 brow tines on one antler. The extreme southern portion of Unit 1C should also be managed under this same hunt.

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Table 1 Unit 1B Stikine area aerial moose surveys, 1989–98

Regulatory year month/day	Adults	Calves	(%)	Unidentified	Total moose	Moose per/hour
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	
1995/96						
02/25	76	17	(18)	0	93	26
1996/97						
3/08	122	35	(22)	0	157	47
1997/98						
	No data	-	-	-	-	-
1998/99						
2/24	103	32	(24)	0	135	44

[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 1B (Stikine) moose harvest, 1989–98

Regulatory	Hunter harvest reported					
year	M	(%)	F	(%)	Unk.	Total
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	19
1993/94	14	(100)	0	(0)	0	14
1994/95[a]	3					3
1995/96	5	(100)	0	(0)	0	5
1996/97	18	(100)	0	(0)	0	18
1997/98	17	(100)	0	(0)	0	17
1998/99[b]	24	(100)	0	(0)	0	24

[a] Taken under federal permits; state season closed by emergency order.
[b] Includes 1 DLP and 2 Illegal kills.

Table 3 Unit 1B (Thomas Bay) moose harvest, 1989–98

Regulatory	Hunter harvest reported					
year	M	(%)	F	(%)	Unk.	Total
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
1995/96[b]	15	(100)	0	(0)	0	15
1996/97[c]	24	(94)	1	(6)	0	25
1997/98[d]	18	(100)	0	(0)	0	18
1998/99[d]	24	(100)	0	(0)	0	24

[a] Includes illegal kill.
[b] Includes one moose harvested in Port Houghton.
[c] Includes DLP.
[d] Includes illegal kill.

Table 4 Unit 1B (Stikine) moose hunter residency and success, 1989–98

	Successful						Unsuccessful						
Regulatory year	Local[a] resident	Nonlocal resident	Non-resident	Unk.	Total	(%)	Local[a] resident	Nonlocal resident	Non-resident	Unk.	Total	(%)	Total hunters
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[c]	State season closed by emergency order				3								
1995/96	5	0	0	0	5	(4)	91	6	0	0	97	(96)	102
1996/97	18	0	0	0	18	(14)	105	7	0	0	112	(86)	130
1997/98	16	1	0	0	17	(12)	117	8	0	0	125	(88)	142
1998/99	23	1	0	0	24	(13)	154	9	0	0	163	(87)	187

[a] Residents of Petersburg and Wrangell.

[b] Unsuccessful hunter data expanded to correct for non-reporting hunters.

[c] Three moose taken under federal permit.

Table 5 Unit 1B (Thomas Bay) moose hunter residency and success, 1989–98

Regulatory year	Successful: Local[a] resident	Successful: Nonlocal resident	Successful: Non-resident	Successful: Total	Successful: (%)	Unsuccessful: Local[a] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Non-resident	Unsuccessful: Total	Unsuccessful: (%)	Total hunters
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
1995/96	14	1	0	15	(11)	108	8	0	116	(89)	131
1996/97	23	2	0	25	(16)	107	15	1	123	(84)	148
1997/98	18	0	0	18	(12)	116	11	1	128	(88)	146
1998/99	23	1	0	24	(19)	91	12	0	103	(81)	127

[a] Residents of Petersburg and Wrangell.

[b] Includes illegal kill.

Table 6 Unit 1B moose harvest chronology, 1993–98

Area	Year	15–21 Sep	22–28 Sep	29 Sep–5 Oct	6–15 Oct
Thomas Bay	1993/94	0	0	19	8
	1994/95	0	0	9	2
	1995/96	8	3	2	2
	1996/97	11	5	3	6
	1997/98	5	4	6	3
	1998/99	9	6	5	4
Stikine	1993/94	5	1	4	4
	1994/95	State season closed by EO			
	1995/96	3	1	0	1
	1996/97	6	6	2	4
	1997/98	7	3	3	4
	1998/99	12	5	3	4

Table 7 Unit 1B successful moose hunter transport methods by area, 1990–98

Area	Year	Airplane	Boat	Highway vehicle	3- or 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
	1995/96	3	11	1	0	0	0	15
	1996/97	0	25	0	0	0	0	25
	1997/98	0	18	0	0	0	0	18
	1998/99	2	22	0	0	0	0	24
Stikine	1993/94	1	13	0	0	0	0	14
	1994/95		state season closed by EO					
	1995/96	0	5	0	0	0	0	5
	1996/97	2	16	0	0	0	0	18
	1997/98	0	17	0	0	0	0	17
	1998/99	2	22	0	0	0	0	24

LOCATION

GAME MANAGEMENT UNIT: 1C (7600 mi^2)

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

BACKGROUND

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, 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 along the Taku River, and 27 moose were harvested there. Moose also occur on 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 to the south.

Berners Bay, one of the most popular moose hunting areas in Southeast Alaska, did not have a naturally occurring moose population. Fifteen calves from the Anchorage area were released there in 1958. A supplemental release of 6 more calves was made in 1960. In June 1960, 3 cows with a single calf each were observed, indicating that 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 to 23 animals.

Moose were first documented in western Unit 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. In 1965 moose were sighted for the first time along the Endicott River and St. James Bay areas. Moose had probably moved into the Adams Inlet area by that time, because sightings were recorded for nearby Gustavus by 1968. The Gustavus moose population has expanded rapidly and has taken on an identity of its own. We now manage moose in Gustavus as a separate population from the remainder of the Chilkat Range.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

The following objectives have been identified by staff based on existing biological data and input from the public:

1. Taku Area: Maintain a post-hunting population of 150 moose, an annual harvest of 20, and a hunter success rate of 20%;

2. Berners Bay: Maintain a post-hunting population of 90 moose, an annual harvest of 8, and a hunter success rate of 90%;

3. Chilkat Range: Maintain a post-hunting population of 150 moose, an annual harvest of 10, and a hunter success rate of 15%.

METHODS

Aerial surveys were conducted throughout most of the subunit during the report period. Survey flights were accomplished at Berners Bay each year, while the Gustavus Forelands, the Chilkat Range, and Taku Inlet were surveyed in 1998 only.

One registration permit hunt (RM046), and 2 drawing permit hunts were used to manage the moose hunting effort in Unit 1C. Berners Bay moose were managed under 2 drawing permit hunts; a bull only hunt (DM041) and a cow only hunt (DM042). The remainder of Unit 1C (not including that area south of Pt. Hobart) was managed under a registration permit hunt (RM046). Since 1995, the area south of Pt. Hobart has been included in the antler-restriction moose hunt conducted in Units 1B and 3 (RM038), and all moose taken in that hunt were included in the management report covering those areas. A condition of all drawing and registration hunts required hunters to bring in the lower jaws of their moose allowing us to collect incisors for aging. Other data collected included the hunt length, hunter residency, hunt location, commercial services used, and transport means (for all hunters), and date of kill (for successful hunters).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

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

Population Size

The Berners Bay moose population appears to be near our objective of 100–150 animals based on aerial surveys conducted during this report period. The number of moose observed in fall and winter surveys has remained fairly steady since 1990 (Table 1).

The number of moose in the Chilkat range appears to be increasing based on the harvest records as well as anecdotal information gathered from hunters. The 1998 harvest was the highest ever recorded for this area. An aerial survey conducted in the Endicott River/Adams Inlet drainages during the winter of 1998 enumerated 72 moose; 12 of these moose were within the Endicott drainage. The moose we observed in the park may move into the Endicott River during the spring and summer, supplementing the herd along the west side of Lynn Canal. The status of the moose population throughout the Chilkat Range as a whole remains unknown, as surveys have not been conducted successfully due to limited snow cover and dense forest canopy.

The Gustavus Forelands moose population appears to be growing based on a 1998 winter survey (Table 1). Both the overall number of moose and the number of calves in the herd indicate a rapidly expanding population. Improving habitat conditions on recently glaciated lands have apparently stimulated moose productivity.

Very little information is available regarding the number of moose in the Taku River drainage. A 1998 winter survey enumerated very few moose (Table 1), but the 1998 harvest was near the mean harvest of the past 9 years. The moose population between Taku River and Cape Fanshaw probably numbers about 150 animals. Animals from upriver in Canada quite possibly supplement the Taku herd, but apparently the harvest in Canada has increased in recent years. Further south on the mainland, a few moose have been harvested in the Port Houghton area. These moose are almost certainly an extension of the population using Thomas and Farragut bays on the south side of the Fanshaw Peninsula and are distinct from other Unit 1C moose populations. Most, if not all of the effort directed at Port Houghton moose comes from Petersburg, in Unit 1B.

Population Composition

We were unable to attain complete composition survey data during either year of the report period for any Unit 1C moose populations. Limited snow cover prevented us from conducting surveys until late in each of the winters when bull moose had already begun dropping their antlers, making it impossible to differentiate male from female moose.

The Berners Bay surveys in 1997 and 1998 enumerated 60 and 70 moose, respectively. In 1997 the minimal bull to cow ratio was 14:100, and in 1998 it was 30:100 based on the ratio of male moose that still retained antlers compared to unantlered adult moose. The minimal calf to cow ratios for 1997 and 1998 were 29:100 and 22:100, respectively.

In a 1998 Chilkat Range survey we enumerated 72 moose, with a minimal bull to cow ratio of 12:100 and a minimal calf to cow ratio of 32:100.

In our Gustavus survey (1998) we enumerated 185 moose with minimum calf to cow ratio of 42:100. All observed moose had dropped their antlers making it impossible to identify males. In the Taku survey we counted 5 moose, with a minimum calf to cow ratio of 25:100. No antlered moose were seen during the survey.

Mean age at harvest of Berners Bay moose was 2.4 years and 3.4 years for males in 1997 and 1998, respectively. The mean age of female moose was 4.0 years in 1997 and 3.4 years in 1998.

Mean age at harvest of moose in the Chilkat Range was 3.3 years and 2.9 years for 1997 and 1998, respectively. The Gustavus Forelands exhibited a younger harvest than the rest of the Chilkat Range, to be expected in a rapidly growing population with ages of 2.0 years in 1997 and 1.4 years in 1998. The Taku harvest continued its trend toward younger animals (Table 3) with mean ages of 2.6 years and 1.3 years for 1997 and 1998, respectively. The harvest of young bulls from the Taku suggests that the herd may be doing better than we had previously thought.

Harvest

Season and Bag Limits.	Resident and nonresident hunters
Unit 1C, Berners Bay drainages only. 1 moose by drawing permit only. Up to 20 permits will be issued.	Sep 15–Oct 15
Unit 1C, except Berners Bay drainages, 1 bull by registration permit only.	Sep 15–Oct 15

Board of Game Actions and Emergency Orders: Since 1993 we have annually issued up to 20 drawing permits for Berners Bay, with the number and sex of moose to be taken determined by aerial survey results. An emergency order was issued during the 1998 season to close the Gustavus hunt on October 3rd instead of October 15 as scheduled, when the harvest exceeded 40 animals (nearly a 50% increase over the previous years harvest).

Hunter Harvest: The Berners Bay drawing permit hunt was managed for a harvest of 15 moose from 1993–95 then increased to 17 in 1996 as part of a Fish and Wildlife undercover operation (Table 4). The permit allocation returned to 15 (8 bulls and 7 cows) for both years of this report period, and hunter success was 100% for both years.

The balance of Unit 1C is managed under terms of a registration permit with no hunt quota. The Chilkat Range harvest (exclusive of Gustavus Forelands) ranged from 6 to 17 during 1990–96 (Table 5). In 1997 the harvest was 13, and in 1998 the harvest reached 28, the highest ever recorded for this area. The Gustavus harvest has climbed dramatically over the past few years, reaching 48 animals in 1998. The harvest in the Taku hunt has ranged between 14 and 20 from 1990–96, then dropped to 6 in 1997 before rebounding to

14 in 1998. The low harvest in 1997 was due to few moose being seen, and not to a decline in effort (Table 4). In 1998 the harvest returned to a level similar to previous years. Harvest in Unit 1C outside of Berners Bay continues to increase, largely due to the influence of hunts in the Chilkat Range and the Gustavus Forelands. These areas accounted for 44 of 65 moose harvested in Unit 1C in 1997, and 76 of 105 moose in 1998 (Table 5). During the same period, harvest in the Taku area has remained at or below historic levels (Table 5). Coupled with the Berners Bay harvest, the total harvest of moose in Unit 1C is at a historic high.

Permit Hunts: Over 1500 applications were submitted for the Berners Bay moose drawing during each year of the previous report period, but these numbers dropped in 1997 and 1998 to 1189 and 1303 applications, respectively. This decline in permittees may be related to the increased interest and success in Gustavus Forelands and Chilkat Range hunts. The proximity of the Berners Bay hunt to Juneau and the high success rate explain the popularity of this hunt. In 1997, 1189 hunters applied for 8 bull and 7 cow permits, for a combined success rate of 1.3%. In 1998, 1303 hunters applied for a success rate of 1.1%.

Since the registration permit format was implemented for Unit 1C except Berners Bay, more than 200 permits have been issued annually (Table 4). In 1997 a record 489 permits were issued, followed by 441 in 1998. The increase in interest stems mainly from the increased popularity of the Gustavus hunt; roughly 70% of hunting permittees went either to Gustavus or the Chilkat Range. As in most hunts, not all the permittees actually participated in a hunt. In 1997 only 300 of the 489 permittees actually hunted, and 266 of 441 permittees hunted in 1998.

Hunter Residency and Success: Most moose harvested in Unit 1C continue to be taken by residents of the subunit (Table 6). For example, during the report period 146 of 170 moose harvested were taken by residents of the subunit, with another 10 taken by other Southeast residents. Alaska residents from outside of Southeast Alaska took only 11 moose, additionally only 3 were taken by nonresidents. This is probably because moose hunting areas are not readily accessible via highway vehicle, and residents from elsewhere in Alaska have better moose hunting opportunities closer to home. Nonresidents eager to take moose focus on areas with larger moose populations and a better chance of getting a trophy animal. Twenty-two percent of all Unit 1C hunters were successful in 1997, and in 1998 the success rate climbed to 40%, with hunters at Gustavus more successful than hunters either in the Chilkat Range or Taku River (Table 5).

Harvest Chronology: Similar to the preceding few seasons, in both years moose harvest was heavily weighted towards the early part of each of the season. Seventy-four percent of the moose killed in 1997 were taken during the first 2 weeks of the season, and in 1998 71% were taken during that period. The late season harvest in 1998 was curtailed by an emergency closure at Gustavus that prevented any harvest after October 3rd.

Transport Methods: Boats continue to be the most common form of transportation for Unit 1C moose hunters (Table 7), and were used by 56% of the successful hunters during the report period. Walking, airplanes, and highway vehicles were also used, with 20, 15, and 9 percent of the hunters using these means, respectively. The predominant use of boats is not surprising, since most hunting areas are removed from highway access points and remote landing strips for aircraft are limited. The high percentage of hunters who walked to their hunting area reflects that Gustavus residents basically hunt in their backyards. The use of airplanes for hunting access is the result of the upper Endicott drainage gaining in popularity as a moose hunting destination, and highway vehicles are used primarily by hunters at Gustavus.

Other Mortality

No natural mortality was documented during the report period, although heavy snows during the winter of 1998/99 could have affected moose throughout the subunit.

HABITAT

In a March 1999 meeting in Gustavus aimed at addressing moose population concerns on the forelands, ADF&G biologists introduced the idea of monitoring the browsing intensity by moose on winter forage there. The area was inundated with nearly 200 moose (observed during an aerial survey) during the winter of 1998/99, resulting in intensive browsing on most of the available forage. Biologists are concerned that moose may exceed the carrying capacity of the winter range. Douglas staff are beginning a forage availability and use monitoring study to address this concern.

CONCLUSIONS AND RECOMMENDATIONS

All Berners Bay management objectives were surpassed. The population there appears to be larger than the targeted 90 animals, hunter success was 100% during the report period, and the harvest exceeded 8 animals each year. Desired hunter success and harvest level were reached for the Chilkat Range during the report period, with the harvest objective (10 moose) being roughly quadrupled in 1997 and nearly 8 times the objective in 1998. Almost all of Unit 1C's increased harvest in 1997 can be attributed to the Gustavus Forelands hunt, while in 1998 both Gustavus Forelands and the Chilkat Range attributed to the dramatic increase in harvest. None of the management objectives for the Taku River area were met in 1997. The harvest of 6 bull moose was much lower than the objective of 20, and the percent success of 15 was considerably lower than the objective of 20%. In 1998 the harvest of 14 bulls was again lower than the objective, but the percent success of 23 surpassed the objective of 20%. The status of this population is unknown, given the difficulty in conducting aerial surveys in the Taku drainage.

In 1998 we revised the management objectives for Unit 1C based on recent hunt and population information. We separated Gustavus Forelands from the remainder of the Chilkat Range because of it's unique set of circumstances. Below is a list of the newly drafted management objectives:

1. Taku Area: Maintain a posthunting population of 100 moose, an annual harvest of 10, and a hunter success rate of 20%;

2. Berners Bay: Maintain a post-hunting population of 90 moose, an annual harvest of 18, and a hunter success rate of 90%;

3. Chilkat Range: Maintain a post-hunting population of 200 moose, an annual harvest of 20, and a hunter success rate of 22%;

4. Gustavus Forelands: Maintain a population of 250, an annual harvest of 40, and a hunter success rate of 33%.

We believe that a continuation of the permit registration system should accommodate current population objectives in Unit 1C. Rising effort and harvest on the Gustavus Forelands increase the importance of acquiring consistent aerial survey data for moose in that portion of the subunit. Decreasing hunter effort in the Taku area suggests that the population may be declining, increasing the importance of acquiring survey data there as well.

Throughout the subunit, jaws of harvested moose should be collected for age analysis. Areas supporting the most critical winter browse should be analyzed, even cursorily, to estimate the status of moose populations in relation to carrying capacity. This is particularly true around Gustavus where habitat information would compliment our aerial survey information and help us anticipate management decisions.

LITERATURE CITED

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Table 1 Unit 1C aerial moose survey data

Year	Bulls	Cows	Calves	Unknown	Total moose	Count time (hrs)	Bulls per 100F	Calves per 100F	Calves % in herd	Moose per hour
					Berners Bay 1990–98					
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[1]	---	---	12	45	67	2.8	---	---	18	24
1994	17	45	13		75	2.0	38	29	17	38
1995–1996					No survey					
1997	6	11	12	31	60	2.1	---	---	20	29
1998	14	9	10	37	70	2.6	---	---	14	27
					Chilkat Range 1968–98					
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	
1987–1991					No survey					
1992[2]	---	---	11	79	97	1.3	---	---	13	75
1993–1995					No survey					
1996[3]				20						
1997					No survey					
1998[4]	6	15	16	35	72	1.1	---	---	22	64
[5]	---	48	54	131	185	1.9	---	---	29	95
					Taku River1978–98					
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
1989–1997					No survey					
1998	---	1	1	3	5	---	---	---	---	---

[1,2] Sex and age unreliable due to the timing of the survey.

[3] April survey with little snow cover.

[4] Endicott River and Adams Inlet.

[5] Gustavus Forelands.

Table 2 Unit 1C moose age at harvest, Berners Bay, 1990–98

							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											
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
1995	0	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	7	100	1.7
1996	0	5	1	0	0	1	0	0	0	0	0	0	0	0	0	0	7	100	1.7
1997	0	2	1	5	0	0	0	0	0	0	0	0	0	0	0	0	8	100	2.4
1998	0	2	3	0	0	0	0	0	2	0	0	0	0	0	0	0	8	88	3.4
								Females											
1990	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
1995	0	1	1	1	2	0	0	1	0	0	0	0	0	0	0	0	6	100	3.5
1996	0	0	1	0	2	0	0	0	1	0	1	0	0	1	0	0	7	100	6.1
1997	0	1	0	3	2	0	0	0	0	0	1	0	0	0	0	0	7	100	4.0
1998	0	2	3	1	0	0	0	0	0	0	0	0	0	1	0	0	7	100	3.4

Table 3 Unit 1C moose age at harvest, excluding Berners Bay, 1990–98

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
Chilkat Range																			
1990	0	6	1	1	0	1	0	0	0	0	0	0	0	0	0	0	16	69	2.3
1991	0	3	0	2	0	0	0	0	1	0	0	0	0	0	0	0	6	100	3.3
1992	0	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	9	56	2.9
1993	0	5	0	2	3	0	1	0	0	0	1	0	0	0	0	0	17	71	3.8
1994	0	3	0	1	0	0	0	2	0	0	1	0	0	0	0	0	7	100	4.8
1995	0	3	3	2	0	0	2	1	1	1	0	0	0	0	0	0	14	93	4.4
1996	0	3	4	5	1	3	1	0	0	4	0	0	0	0	0	0	21	98	4.1
1997	0	5	0	3	1	1	0	1	0	1	0	0	0	0	0	0	13	92	3.3
1998	0	10	2	7	1	0	2	2	1	0	0	0	0	0	0	0	28	89	2.9
Gustavus Forelands																			
1990	0	1	2	2	1	0	1	0	0	0	0	0	0	0	0	0	8	88	3.5
1991	0	2	1	1	0	0	1	0	0	0	0	0	0	0	0	0	6	83	3.1
1992	0	1	2	1	1	1	0	1	0	0	0	0	0	0	0	0	11	64	3.9
1993	0	3	5	4	0	1	0	0	0	0	0	0	0	0	0	0	13	100	2.8
1994	0	7	4	1	1	3	0	0	1	0	0	0	0	0	0	0	20	85	3.1
1995	0	4	9	3	2	1	0	0	0	0	0	0	0	0	0	0	21	90	2.8
1996	0	18	5	4	1	1	0	0	0	0	0	0	0	0	0	0	30	97	2.2
1997	1	11	9	2	2	0	2	0	0	0	0	0	0	0	0	0	31	86	2.0
1998	2	24	10	5	3	0	0	0	0	0	0	0	0	0	0	0	48	92	1.4
Taku River																			
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
1995	0	7	4	0	1	1	1	0	0	0	0	0	0	0	0	0	14	100	2.1
1996	0	10	3	0	0	0	1	0	0	0	0	0	0	0	0	0	15	93	1.6
1997	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	6	83	2.6
1998	0	11	0	2	0	0	0	0	0	0	0	0	0	0	0	0	14	93	1.3

Table 4 Unit 1C moose hunter effort and success, 1990–98

		Successful hunters			Unsuccessful hunters			Total hunters		
Year	Permits issued[1]	Nr hunters	Total days	Avg. days	Nr hunters	Total days	Avg. days	Nr hunters	Total days	Avg. days
					Berners Bay					
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
1995	15	13	40	3.1	1	6	6.0	14	46	3.3
1996	17	14	35	2.5	0	0	---	14	35	2.5
1997	15	15	42	2.8	0	0	0	150	42	2.8
1998	15	15	29	1.9	0	0	0	15	29	1.9
					Chilkat Range					
1990	331	16	57	3.6	94	267	2.8	106	350	3.3
1991	316	6	17	2.8	37	143	3.9	43	160	3.7
1992	317	9	41	4.6	62	234	3.8	71	275	3.9
1993	352	17	69	4.1	62	259	4.2	79	328	4.2
1994	346	7	15	2.1	47	173	3.7	54	188	3.5
1995	380	13	34	2.6	96	375	3.9	109	409	3.8
1996	396	17	31	1.8	65	308	4.7	82	339	4.1
1997	489	13	42	3.2	92	370	4.2	105	412	3.9
1998	441	28	85	3.0	58	190	3.3	86	275	3.2
					Gustavus Forelands					
1990[2]	---	8	26	---	NA	NA	---	NA	NA	---
1991	---	6	21	3.5	29	163	5.6	35	184	5.3
1992	---	11	38	3.5	36	163	4.5	47	201	4.3
1993	---	13	59	4.5	45	229	5.1	58	288	5.0
1994	---	20	96	4.8	64	281	4.4	84	377	4.5
1995	---	21	90	4.3	69	294	4.3	90	384	4.3
1996	---	30	115	3.8	65	331	5.1	95	446	4.7
1997	---	31	125	4.0	73	279	4.1	104	404	4.1
1998	---	48	139	3.0	71	255	3.7	119	394	3.4
					Taku River					
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
1995	---	14	48	3.4	71	254	3.6	85	302	3.6
1996	---	15	57	4.4	85	320	3.8	100	377	3.8
1997	---	6	25	5.0	85	365	4.5	91	390	4.5
1998	---	14	49	3.5	47	219	4.7	61	268	4.4

[1] Number given for the Chilkat Range is actually the number of permits issued for Unit 1C excluding Berners Bay; only permittees who hunted may be categorized to specific areas such as the Chilkat Range or Taku River.

[2] Effort information for unsuccessful hunters at Gustavus Forelands is combined with the Chilkat Range for 1990.

Table 5 Unit 1C moose historical harvests, number of hunters, and percent success, 1990–98

Year	Nr males	Nr females	Nr unknown	Total kill	Nr hunters	% success
			Berners Bay			
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
1995	7	6	0	13	14	93
1996	7	7	0	14	14	100
1997	8	7	0	15	15	100
1998	8	7	0	15	15	100
			Chilkat Range			
1990	16	0	0	16	106[1]	23
1991	6	0	0	6	47	13
1992	11	0	0	11	42	26
1993	17	0	0	17	90	19
1994	7	0	0	8	56	14
1995	13	0	0	13	109	12
1996	17	0	0	17	82	21
1997	13	0	0	13	105	12
1998	28	0	0	28	86	33
			Gustavus Forelands			
1990	8	0	0	8	n/a	n/a
1991	6	0	0	6	35	17
1992	9	0	0	9	47	19
1993	13	0	0	13	58	22
1994	19	0	0	19	84	23
1995	21	0	0	0	90	23
1996	30	0	0	29	95	31
1997	30	1	0	31	104	29
1998	47	1	0	48	118	40
			Taku River			
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
1995	14	0	0	14	85	16
1996	15	0	0	15	97	15
1997	6	0	0	6	91	15
1998	14	0	0	14	61	23

[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 River (based on proportion hunting in each area) as they reported no specific area within Unit 1C.

Table 6 Unit 1C annual moose kill by community of residence, 1990–98

Year	Total kill	Gustavus	Juneau	Sitka	Wrangell	Petersburg	Haines	Other Alaska	Non-resident
				Berners Bay					
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
1995	13	0	11	0	0	0	0	2	0
1996	14	0	14	0	0	0	0	0	0
1997	15	0	13	1	0	0	0	0	1
1998	15	0	12	1	0	1	1	0	0
				Chilkat Range					
1990	16	0	13	0	0	0	3	0	0
1991	6	0	6	0	0	0	0	0	0
1992	9	0	8	0	0	0	1	0	0
1993	17	0	11	0	0	0	5	1	0
1994	7	0	6	0	0	0	0	1	0
1995	13	2	10	0	0	0	0	1	0
1996	17	0	14	0	0	0	0	1	0
1997	13	0	12	0	0	0	0	3	0
1998	28	1	20	0	0	0	1	6	0
				Gustavus Forelands					
1990	8	7	1	0	0	0	0	0	0
1991	6	6	0	0	0	0	0	0	0
1992	11	10	0	0	0	0	0	0	1
1993	11	2	0	0	0	0	0	0	0
1994	20	15	4	0	0	0	0	0	1
1995	21	13	7	0	0	0	0	1	0
1996	30	22	7	0	0	0	0	0	1
1997	31	20	7	1	0	0	0	2	1
1998	48	27	16	1	0	0	1	2	1
				Taku River					
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
1995	14	0	12	1	0	0	0	1	0
1996	15	1	14	0	0	0	0	0	0
1997	6	0	5	1	0	0	0	0	0
1998	14	0	13	1	0	0	0	0	0

Table 7 Unit 1C successful moose hunters transport methods, 1993–98

	Airplane		Boat		3- or 4-wheeler		Hwy vehicle		Foot	
Year	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
					Berners Bay					
1993	0	---	14	(100)	0	---	0	---	0	---
1994	0	---	14	(100)	0	---	0	---	0	---
1995	1	(8)	12	(92)	0	---	0	---	0	---
1996	1	(7)	13	(93)	0	---	0	---	0	---
1997	0	---	15	(100)	0	---	0	---	0	---
1998	0	---	15	(100)	0	---	0	---	0	---
					Chilkat Range					
1993	5	(29)	12	(71)	0	---	0	---	0	---
1994	0	---	7	(100)	0	---	0	---	0	---
1995	5	(38)	8	(62)	0	---	0	---	0	---
1996	9	(53)	8	(47)	0	---	0	---	0	---
1997	6	(46)	7	(54)	0	---	0	---	0	---
1998	9	(32)	19	(68)	0	---	0	---	0	---
					Gustavus Forelands					
1993	1	(8)	4	(31)	1	(8)	4	(31)	3	(23)
1994	1	(5)	3	(15)	0	---	11	(55)	5	(25)
1995	3	(14)	7	(33)	0	---	2	(10)	0	---
1996	1	(3)	7	(23)	3	(10)	4	(13)	12	(40)
1997	0	---	9	(31)	0	---	4	(14)	16	(55)
1998	0	---	10	(21)	0	---	21	(44)	17	(35)
					Taku River					
1993	4	(25)	11	(69)	0	---	0	---	1	(6)
1994	3	(18)	14	(82)	0	---	0	---	0	---
1995	2	(14)	12	(86)	0	---	0	---	0	---
1996	6	(33)	12	(67)	0	---	0	---	0	---
1997	0	---	6	(100)	0	---	0	---	0	---
1998	0	---	14	(100)	0	---	0	---	0	---

Table 8 Unit 1C moose hunters commercial services use, 1991–1998

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
1995	13	0	1	0	0	0	14	0	0	0	0
1996	12	1	0	0	0	0	12	1	1	0	0
1997	13	0	1	0	0	1	14	1	1	0	0
1998	12	0	2	1	0	0	14	1	0	0	1
Chilkat Range											
1992	88	6	12	4	0	1	100	11	10	1	0
1993	37	2	20	7	0	0	57	10	5	3	2
1994	26	5	19	0	0	0	45	4	0	0	0
1995	72	2	29	0	0	0	101	2	2	0	0
1996	56	5	13	0	0	0	64	5	5	0	0
1997	66	4	13	0	1	3	80	7	7	0	0
1998	70	1	11	4	0	0	81	5	5	0	0
Gustavus Forelands											
1992	8	0	0	0	0	0	8	0	0	0	0
1993	55	4	3	0	0	0	58	4	4	0	0
1994	81	1	0	0	1	0	82	2	2	0	0
1995	80	0	10	0	0	0	90	0	0	0	0
1996	78	3	12	1	0	1	95	5	5	0	0
1997	81	2	7	0	1	2	89	4	1	2	1
1998	104	2	9	0	1	0	114	2	2	0	0
Taku River											
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
1995	70	5	9	0	0	0	79	5	3	0	2
1996	71	5	3	1	0	2	74	8	2	2	4
1997	60	6	4	0	0	0	64	6	5	0	1
1998	53	3	4	0	0	0	57	3	3	0	0

LOCATION

GAME MANAGEMENT UNIT: Unit 1D (2700 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

Most Unit 1D 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, when as many as 700 animals may have been present (ADF&G, 1991). By the early 1970's the moose population had sharply declined to 400–500 animals, possibly because of overutilization of the range and overharvest. Survey data collected during the mid-1980s suggested that the herd had declined to 400 animals. Recent surveys suggest that the moose population now numbers between 300 and 400 animals.

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 (i.e., a spike-fork/50-inch/3 brow tine requirement) to slow the pace of the hunt, but these were preempted when a Tier II subsistence hunt was implemented for the area by the Board of Game for 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 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 legal moose while affording protection to bulls that did not meet antler requirements. 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 opportunity to hunt and a chance at harvesting a moose.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Population management objectives identified by staff for Unit 1D are as follows:

1. Maintain a post-hunt population of 450 moose;

2. Maintain a post-hunt bull to cow ratio of 25:100;

3. Allow for 250 hunters expending 500 hunter days;

4. Reach a harvest of 30 moose with a hunter success rate of 12%.

METHODS

Aerial surveys of the Chilkat River valley were conducted in January and December 1998 (Table 1). Areas covered included the Chilkat River valley from Murphy Flats to the vicinity of Turtle Rock, and the Klehini, Takhin, Tsirku, Kelsall, and Chilkoot river valleys.

Prior to the moose hunt each year we held an informational meeting in Haines to discuss the identification of legal and non-legal moose. We showed the video "Is This Moose Legal", to help hunters interpret the spike-fork/50-inch/3 brow tine regulation that is used to manage the hunt in Unit 1D.

During each year of the report period we maintained a moose check station in Haines and required hunters to check in their moose within 2 days of the kill. Incisors were collected from moose taken by successful hunters as a condition of the Tier II permit. Hunters were also required to turn in a hunt report card specifying hunt length, hunt location, transport means (for all hunters), and date of kill (for successful hunters). We also collected data on antler measurements and configurations.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

We conducted winter surveys flown in times of good snow cover and excellent viewing conditions in January and December 1998 that indicated the Chilkat Valley moose population was about 350 animals. The January 1998 count of 199 was the 2nd highest in 10 years, and the December 1998 survey tallied 177 moose. The number of moose seen per hour of survey time was at or above the mean of the past 10 years for both 1997 and 1998 (Table 1).

Population Composition

We were unable to obtain thorough sex and age composition during either of the surveys conducted during this report period. In both cases bulls had begun dropping their antlers (nearly all in the January survey, and a few in the December survey had shed their antlers). We therefore had to classify many adult moose as sex unknown, and listed only those adults accompanied by calves as females (Table 1). We were able to differentiate calves during both surveys, and the percent of moose seen that were calves was 18% in January and 15% in December. These percentages are nearly identical to the previous report period, and are above the mean of 13% during 1990–96 (Table 1). Mean age at harvest was 4.2 years during this report period, a decrease from the mean age of 4.8 and 5.6 years during the previous 2 report periods.

It is interesting to compare the age at harvest from the 1980s to the post-Tier II era (1993), to the present. While the mean age was less than 4 years for the (any bull) seasons during 1983 through 1989, the mean age was greater than 5 years from 1993 through 1995 (immediately after the antler restriction regulation was implemented). The mean age has been around 4 years during 1996–1998. The age distribution of animals harvested from 1993–1995 is skewed towards older animals, most likely a result of the spike–fork/50–inch/3 brow tine regulation implemented in 1993, and the fact that no hunts were held during 1991 and 1992. The increase in older bulls available after 2 years of no hunting provided for a harvest of older animals.

MORTALITY

Harvest

Season and Bag Limit.	Resident hunters	Nonresident hunters
1 bull by Tier II permit only. Up to 200 permits may be issued.	Sep 15–Sep 30 (Subsistence hunt only)	No open season

Board of Game Actions and Emergency Orders. During both years of this report period the moose hunting season remained open for the entire 2-week season. Despite the theoretical self-limiting aspects of a spike-fork/50-inch/3 brow tine hunt, we felt it wise to kill no more than 30 bulls per year, and to target the harvest at about 2 dozen bulls.

Hunter Harvest. During this report period the mean annual harvest was 18 animals, substantially lower than the mean harvest of 27 during the previous report period.

Permit Hunts. All moose hunting within the subunit is conducted under a Tier II subsistence permit system. Two hundred permits were issued during each year of the report period (Table 3), but the number of applicants declined from 293 in 1997 to 266 in 1998.

Hunter Residency and Success. During the report period Unit 1D residents were the primary moose hunters there, although all Alaskans were eligible to apply for any Tier II hunt. Residents of Haines or Klukwan (Table 4) took all but 2 of the 36 moose harvested in 1997 and 1998. Hunter success was 12% during the report period, a decline from the mean of 17% reported during 1995–1996 (Table 5). Successful hunters spent an average of 3.8 and 4.4 days in the field during 1997 and 1998, respectively (Table 3). Total hunter days expended were 941 in 1997 and 1,055 in 1998 (Table 3). The dramatic increase in days afield over the previous report period is partially due to the season remaining open during the entire 2-week season in both 1997 and 1998.

Harvest Chronology. Since 1995 the opening date of the Tier II moose season has been 2 weeks earlier than in the past, beginning on September 15 rather than October 1. Because of this early start date, it is often difficult for hunters to locate and positively identify a legal bull due to the presence of leaves on trees and shrubs. As a result the harvest during both years of this report period was scattered throughout the season.

Transport Methods. Most hunters have historically used boats or highway vehicles to hunt moose in Unit 1D (Table 6). During the 1997 and 1998 hunting seasons, 71% and 65% of successful hunters used boats. Nearly all of the remaining successful hunters used highway vehicles (Table 6).

Commercial Services. Only 3 hunters used Commercial services during the report period (Table 7). This is not surprising because virtually all hunters reside within or very near the subunit, and are well equipped for moose hunting.

Other Mortality

Discussions with residents of Unit 1D suggest the brown bear population there has increased in recent years, and that predation on moose calves by bears may be partly responsible for low recruitment rates observed. Data in support of this contention is not available. Wolf predation during this report period did not seem to pose any serious threat to the moose population. In some years deep snow probably contributes to calf mortality, although conditions during this report period were relatively mild. Deteriorating range conditions (Hundertmark et al., 1983) may also play a role in low calf production and survival.

We estimate about 4 moose are struck and killed by highway vehicles in the subunit each winter. Poaching is known to occur, but the number of moose lost to this activity is not known.

There is some degree of unreported harvest of illegal bull moose that are shot and left by hunters, although we believe that this number is relatively small.

HABITAT

Nearly all of the moose habitat in this subunit lies within the Haines State Forest, managed under the multiple-use guidelines of the 1986 Haines State Forest Management Plan. The plan's goals include an annual harvest of up to 8.8 million board feet of timber (approximately 300 to 580 acres). While some increased browse production may occur in logged areas, the extent and value of deciduous reproduction in these areas has not been determined. The long-term usefulness of cutover areas to moose will be reduced if a) timber harvest occurs in high value wintering areas, and b) cutover areas are managed to produce second growth coniferous stands rather than deciduous browse species.

Habitat changes within non-forested 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 post-glacial 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, at least for awhile. There is some degree of local interest in mechanically changing vegetation in areas close to Haines, but no efforts have been made to date.

CONCLUSIONS AND RECOMMENDATIONS

The management objectives listed at the beginning of this report were adopted from the Strategic Plan for Management of Moose in Region I, Southeast Alaska 1990–94 (ADF&G, 1991). We were not able to collect data needed to determine the bull to cow ratio due to the timing of our surveys. The objective for maintaining a population of 450 moose was not met; post-hunt carrying capacity is probably closer to 350–400 animals based on our aerial survey information. The harvest objective of 30 bull moose was not met either, and is a higher goal than we prefer at this time. Finally, the number of hunter-days was nearly double the objective. We did meet the objective of a 12% hunter success rate.

We revisited management objectives for this herd and updated it based on the most recent information we have. The following is a list of the newly adopted management objectives:

1. Maintain a post-hunt population of 350 moose;

2. Maintain a post-hunt bull to cow ratio of 25:100 (same);

3. Allow for 200 hunters expending 600 hunter days;

4. Reach a harvest of 25 moose with a hunter success rate of 12%.

The implementation of an antler restriction hunt has resulted in an increased age of harvested moose, and assuming calf survival is adequate this strategy 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 also has the important effect of allowing more people to moose hunt while reducing the impact of the hunt upon the herd. While the difficulties of judging a legal bull cause some complaints, the local community is generally supportive of the spike-fork/50-inch/3 brow tine hunt. The program we present each year prior to the hunt seems to be paying off as only 2 illegal bulls were killed in 1998.

The effect of predation upon moose calf survival in this area is unknown. An apparently healthy brown bear population (as well as a less prominent black bear population) probably accounts for substantial summer mortality, based on anecdotal accounts. Winter wolf predation does not appear to be a serious problem except when moose movements are restricted by extremely deep snow. Anecdotal information gathered from trappers and others is probably our best source of information regarding winter severity and winter predation. The low calf to cow ratios we observed during aerial surveys indicates there are some factors affecting recruitment that we are unable to document.

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 on a pilot basis.

Recent surveys suggest that moose numbers in Unit 1D are no longer declining, and that the present hunting scheme is working to support a population concomitant with habitat capabilities. Predation, deep snows, and mediocre habitat point to the need for regular surveys to better understand the status and trend of the population.

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Table 1 Unit 1D moose aerial survey data, 1982–1998

Regulatory year	Total males	Total females	Total calves	Unk	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
1995					No survey					
1996	48	121	31	7	207	3.8	40	26	16	54
1997	10	37	36	115	198	4.1	---	---	18	48
1998	20	23	25	103	171	5.2	---	---	15	39

[1]Late winter survey, sex and age ratios are 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 are 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 2.9 hours.

Table 2 Unit 1D age structure of harvested moose, 1983–1998

Year	Age class																Total kill	% aged	Mean age
	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			
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
1991–1992	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
1995	0	0	1	5	4	3	5	3	3	1	2	0	0	0	0	0	27	100	5.6
1996	0	5	2	3	2	4	2	2	1	1	0	0	0	0	0	0	27	78	4.0
1997	0	2	0	3	6	1	1	1	0	1	0	0	0	0	0	0	15	88	4.1
1998	0	4	2	0	7	2	0	1	0	1	2	0	0	0	0	0	19	100	4.3

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

Table 3 Unit 1D moose hunter effort and success, 1983–1998

		Successful hunters			Unsuccessful hunters			Total hunters		
	Permits	Nr	Total	Avg nr		Total	Avg nr		Total	Avg nr
Year	issued	hunters	days	days	Hunters	days	days	hunters	days	days
1983	---	62			292			354		
1984	---	35	149	4.3	314	1540	4.9	349	1,689	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
1991–1992					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
1995	200	27	58	2.1	130	401	3.1	157	459	3.0
1996	181	24	70	3.3	121	735	6.1	145	805	5.7
1997	200	17	50	3.8	130	891	6.9	145	941	6.6
1998	200	19	79	4.4	146	976	6.8	164	1,055	6.5

Table 4 Unit 1D annual moose kill by community of residence, 1984–1998

Regulatory year	Total kill	Haines	Skagway	Juneau	Sitka	Other Alaska	Non-resident
1984	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[1]	18	18	0	0	0	0	0
1990	19	19	0	0	0	0	0
1991–1992				Season closed			
1993	24	22	0	2	0	0	0
1994	17	17	0	0	0	0	0
1995	[2]27	26	0	1	0	0	0
1996	[3]27	23	0	0	0	1	0
1997	17	16	0	1	0	0	0
1998	19	18	0	1	0	0	0

[1]Includes 3 illegally harvested bulls.
[2]Includes 1 illegally harvested bull, 1 unrecovered bull, and 2 illegally harvested cows.
[3]Data are only available for 51 of the 54 moose listed for 1995/96.

Table 5 Unit 1D historical moose harvests, number of hunters, and percent success, 1980–1998

Regulatory year	Nr males	Nr females	Nr unknown	Total kill	Nr hunters	Percent 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
1991–1992			Season closed			
1993	24	0	0	24	107	22
1994	17	0	0	17	147	12
1995	27[1]	0	0	27	157	17
1996	25	2	0	27	145	17
1997	17	0	0	17	145	12
1998	19	19	0	19	164	12

[1]Includes 2 illegal bulls, one unrecovered bull, and 2 cows, these show up in the total kill of 27.

Table 6 Unit 1D transport methods used by successful moose hunters, 1987–98

	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	2	(11)	10	(55)	2	(11)	4	(22)	1	(1)
1990	0	---	10	(58)	0	---	7	(37)	2	(8)
1991–1992					Season closed					
1993	0	---	13	(54)	0	---	10	(45)	1	(4)
1994	0	---	13	(81)	0	---	3	(19)	0	---
1995	0	---	5	(22)	0	---	15	(65)	3	(13)
1996	3	(13)	10	(42)	0	---	10	(42)	1	(4)
1997	0	---	10	(71)	0	---	4	(29)	0	---
1998	1	(6)	11	(65)	2	(8)	3	---	0	---

Table 7 Unit 1D commercial services used by moose hunters, 1993–98

	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
1995	97	0	3	0	100	0	0
1996	82	1	5	0	87	1	0
1997	76	2	3	0	79	2	0
1998	133	1	6	0	139	1	0

LOCATION

GAME MANAGEMENT UNIT: Unit 3 (3000 mi^2)

GEOGRAPHIC DESCRIPTION: Islands of the Petersburg, Kake, and Wrangell area

BACKGROUND

Isolated populations of moose (*Alces alces*) inhabit Unit 3 and are believed to be the *andersonii* subspecies. They emigrated from interior British Columbia by the Coast Range and the Stikine River Valley around the turn of the 20^{th} century.

Moose inhabit the major islands of Unit 3. Increased sightings of moose during the 1980s and 1990s indicate 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 in 1968 and reopened on Wrangell Island in 1990; Mitkof Island was opened in 1991. All of Unit 3 was opened in 1993.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

During the formulation of the Region I moose plan in the late 1980s, we were unaware that by the mid-1990s a moose population would be established and support an annual harvest. Moose numbers are presently high enough to support a hunting season in Unit 3, and we intend to continue the hunt as long as it does not affect the integrity of the population. Unit 3 moose harvest is often opportunistic, and habitat management and road construction will undoubtedly affect moose numbers and access. We cannot estimate how long Unit 3 habitat will support a viable moose population. The issue of rebuilding Sitka black-tailed deer populations on the Unit 3 islands compounds the complexity of establishing moose management goals. We have established the following draft goals for Unit 3 moose, which include a crude estimate of the population size, limited knowledge of habitat and moose movements, and anecdotal information from people in the field.

Unit 3

	Plan Objective	1997	1998
Posthunt numbers	400	N/A	N/A
Annual hunter kill	40	22	42

	Plan Objective	1997	1998
Number of hunters	470	372	466
Hunter-days of effort	2300	2071	2395
Hunter success	10%	6%	9%

METHODS

Public moose management meetings were attended in Wrangell and Petersburg. Hunters in Unit 3 were asked to report on their registration permit reports 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

No population data are available for Unit 3 this reporting period. During the past 5 years, data have been insufficient for us to accurately estimate population size. We believe moose numbers in Unit 3 are at low to moderate density and are increasing.

Population Composition

No surveys were conducted in Unit 3.

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 move in both directions. Moose appear to be well distributed on Mitkof, Wrangell, and Kupreanof islands. Moose are becoming established on Etolin, Zarembo, and Kuiu Islands.

MORTALITY

Harvest

Season and Bag Limit	Nonresident and resident hunters
Unit 3	Sep 15–Oct 15
1 bull with spike fork-50"/3-brow-tine antlers, by registration permit only.	

Board of Game Actions and Emergency Orders. Action by the Board of Game effective July 1, 1995 put all of Units 1B and 3 and that portion of Unit 1C south of Point Hobart under one registration permit hunt (RM038). A legal moose for this registration permit hunt is a bull with a spike/fork or 50-inch antlers or 3 brow tines on at least one side. During the current report period no emergency orders were issued.

Hunter Harvest. In 1997 the Unit 3 moose kill was 22 by 372 hunters (Table 1). The 1998 harvest of 42 moose by 466 permittees was the highest harvest ever recorded.

Harvest Chronology. Moose harvest chronology for Unit 3 has varied. In general, most bulls are killed in the first half of the season and the harvest rate declines throughout the season

(Table 2). Most hunters are in the field early in the season, then effort drops except on weekends. Inclement weather does not seem to slow hunting effort early in the season.

Transport Methods. Hunters in Unit 3 relied on highway vehicles and the extensive road system to reach the field (Table 3).

Hunter Residency and Success. Almost all Unit 3 moose hunters are local residents from Kake, Wrangell, and Petersburg (Table 4). The hunter success rate was 6% in 1997 and 9% in 1998.

Other Mortality

Predation by wolves on adult and calf moose has been reported in Unit 3. Substantial predation of moose calves by black bears has been documented in other areas and probably occurs in Unit 3.

CONCLUSIONS AND RECOMMENDATIONS

In the 1997 Unit 3 moose hunt, the management objectives were not met for harvest, hunter numbers, days afield, and success rate. In 1998 all the objectives were met or were close to being met. The Unit 3 moose population is increasing. We recommend that Units 1B and 3 remain unified under 1 registration permit with season dates from September 15–October 15 and a bag limit of 1 bull with spike/fork or 50" antlers or with at least 3 brow tines on 1 antler.

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Table 1 Unit 3 moose harvest, 1990–98

Regulatory year	Hunter harvest reported							
	M	(%)	F	(%)	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
1995/96	13	(100)	0	(0)	0	13	0	13
1996/97	21	(100)	0	(0)	0	21	3	24
1997/98	22	(100)	0	(0)	0	20	2	22
1998/99	40	(40)	0	(0)	0	40	2	42

[a] Wrangell Island only.
[b] Wrangell and Mitkof islands.

Table 2 Unit 3 moose harvest chronology, 1993–98

Regulatory year	15–21 Sep	22–28 Sep	29 Sept.–5 Oct	6–15 Oct	Total
1993/94	0	0	7	6	13
1994/95	0	0	15	4	19
1995/96	4	1	5	3	13
1996/97	9	6	4	5	24
1997/98	4	7	5	6	22
1998/99	14	13	7	8	42

Table 3 Unit 3 successful moose hunter transport methods, 1993–98

Regulatory year	Airplane	Boat	Highway vehicle	3/4 wheeler	Horse	Unknown	Total
1993/94	1	0	12	0	0	0	13
1994/95	0	3	16	0	0	0	19
1995/96	1	1	11	0	0	0	13
1996/97	1	5	17	1	0	0	24
1997/98	0	8	13	1	0	0	22
1998/99	0	9	32	0	0	1	42

Table 4 Unit 3 moose hunter residency and success, 1993–98

	Successful					Unsuccessful					
Regulatory year	Local[a] resident	Nonlocal resident	Non-resident	Total	(%)	Local[a] resident	Nonlocal resident	Non-resident	Total	(%)	Total hunters
1993/94	12	1	0	13	(4)	305	15	3	323	(96)	336
1994/95	18	1	0	19	(5)	351	23	0	374	(95)	393
1995/96	13	0	0	13	(4)	306	18	0	324	(96)	337
1996/97	23	1	0	24	(7)	319	10	1	330	(93)	354
1997/98	22	0	0	22	(6)	329	21	0	350	(94)	372
1998/99	40	2	0	42	(9)	399	24	1	424	(91)	466

[a] Residents of Kake, Petersburg, and Wrangell.

LOCATION

GAME MANAGEMENT UNIT: 5 (5800 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 Game Management 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. It is believed that the glaciers and waters of Icy Bay curtailed westward movement of this moose population.

The moose population in Unit 5 grew rapidly and peaked in the early 1960s, with population estimates exceeding 2000 animals. The population began declining toward a more realistic carrying capacity in the mid-1960s. Poor reproductive success and severe winters in 1970 and 1972 depressed moose numbers enough that Unit 5A hunting seasons were closed from 1974–1977. Since 1978 Unit 5 moose hunting has been managed under a registration permit system. In 1991 a federal subsistence season was instituted, and ran concurrently with the state season until 1996. This federal season restricted hunting on federal public lands to local resident hunters only during the first week of the season. In 1996 the Federal Subsistence Board lengthened the subsistence season by one week, starting it a week earlier than the state season. Although the concurrent seasons had been managed under the state's registration permit system, the new "early hunt" is conducted under a separate federal registration permit issued by the U.S. Forest Service and the National Park Service. Regardless of whether a moose is harvested under the state or federal registration permit system, it must be reported to ADF&G within 3 days of the kill. The federal government also began authorizing Yakutat residents to kill moose (either sex) for ceremonial purposes in a separate permit program in 1995.

The federal subsistence season is managed under a federal registration permit issued by the US Forest Service and the National Park Service in Yakutat. Hunters are required to turn in their hunt reports to the US Fish and Wildlife Service in Anchorage and there is often a delay of many months before we see the data. The USFWS does not pursue hunters who do not report, so there is some hunting effort that is not accounted for. The data presented in the following text and tables contains complete state registration permit hunt information, but only partial federal hunt information.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

The following objectives based on existing biological data have been identified by staff 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 with estimates of current population and use levels (these estimates include data from both state and federal hunts).

	Current report period means (1997–1998)	Plan Objective
Unit 5A Yakutat Forelands		
Post-hunt moose numbers	800	1,000
Annual hunter kill	58	70
Number of hunters	195	250
Hunter–days of effort	541	1,025
Hunter success	28%	28%
Unit 5A Nunatak Bench		
Post-hunt moose numbers	50	50
Annual hunter kill	1.5	5
Number of hunters	2.5	10
Hunter–days of effort	5	60
Hunter success	60%	50%
Unit 5B Malaspina Forelands		
Post-hunt moose numbers	Unknown	250
Annual hunter kill	11.5	25
Number of hunters	26.5	50
Hunter–days of effort	106	200
Hunter success	44%	50%

METHODS

Aerial surveys of Units 5A and Unit 5B were conducted in late January 1999. Ages of harvested moose were determined from incisors submitted by hunters under terms of the registration permit. Other data collected included the number of days hunted, hunter residency, kill date and location, and transport type. Information from Federal permits was collected for successful hunters, but was not available for many of the unsuccessful hunters.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Since the hunting closures in the mid-70s, the Yakutat Forelands moose population slowly increased to near habitat carrying capacity. The Nunatak Bench moose herd reestablished itself following the retreat of the Hubbard Glacier and the subsidence of the waters of Russell Fiord in 1986. Based on 1994 surveys, the Board of Game reopened moose hunting in this area beginning with the 1995 season. The Unit 5B moose population appears healthy at moderate densities.

Population Size

Aerial surveys were conducted in Unit 5A and 5B in January and early February of 1999. We assume that because moose use forested areas in the Yakutat area, especially east of the Dangerous River, the animals enumerated in surveys comprise roughly 50% of the moose present. Given the wide range of survey effort from year to year for these populations, perhaps the best gauge of moose numbers is the number of moose observed/hour of survey time (Table 1).

In January of 1999, 374 moose were counted on the Yakutat Forelands (Table 1). Survey time was comparable to that expended during the previous 5 years, while the sighting rate was the highest since 1990. Because this was a January survey, composition data are unreliable due to antler loss. Based on this survey, the Yakutat Forelands population is estimated to be 600–800 animals.

Thirty-three moose were counted at Nunatak Bench, equal to the 1996 survey (Table 1). Prior to 1986, when the blockage of Russell Fiord by the Hubbard Glacier caused flooding of much of this herd's winter range, there were an estimated 50 animals in this area. Brushy vegetation has invaded the shoreline as saltwater levels have receded and moose have reoccupied Nunatak Bench. Based on this survey, we estimate there to be approximately 50 moose in the area.

Moose population dynamics in Unit 5B are not as well understood as those in Unit 5A. Only a portion of the subunit has been surveyed since 1982, and the most recent effort in January occurred after antler drop when accurate sex determination was not possible. Only thirty-eight moose were counted during this survey, substantially fewer animals than the 1995 survey of 109. It is assumed that this lower number is due more to factors affecting sightability than to a real decline in moose numbers. Although the population is estimated to be approximately 250 moose (Table 1), every effort needs to be made during the next regulatory year to acquire better population information through aerial surveys.

Population Composition

We were unable to attain composition data during this report period for any of the 3 moose populations in Unit 5 (Table 5). The January 1999 survey provided us with general population information for the Yakutat Forelands, but was not a reliable composition survey because it occurred after antler drop. Age at harvest of Yakutat Forelands moose has ranged from 2.2 years to 3.6 years since 1984 (Table 2). Mean age at harvest increased from 2.5 during the previous report period to a mean of 2.8 years during 1997–98. From 1994–1998, 34% of the bulls harvested were age 1.5 (Table 2). In contrast to the relatively consistent age of moose harvested in Unit 5A, the mean age of moose harvested from the Malaspina Forelands has been erratic and has ranged between 2.7 and 5.4 years since 1990. The limited access and resultant lower hunting pressure on the Malaspina Forelands probably allows bulls to reach an older age than those on the Yakutat Forelands (Table 2). In spite of this, the distribution of ages of harvested animals in Unit 5B does not appear to follow any pattern.

MORTALITY

Harvest

<u>Season and bag limits</u>	<u>Resident and nonresident hunters</u>
Unit 5A, except Nunatak Bench One moose by registration permit. Up to 60 bulls may	Oct 15–Nov 15

be taken; season will close west of Dangerous River when 30 bulls have been taken in that area.

Unit 5A, Nunatak Bench One moose by registration permit; up to 5 moose may be taken.	Oct 15–Nov 15
Unit 5B, Malaspina Forelands One bull by registration permit; up to 25 bulls may be taken.	Sep 1–Dec 15

Board of Game Actions and Emergency Orders. In 1997 that portion of Unit 5A west of the Dangerous River was closed by emergency order on October 21 in anticipation of the harvest target of 30 bulls being reached (the harvest eventually reached 33 bulls). The remaining portion of the Yakutat Forelands remained open until the scheduled November 15 closure. In 1998 the portion of Unit 5A west of the Dangerous River was closed on October 15 in anticipation of the harvest target of 30 bulls being achieved (the harvest reached 34 bulls). This was the shortest period ever needed to reach the harvest target on the west side of the Dangerous River. The portion of the subunit east of the Dangerous River remained open until the scheduled November 15 closure. This is the usual pattern of hunt management in Unit 5A, with the easier accessed habitat being closed early, and the difficult to access areas remaining open until the season ends.

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 57–77 moose being taken within all of Unit 5 each year since then. A total of 61 moose (59 bulls taken in state and federal registration hunts, and 1 cow and 1 moose of unknown sex harvested under federal ceremonial permits) were legally killed in Unit 5A in 1997. Fifty-five legal animals (52 bulls in state and federal hunts) and 2 bulls and 1 cow taken under state and federal ceremonial permits were taken in 1998 (Table 3).

Permit Hunts. During this 2-year period, state regulations provided for 3 registration permit hunts within Unit 5. The RM061 (Yakutat Forelands) and RM059 (Nunatak Bench) hunts are in Unit 5A, and RM062 (Malaspina Forelands) hunt is in Unit 5B. There is also a Federal registration hunt for Unit 5A. In 1995 the federal hunt ran concurrent with the state hunt, and prohibited hunting on federal public lands except by Yakutat residents from October 15 through October 21. In 1996 the federal hunt began on October 8, a week before the state hunt. This resulted in the nonlocal restriction covering a span of 2 weeks.

Although there is a block of 9 townships of non-federal land near Yakutat where nonlocals can legally hunt during the first week of the state season that begins on October 15, local residents have always harvested the majority of moose taken on the Yakutat Forelands before October 22.

Additionally they take the majority of moose taken west of the Dangerous River during the entire season (Table 4). The advent of the early federal hunt reinforced this tendency. The total number of permits (both state and federal) issued for the Yakutat Forelands reached 300 in 1997 and 303 in 1998, in part due to Yakutat residents obtaining both kinds of permits (Table 5). Combining state and federal registration permits, 59 bull moose were taken in 1997 and 52 were killed in 1998 in the RM061 hunt area. Forty-eight and 43 permits were issued for hunt RM062 in Unit 5B during 1997 and 1998 respectively (Table 5), both below the 1988–1996 mean of 56. Thirteen bulls were taken in Unit 5B in 1997, while the 1998 harvest was 10 bulls. Alaska Native corporation lands west of the Wrangell/St. Elias National Park boundary at Yana Stream were closed to hunters other than clients of a single guide, which effectively halved the area in Unit 5B where the general public can take moose.

The Nunatak Bench hunt remained open for moose hunting during the report period, but received very little effort due to the difficult access to the area. In 1997, 10 permits were issued, 2 people hunted, and 2 bulls were harvested. In 1998, 11 permits were issued, 3 people hunted and one cow was harvested. Staff from the Division of Fish and Wildlife Protection and both ADF&G fisheries divisions 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 report period. Reminder cards and certified letters were used to increase compliance with permit reporting requirements for the state permit hunts. In spite of these efforts, a few permittees were still cited for failing to report their hunts. The federal permit process complicates matters as some hunters pick up both a state and a federal permit, while other hunters get one or the other. In addition, the Federal hunt reporting requirements are not as stringent as ours, in that delinquent hunt reports are not pursued.

Hunter Residency and Success. Local residents hunt primarily in Unit 5A on the Yakutat Forelands (Table 4). Beginning with state regulations in 1987, local residents were able to hunt the first week of the season before it opened to nonlocal hunters. In 1991 new federal subsistence regulations allowed local residents exclusive hunting rights on federal lands for the first week of the concurrent state and federal seasons. Most recently the 1996 implementation of a federal season that precedes the state season by one week has further enhanced opportunity for local hunters. The first portion of the moose hunt traditionally accounts for a majority of the Unit 5A harvest, and since most easily accessible land is under federal management, harvest by Yakutat residents predominates. Local hunters took 73% of the bulls harvested in Unit 5A in 1997 and 64% in 1998. The majority of moose taken by local hunters were taken during the first week of the season. Later in the season, use by non-local hunters in areas further from Yakutat and accessible only by airplane increased. Nonlocal Alaskans hunting in Unit 5A took 15 moose (25% of bulls taken under registration permits) in 1997 and 14 (26%) in 1998. Nonresidents took one moose in Unit 5A during the 1997 season and 3 in 1998 (Table 4).

Since 1986 the overall success of hunters in Unit 5A has ranged from 19 to 32 percent (Table 3). During this report period, hunter success was 30% in 1997 and 27% in 1998. The average number of days expended by hunters on the Yakutat Forelands reached an all time high in 1993 (Table 5), but returned to historic levels during this report period. The Malaspina Forelands hunt (Unit 5B) is less dominated by local use, although it is an important alternative for Yakutat hunters who fail to take a moose during the Unit 5A hunt. Local residents took 4 of 13 moose

(31%) harvested in 1997 and 4 of 10 moose (40%) in 1998. Nonlocal state residents killed 2 moose in 1997 and 1 in 1998.

Harvest Chronology. The early state 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), and this area typically accounts for only a small portion of the total Unit 5 moose harvest. Most of the Unit 5 harvest takes place during the first weeks of the Unit 5A season, when areas adjacent to Yakutat and easily accessible by boat or highway vehicle are first open. In 1997 that portion of Unit 5A west of the Dangerous River opened on October 15 and was closed by emergency order on October 21 when the harvest target of 30 bulls was reached. That portion east of the Dangerous River remained open until the scheduled November 15 closure. The following year the opening date for the federal registration hunt was changed to October 8, followed by the state season on October 15; Unit 5A west of the Dangerous River was closed on October 15 when the harvest target was approached. The remainder of the hunt area remained open until the scheduled November 15 closure. The quota of 25 bulls for the Malaspina Forelands area (Unit 5B) has not been reached since 1981. While the season is longer than in Unit 5A, the area is more difficult to access. Three moose were harvested on Nunatak Bench during this report period, all during the month of February.

Transport Methods. Transport methods used during the report period differed from the previous report period (Table 6). Although aircraft continue to be the most popular single means of transportation among successful hunters (37%), the use of highway vehicles (29%) surpassed boats (22%) as the next most popular means. Three and 4-wheelers accounted for 14% of the transportation used and are probably underrepresented, as some hunts reported under other modes probably include the use of off-road vehicles. Many unsuccessful hunters also use these machines for access. Habitat impacts, wounding loss, animal harassment, and fair chase ethics are all concerns involved with the use of 3- and 4-wheelers. Virtually every fish camp has one or more of these machines present, and although these off-road vehicles have been used in Yakutat for many years, more hunters seem to be using them in a less incidental fashion and more 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.

Despite the importance of aircraft for hunter transportation, relatively few Yakutat resident hunters use them. Most local residents hunt with the aid of river boats, ATV's, or highway vehicles, while most nonresident hunters charter aircraft for access. The use of aircraft generally increases later in the season as non-local hunters begin hunting in non-roaded portions of the unit.

Commercial Services. Commercial services were used by 18% of Unit 5 moose hunters during the report period (Table 7). Nonlocal hunters were more likely to use commercial services, with transport to the field being used the most. Commercial services were used by a higher percentage of Unit 5B hunters than in Unit 5A. This undoubtedly reflects the fact that the Malaspina Forelands are much more difficult to access.

Other Mortality

One male, one female, and one moose of unidentified sex were harvested under federal ceremonial permits, and one male and one female were taken under state ceremonial permits during the report period. This represents a 50% decline in the federal ceremonial harvest from the previous report period, but an increase from zero to three in the state ceremonial harvest.

The winter of 1998/99 was very severe with deep snow persisting until late May on much of the forelands. Anecdotal information from a local pilot suggests that many moose succumbed to wolf and bear predation during late winter and spring.

HABITAT

ADF&G staff undertook no habitat assessment or enhancement procedures during the reporting period.

CONCLUSIONS AND RECOMMENDATIONS

Complete fall sex and age composition counts of all Unit 5 moose herds need to be conducted. Age data on harvested moose should continue to be collected and carefully scrutinized.

Most management goals for Unit 5 moose hunts were not met during this report period. For example, although management goals regarding hunter success were attained during 1997 for the Yakutat Forelands (RM061) as well as the Nunatak Bench hunt (RM059), they were not reached in 1998 for either hunt (Table 3). This trend continued for the hunter success on the Malaspina Forelands which was 45% and 42% in 1997 and 1998, respectively, both below the objective of 50% (Table 3). Hunter effort was below management objectives for all hunts, although for the Malaspina Forelands and the Nunatak Bench hunts, this is related primarily to difficult access.

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Table 1 Unit 5 aerial survey data, 1984–1998

Year	M	F	Calves	Unk	Total	Count time (hrs)	M Per 100 F	Calves per 100 F	Percent calves in herd	Moose per hour
					5A Yakutat Forelands					
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
1995	14	71	78	303	466	8.5	---	---	17	55
1996	10	68	8	---	86	1.9	15	12	9	45
1997						No survey				
1998						No survey				
1999	7	17	17	333	374	6.7	---	---	---	56
					5A Nunatak Bench					
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
1987–1993						No survey				
1994	3	18	---	---	25	0.3	16	22	16	75
1995	5	6	6	16	33	0.3	---	---	18	110
1996–1998						No survey				
1999	---	---	---	33	33	0.4	---	---	---	83
					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

Table 1 Continued

Year	M	F	Calves	Unk	Total	Count time (hrs)	M Per 100 F	Calves per 100 F	Percent calves in herd	Moose per hour
1984–1986	No surveys									
1987[5]	---	---	14	---	69	2.8	---	---	20	25
1988–1994	No surveys									
1995	4	10	11	84	109	1.75	---	---	10	62
1996–1998	No surveys									
1999	---	---	---	38	38	0.8	---	---	---	48

[1] Natl. Park Service survey using a PA-18 from 3/1 to 3/5, 1991, beginning at the mouth of the Doame River and surveying northwest to 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); total numbers include flights in PA-18 and C-185 (3.62 hrs. from 12/6 to 12/7, 1994

[4] Bancas Point to Sitkagi Bluffs only.

[5] Sex and age ratios unreliable.

Table 2 Unit 5 age structure of moose harvests, 1984–1998

							Age	Class								Total	%
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
								Yakutat Forelands										
1984	2	13	11	6	7	3	2	3	0	0	0	0	0	0	0	0	49	96
1985	1	15	10	10	2	1	3	1	0	1	1	1	0	0	0	0	46	100
1986	3	10	13	8	4	9	3	1	0	2	0	0	0	0	0	0	54	98
1987	1	14	7	3	7	2	1	0	1	0	0	0	0	0	0	0	38	95
1988	0	17	16	5	2	3	1	0	1	0	1	0	0	0	0	0	47	98
1989	0	10	16	7	5	4	0	1	0	0	0	0	0	0	0	0	45	96
1990	0	16	18	14	4	3	2	0	0	0	0	0	0	0	0	0	57	100
1991	0	20	18	7	4	1	0	1	1	0	0	0	0	0	0	0	52	100
1992	0	13	5	5	3	1	2	1	0	0	0	0	0	0	0	0	50	60
1993	0	12	7	14	3	2	1	2	1	0	0	0	0	0	0	0	50	84
1994	0	23	8	6	5	4	0	3	2	1	0	1	0	0	0	0	60	90
1995	0	20	12	4	2	3	1	0	1	0	0	0	0	0	0	0	45	96
1996	0	19	12	9	5	2	5	1	0	2	0	0	0	0	0	0	60	92
1997	1	22	18	8	4	3	1	0	2	0	1	0	0	1	0	0	61	97
1998	1	15	11	10	6	2	4	1	0	2	0	0	0	0	0	0	55	95
								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
1991	0	3	3	1	2	2	1	0	3	0	0	0	0	0	0	0	17	88
1992	0	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	7	86
1993	0	2	4	3	3	0	1	0	0	0	0	0	0	0	0	0	15	87
1994	0	0	0	1	3	1	1	0	1	0	0	0	0	0	0	0	7	100
1995	0	2	5	1	3	0	0	0	1	0	0	0	0	0	0	0	12	100
1996	0	1	2	1	2	3	1	0	0	2	1	1	0	0	0	0	16	88
1997	0	1	2	3	1	0	0	1	2	0	0	0	0	0	0	0	13	77
1998	0	1	3	3	2	0	0	0	0	0	0	0	0	0	0	0	10	90

Table 3 Unit 5 historical harvests, hunters, and success, 1984–1998

Year	Nr M	Nr F	Nr unk	Total kill	Nr hunters	Percent success
			5A Yakutat Forelands			
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[1a]	0	51	204	25
1994	60	1[1b]	0	61	208	29
1995	48[2]	2	0	50	185	24
1996	60	1	0	61	190	32
1997	59	1	1	61	194	30
1998	54	1	0	55	195	27
			5A Nunatak Bench			
1984	3	3	0	6	14	43
1985	2	0	0	2	3	67
1986–1994			Season closed			
1995–1996			No moose harvested			
1997	2	0	0	2	2	100
1998	0	1	0	1	3	33
			5B Malaspina Forelands			
1984	15	0	0	15	50	30
1985	13	0	0	13	62	21
1986	9	0	0	9	34	26
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
1995	12	0	0	12	28	43
1996	16	0	0	16	31	52
1997	13	0	0	13	29	45
1998	10	0	0	10	24	42

[1]a,b Illegal kills not included in the calculation of hunter success.

[2] Includes 3 bulls harvested under ceremonial permits; not included in hunter success ratios

Table 4 Unit 5 annual moose kill by community of residence, 1984–1998

Year	Total kill	Yakutat	Juneau	Ketchikan	Sitka	Pelican	Hoonah	Petersburg	Haines	Wrangell	Other Alaska	Non-resident
						5A Yakutat Forelands						
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
1995	50[2]	35	14	0	0	1	0	0	0	0	0	0
1996	60	45	7	0	1	0	0	0	0	0	3	4
1997	61	45	13	0	0	1	0	0	0	0	1	1
1998	55	38	10	0	0	0	0	0	0	0	4	3
						5A Nunatak Bench						
1980–96							(No Data)					
1997	2	2	0	0	0	0	0	0	0	0	0	0
1998	1	1	0	0	0	0	0	0	0	0	0	0
						5B Malaspina Forelands						
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
1995	12	4	3	0	1	0	0	0	0	0	0	4
1996	16	6	2	0	0	0	1	0	1	0	0	6
1997	13	4	1	0	0	0	0	0	0	0	1	7
1998	10	4	2	0	0	0	0	0	0	0	0	4

[1] Does not include the single known illegal kill.
[2] Includes 5 moose harvested under ceremonial permits, 3 bulls and 2 cows.
[3] Includes one kill by hunter of unknown residency.

Table 5 Unit 5 hunter effort and success, 1990–1998

Year	Permits issued	Successful hunters Nr hunters	Successful hunters Total days	Successful hunters Avg days	Unsuccessful hunters Nr hunters	Unsuccessful hunters Total days	Unsuccessful hunters Avg days	Total hunters Nr hunters	Total hunters Total days	Total hunters Avg days
5A Yakutat Forelands										
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
1995	245	45	99	2.3	140	471	3.4	185	570	3.1
1996	277	60	147	2.6	76	427	3.6	190	574	3.0
1997	300	59	154	2.8	110	453	4.1	194	607	3.1
1998	303	52	102	2.0	135	373	2.8	195	475	2.4
5A Nunatak Bench										
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									
1995	19	0	0	0	3	3	1.0	3	3	1.0
1996	9	0	0	0	3	4	1.3	3	4	1.3
1997	10	2	3	1.5	0	0	0	2	3	1.5
1998	11	1	2	2.0	2	5	2.5	3	7	2.3
5B Malaspina Forelands										
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
1995	56	12	46	3.8	15	57	3.8	27	103	3.8
1996	55	16	71	4.4	14	75	5.4	30	146	4.9
1997	48	13	44	3.4	16	62	4.8	29	106	4.1
1998	43	10	44	4.4	14	63	4.5	24	107	4.6

Table 6 Unit 5 transport methods used by successful hunters, 1990–1998

	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)
1995	15	(37)	11	(27)	9	(23)	1	(3)	4	(10)	0	---
1996	13	(22)	15	(26)	10	(17)	0	---	16	(28)	4	(7)
1997	17	(44)	6	(16)	4	(11)	0	---	11	(29)	0	---
1998	16	(29)	15	(28)	8	(15)	0	---	15	(28)	0	---
5A Nunatak Bench												
1995	0	---	0	---	0	---	0	---	0	---	0	---
1996	0	---	0	---	0	---	0	---	0	---	0	---
1997	0	---	2	(100)	0	---	0	---	0	---	0	---
1998	0	---	1	(100)	0	---	0	---	0	---	0	---
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	---
1995	8	(89)	0	---	0	---	1	(11)	0	---	0	---
1996	8	(58)	1	(7)	3	(21)	0	---	0	---	2	(14)
1997	3	(22)	4	(31)	4	(31)	1	(8)	0	---	1	(8)
1998	6	(60)	1	(10)	3	(30)	0	---	0	---	0	---

Table 7 Unit 5 commercial services used by hunters, 1992–1998

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
1995	111	9	21	26	3	3	135	38	36	1	0
1996	44	1	16	18	4	2	64	21	19	1	1
1997	67	5	21	13	4	7	92	24	22	1	2
1998	101	1	18	17	7	5	126	23	18	3	1
					5A Nunatak Bench						
1995	3	0	----	----	----	----	3	0	----	----	----
1996	3	0	----	----	----	----	3	0	----	----	----
1997	2	0	----	----	----	----	3	0	----	----	----
1998	3	0	----	----	----	----	3	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
1995	6	9	1	5	3	4	10	18	15	2	1
1996[2]	3	1	2	9	0	9	5	19	11	8	1
1997	1	3	0	1	0	5	1	9	3	5	0
1998	3	1	0	2	3	4	6	7	4	5	0

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

[2] Does not include effort data for federal permit hunts.

LOCATION

GAME MANAGEMENT UNIT: 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 translocations of calves from the Kenai Peninsula, Anchorage, and Matanuska-Susitna Valley (Burris & McKnight 1973). During 1949–1958, Cordova residents successfully raised 24 captive moose calves and released them on the western Copper River Delta in Unit 6C. This small population rapidly extended eastward, first into Unit 6B and then advancing by the late 1960s into the Bering River area in Unit 6A. Moose may also have reached Unit 6A through dispersal westward from the Malaspina Glacier forelands in Unit 5A. The introduced population reached a record high of approximately 1600 in 1988 (Griese 1990), then declined to about 1227 by 1994 as part of a planned reduction (Nowlin 1998). The only moose endemic to Unit 6 are small populations in the Lowe River drainage and Kings Bay in Unit 6D. These populations never grew and today include only about 40 animals.

Harvest of the introduced population began with 25 bulls in 1960. Hunters have taken a total of 3798 moose through 1998–99. In contrast, total harvest of the endemic moose population in Unit 6D during the same period was approximately 40 moose.

Population objectives were relatively conservative in the 1970s and early 1980s because of concern about mortality during severe winters. Objectives were established at 0.9–1.2 moose/mi^2 after a severe winter in 1971/72 and remained conservative under management plans written in 1976 (Rausch 1977). Nowlin (1995) revised objectives in 1994 using new information about carrying capacity of the winter ranges (MacCracken 1992) and refined estimates of population size.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

Our primary and secondary management goals in Unit 6A (East) are to take large moose and to provide for optimum harvest. Primary and secondary goals for the remainder of Unit 6 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 maintain a minimum bull:cow ratio of 15:100.

METHODS

We conducted modified (Gasaway et al. 1986) censuses to estimate moose population size and composition. Density stratifications for Units 6A and 6B were based upon prior knowledge of moose distribution from radio telemetry data (MacCracken 1992) and from a stratification flight in a Cessna 185 aircraft for Unit 6C. We used Piper Super Cub (PA-18) and Bellanca Scout aircraft for searches of sample units. Sex and age ratio estimates were 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 present (Nowlin 1998).

Areas censused included only important moose habitat. Viereck et al. (1986) described the habitat types present, and MacCracken (1992) identified types that were most important for moose. Important types were below 500 ft elevation in river valleys and deltas of the coastal plain and included open tall-willow (*Salix sp.*), closed tall alder-willow (*Alnus sinuata-Salix sp.*), low sweetgale-willow (*Myrica gale-Salix sp.*), woodland spruce (*Picea sitkensis*) and aquatic (wet forb-herbaceous) (Nowlin 1995).

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 a reminder letter if they failed to return their hunt report.

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

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

We conducted censuses in Units 6B (21 January 1999) and 6C (17 December 1998). No estimates of bull:cow ratios were obtained because many bulls had shed antlers when we conducted the censuses. We could not complete censuses in Units 6A (East) and 6A (West) because of inadequate snow conditions. For these units we estimated population size based upon previous censuses, productivity and survival, and anecdotal information. Lack of snow and high winds limit moose censuses almost annually in Unit 6.

Population Size

The posthunt moose population in Unit 6 during 1998/99 was approximately 1340 moose, including 300 in Unit 6A (East), 340 in 6A (West), 320 in 6B, 330 in 6C, and 40 in 6D. Censuses indicated that the moose population in Unit 6C increased from 259 to 334 between 1996/97 and 1998/99, probably as a result of high productivity and low winter mortality (Table 1). Moose in Unit 6B increased slightly despite continued low productivity. Until we can complete censuses in Unit 6A, we assume that those populations are also increasing given the conservative harvest and favorable hunter reports.

Population Composition

Censuses indicated that proportion of calves in Units 6B and 6C were 9% and 24%, respectively during this reporting period (Table 1). Low calf survival during 1996/97 in Unit 6B (6%) prompted cancellation of the moose hunts in Unit 6B and more conservative harvests in Units 6A (West) and 6A (East) during 1997–98. Over the past 10 years the proportion of calves in the population has declined in Unit 6B.

MORTALITY

Harvest

Season and Bag Limit. In Unit 6A (East), the bag limit for all hunters was 1 moose. The bull moose season during this reporting period was 1 September–31 October. Hunters were restricted to bulls with 50-inch antlers or antlers with 3 or more brow tines on at least 1 side, a regulation first implemented in 1996/97.

In Unit 6A (West), the season for all hunters was 1 September–31 October, with a bag limit of 1 moose. Residents were allowed to take up to 20 bulls by registration permit, and nonresidents were allowed to take up to 5 bulls by drawing permit. We established an annual allowable harvest for bulls that included both hunts. When that harvest limit was reached, both hunts were closed by emergency order.

The season in Unit 6B was open during 27 August–31 October, 1998/99 for resident hunters only with a bag limit of 1 moose. We authorized a harvest of 20 bull moose by registration permit. No motorized vehicles were allowed for transportation from 15 August–31 August, with the exception of highway vehicles on the maintained surface of the Copper River Highway. Also, moose could not be taken until after 3:00 a.m. following the day on which an airboat was used for transportation. All airboats were required to display an ADF&G identification number. Airboat restrictions were in effect only while the registration permit hunt for bulls was open. Unit 6B was closed to moose hunting during 1997/98.

In Unit 6C the season was open for resident hunters only and was 1 September–31 October, with a bag limit of 1 moose by drawing permit. Up to 25 drawing permits were authorized, 20 for bulls and 5 for antlerless moose. The season in Unit 6D for all hunters was 1–30 September, and the bag limit was 1 bull by harvest ticket.

Board of Game Actions and Emergency Orders. We issued emergency orders to close the registration permit hunts for bull moose in Units 6A (West) (9 September 1997 and 06 September 1998) and 6B (6 September 1998). The purpose was to limit harvest to $\leq$30 bulls, as authorized in regulations for each hunt. These were normal management actions.

Hunter Harvest. Reported moose harvest for Unit 6 was 53 in 1997–98 and 81 in 1998–99 (Table 2). These were the lowest kills in over 20 years. Nowlin (1998) lowered harvests in Units 6A (West) and 6A (East) during the last reporting period to stabilize the populations after a planned reduction in numbers. Allowable harvest remained low in those units because of poor calf survival in adjacent Unit 6B and lack of censuses during 1997–98. We kept harvest low in Unit 6B because of continued poor calf survival, and in Unit 6C to allow a planned population increase (Nowlin 1998).

Mean antler size of moose killed in Unit 6A (East) was significantly larger (T-test, P=0.003) during the 3 years (n = 39) after implementation of the restriction to 50-inch antlers or 3 brow tines, compared to the previous 5 years (n = 227). The annual average number of bulls killed during the season in Unit 6A (East) dropped from 45 to 13 during the same periods.

Composition of the moose harvest in Unit 6 was 91% males and 9% females during 1997–98 and 93% males and 7% females during 1998–99.

Permit Hunts. During this reporting period, Unit 6A (West) had 1 registration and 1 drawing permit hunt, Unit 6B had 1 registration hunt, and Unit 6C had 2 drawing hunts (Table 3). Success was very high in drawing hunts (67–100%) and somewhat lower in registration hunts (17–58%). Lower success in registration hunts was due to unlimited hunter participation, and to closures by emergency order when the allowable harvest was reached.

Hunter Residency and Success. Local residents comprised 61% and 82%, respectively, of all hunters reporting residency in Unit 6 during 1997–98 and 1998–99 (Table 4). Alaska residents from other parts of the state were 18% and 10% of hunters, while nonresidents were 20% and 8%, respectively. More conservative seasons across the unit discouraged nonlocal hunters from participating.

Hunter success during 1997–98 and 1998–99 was 51% and 36%, respectively. Conservative seasons and airboat restrictions were responsible for this low rate.

Harvest Chronology. Most of the Unit 6 harvest over the past 2 years occurred during September (Table 5). During 1997–98, 88% of the moose were taken during this period, and 82% were harvested during this time in 1998–99. The harvest pattern has not changed over the past 5 years.

Transport Methods. Boats, primarily airboats, were the most commonly used transport method during this reporting period (Table 6). Airplanes and highway vehicles followed them in decreasing order of importance. This pattern of use has not changed over the past 5 years.

Other Mortality

Calf survival has been cyclical in Unit 6B since surveys began in 1965, but the long term trend has been down (Correlation coefficient = -0.62, P<0.05). In contrast, calf survival in Units 6A (West) (preliminary results, 1999 survey) and 6C (Table 1) were at a 5–7 year high. Weather and predation by brown bears and wolves were causes of calf mortality. Circumstantial evidence was found in Unit 6C that calf survival was correlated with adverse weather conditions during calving and brown bears were responsible for some neonatal mortality (MacCracken et al. 1997). Brown bears and radio-collared wolves were observed feeding on neonatal moose in various parts of the unit (Carnes et al. 1996). In addition, brown bear populations increased in Units 6A, 6B, and 6C (Crowley 2000).

Nowlin (1998) suggested that habitat was unlikely a major factor in lower calf survival because of good female body condition found in Unit 6C and the deliberate reduction of herd size in Unit 6A. However, we have no data on body condition or habitat suitability for Unit 6B. Anecdotal information suggests that a large area of moose habitat in Unit 6B has succeeded into woodland spruce and cottonwood, which MacCracken (1992) found was least used for calving in Unit 6C. In addition, advancing alder and spruce along slough banks provide a network of travel corridors for predators.

The Copper River/Prince William Sound Fish and Game Advisory Committee believed that brown bear predation was an important cause of calf mortality and that reducing the brown bear population would increase recruitment. They proposed increasing the harvest of brown bears by changing the bag limit for resident hunters from 1 bear every 4 regulatory years to 1 bear every year. The Department opposed the proposal (Nowlin 1998). The Board of Game passed the proposal for Units 6A (East), 6A (West), 6B, and 6C. The new regulation took effect in 1997–98.

CONCLUSIONS AND RECOMMENDATIONS

Population goals were achieved in all units except for Unit 6C, in which population size progressed toward our objective of 400 moose by the year 2006. At the current growth rate this population will exceed 400 by 2001, requiring a proposal to increase allowable harvest during the next Board of Game cycle. We could not evaluate our objectives for bull:cow ratios because we completed no censuses before mid-December when a significant number of bulls have dropped their antlers.

An objective to harvest a minimum number of large antlered bulls was established for Unit 6A (East) and harvest was restricted to bulls with 50-inch antlers or 3 brow tines in 1996–97. Although size of antlers increased and bull harvest decreased, we do not yet have census data to determine population-level effects of the antler restriction, or to establish objectives for mean antler size and harvest level.

Because high calf mortality has persisted in Unit 6B, we are cooperating with the U.S. Forest Service on a feasibility study to determine sources of calf mortality. The tentative plan will be to radiocollar neonatal calves, monitor continuously by remote tracking station, and examine immediately if they are killed. Such monitoring will allow us to determine the importance of predation and to evaluate effects of individual predators on calf survival.

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Table 1 Unit 6 moose estimated population composition and size, 1992–98

Unit	Regulatory year	Bulls: 100 cows	Calves(%)	Adults	Population size	Population 90% C.I.	Total moose observed
6A (East)	1992–93	-	8	384	416	373–459	378
	1995–96	-	10	253	282	249–316	162
6A (West)	1992–93	23	12	259	295	255–334	273
	1995–96	-	14	271	316	272–361	221
6B	1992–93	19	17	271	328	268–387	203
	1994–95	22	10	266	296	244–347	182
	1996–97	-	6	289	308	249–367	167
	1998–99	-	9	266	320	243–396	286
6C	1992–93	26	25	225	299	263–335	204
	1994–95	27	14	242	281	205–358	236
	1996–97	-	17	214	259	232–287	216
	1998–99	-	25	221	334	293–375	293

Table 2 Unit 6 moose harvest and accidental death, 1994–98

		Hunter harvest									
	Regulatory	Reported					Estimated			Accidental	
Unit	year	M	(%)	F	(%)	Total[a]	Unreported	Illegal	Total	death	Total
6A (East)	1994–95	29	(76)	9	(24)	39	2	1	3	0	42
	1995–96	9	(38)	15	(63)	25	2	2	4	0	29
	1996–97	16	(100)	0	(0)	16	2	2	4	0	20
	1997–98	10	(100)	0	(0)	10	1	1	2	0	12
	1998–99	13	(100)	0	(0)	13	1	0	1	0	14
6A (West)	1994–95	25	(83)	5	(17)	30	0	2	2	0	32
	1995–96	23	(72)	9	(28)	32	0	2	2	0	34
	1996–97	24	(73)	9	(27)	33	0	2	2	0	35
	1997–98	18	(100)	0	(0)	18	0	2	2	0	20
	1998–99	19	(95)	1	(5)	20	0	2	2	0	22
6A TOTAL	1994–95	54	(79)	14	(21)	69	2	3	5	0	74
	1995–96	32	(57)	24	(43)	57	2	4	6	0	63
	1996–97	40	(82)	9	(18)	49	2	4	6	0	55
	1997–98	28	(100)	0	(0)	28	1	3	4	0	32
	1998–99	32	(97)	1	(3)	33	1	2	3	0	36
6B	1994–95	32	(73)	12	(27)	44	0	1	1	1	46
	1995–96	21	(70)	9	(30)	30	0	1	1	0	31
	1996/97	16	(73)	6	(27)	22	0	3	3	0	25
	1997–98	0	(0)	0	(0)	0	0	2	2	0	2
	1998–99	23	(100)	0	(0)	23	0	0	0	0	23

Table 2 Continued

		Hunter harvest									
	Regulatory	Reported					Estimated			Accidental	
Unit	year	M	(%)	F	(%)	Total[a]	Unreported	Illegal	Total	death	Total
6C	1994–95	20	(57)	15	(43)	35	0	2	2	2	39
	1995–96	17	(81)	4	(19)	21	1	1	2	1	24
	1996–97	18	(78)	5	(22)	23	1	1	2	0	25
	1997–98	18	(78)	5	(22)	23	1	0	1	0	24
	1998–99	19	(79)	5	(21)	24	0	0	0	0	24
6D	1994–95	1	(100)	0	(0)	1	0	0	0	0	1
	1995–96	2	(100)	0	(0)	2	0	1	1	0	3
	1996–97	1	(100)	0	(0)	1	0	0	0	0	1
	1997–98	2	(100)	0	(0)	2	0	1	1	0	3
	1998–99	0	(0)	0	(0)	0	0	1	1	0	1
Unit 6	1994–95	107	(72)	41	(28)	149	2	6	8	3	160
TOTAL	1995–96	72	(66)	37	(34)	110	3	7	10	1	121
	1996–97	75	(79)	20	(21)	95	3	8	11	0	106
	1997–98	48	(91)	5	(9)	53	2	6	8	0	61
	1998–99	75	(93)	6	(7)	81	1	3	4	0	85

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

Table 3 Unit 6 moose harvest data by permit hunt, 1994–98

Unit/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]	1994–95	Bull	86	43	49	51	25	(100)	0	(0)	25
	1995–95	Bull	67	55	37	63	19	(100)	0	(0)	19
	1996–97	Bull	73	40	55	45	20	(100)	0	(0)	20
	1997–98	Bull	46	37	52	48	14	(100)	0	(0)	14
	1998–99	Bull	64	52	39	58	20	(95)	1	(5)	21
6A/DM160[b]	1995–96	Bull	5	40	0	100	3	(100)	0	(0)	3
	1996–97	Bull	5	20	0	100	4	(100)	0	(0)	4
	1997–98	Bull	5	20	0	100	4	(100)	0	(0)	4
	1998–99	Bull	5	40	33	67	2	(100)	0	(0)	2
6A/DM162	1994–95	Antlerless	20	55	44	56	0	(0)	5	(100)	5
	1995–96	Antlerless	20	30	29	71	1	(10)	9	(90)	10
	1996–97	Antlerless	15	27	18	82	0	(0)	9	(100)	9
	1997–98	No hunt									
	1998–99	No hunt									
6B/RM164	1994–95	Bull	164	34	70	30	32	(100)	0	(0)	32
	1995–96	Bull	191	38	82	18	21	(100)	0	(0)	21
	1996–97	Bull	172	37	85	15	16	(100)	0	(0)	16
	1997–98	No hunt									
	1998–99	Bull	201	33	83	17	23	(100)	0	(0)	23

Table 3 Continued

Unit/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	1994–95	Antlerless	20	10	28	67	0	(0)	12	(100)	12
	1995–96	Antlerless	10	10	0	100	0	(0)	9	(100)	9
	1996–97	Antlerless	10	20	25	75	0	(0)	6	(100)	6
	1997–98	No hunt									
	1998–99	No hunt									
6C/DM167	1994–95	Bull	20	0	0	100	20	(100)	0	(0)	20
	1995–96	Bull	20	10	6	94	17	(100)	0	(0)	17
	1996–97	Bull	20	10	0	100	18	(100)	0	(0)	18
	1997–98	Bull	20	5	5	95	18	(100)	0	(0)	18
	1998–99	Bull	20	5	0	100	19	(100)	0	(0)	19
6C/DM168	1994–95	Antlerless	15	0	0	100	0	(0)	15	(100)	15
	1995–96	Antlerless	5	0	20	80	0	(0)	4	(100)	4
	1996–97	Antlerless	5	0	0	100	0	(0)	5	(100)	5
	1997–98	Antlerless	5	0	0	100	0	(0)	5	(100)	5
	1998–99	Antlerless	5	0	0	100	0	(0)	5	(100)	5

[a] R or RM prefix was a registration permit hunt.

[b] D or DM prefix was a drawing permit hunt.

Table 4 Unit 6 moose hunter residency and success, 1994–98

Unit	Regulatory year	Successful					Unsuccessful					Total hunter
		Local [a] resident	Nonlocal resident	Nonresident	Total	(%) [b]	Local resident	Nonlocal resident	Nonresident	Total	(%) [c]	
6A (East)	1994–95	9	7	21	39	(53)	12	12	11	35	(47)	74 s
	1995–96	16	2	7	25	(36)	12	12	20	44	(64)	69
	1996–97	1	0	15	16	(41)	5	6	12	23	(59)	39
	1997–98	2	1	7	10	(29)	6	4	14	24	(71)	34
	1998–99	2	0	11	13	(62)	5	0	3	8	(38)	21
6A (West)	1994–95	18	3	9	30	(52)	15	8	5	28	(48)	58
	1995–96	28	1	3	32	(67)	11	5	0	16	(33)	48
	1996–97	24	5	4	33	(57)	22	3	0	25	(43)	58
	1997–98	14	4	0	18	(55)	8	7	0	15	(45)	33
	1998–99	13	5	2	20	(61)	11	1	1	13	(39)	33
6A TOTAL	1994–95	27	10	30	69	(52)	27	20	16	63	(48)	132
	1995–96	44	3	10	57	(49)	23	17	20	60	(51)	117
	1996–97	25	5	19	49	(51)	27	9	12	48	(49)	97
	1997–98	16	5	7	28	(42)	14	11	14	39	(58)	67
	1998–99	15	5	13	33	(61)	16	1	4	21	(39)	54
6B	1994–95	41	3	- [c]	44	(35)	68	13	- [c]	81	(65)	125
	1995–96	27	3	- [c]	30	(23)	92	6	- [c]	98	(77)	128
	1996–97	17	5	- [c]	22	(19)	84	11	- [c]	95	(81)	117
	1997–98	0	0	- [c]	0	(0)	0	0	- [c]	0	(0)	0
	1998–99	20	3	- [c]	23	(17)	106	5	- [c]	111	(83)	134

Table 4 Continued

Unit	Regulatory year	Successful: Local resident[a]	Successful: Nonlocal resident	Successful: Nonresident	Successful: Total	(%)[b]	Unsuccessful: Local resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Total	(%)[c]	Total hunter
6C	1994–95	27	8	-[c]	35	(100)	0	0	-[c]	0	(0)	35
	1995–96	17	4	-[c]	21	(91)	0	2	-[c]	2	(9)	23
	1996–97	16	7	-[c]	23	(100)	0	0	-[c]	0	(0)	23
	1997–98	23	0	-[c]	23	(96)	1	0	-[c]	1	(4)	24
	1998–99	20	4	-[c]	24	(96)	1	0	-[c]	1	(4)	25
6D	1994–95	1	0	0	1	(4)	14	7	2	23	(96)	24
	1995–96	0	0	2	2	(13)	9	3	1	13	(87)	15
	1996–97	1	0	0	1	(8)	4	6	2	12	(92)	13
	1997–98	2	0	0	2	(17)	7	3	0	10	(83)	12
	1998–99	0	0	0	0	(0)	3	5	0	8	(100)	8
Unit 6 TOTAL	1994–95	96	21	30	149	(47)	109	40	18	167	(53)	316
	1995–96	88	10	12	110	(39)	124	28	21	173	(61)	283
	1996–97	59	17	19	95	(38)	115	26	14	155	(62)	250
	1997–98	41	5	7	53	(51)	22	14	14	50	(49)	103
	1998–99	55	12	13	80	(36)	126	11	4	141	(64)	221

[a] Resident of Unit 6.

[b] Totals may include harvest by hunters of unknown residency and may include harvest from unknown units.

[c] Nonresidents ineligible to receive permits.

Table 5 Unit 6 moose harvest percent by time period, 1994–98

Unit	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*
6A (East)	1994–95	0	8	26	18	15	26	8	39
	1995–96	0	12	4	8	8	44	24	25
	1996–97	0	25	31	31	13	0	0	16
	1997–98	0	30	40	10	20	0	0	10
	1998–99	0	38	38	15	8	0	0	13
6A (West)	1994–95	0	93	3	3	0	0	0	30
	1995–96	0	97	0	3	0	0	0	32
	1996–97	0	76	18	3	3	0	0	33
	1997–98	0	100	0	0	0	0	0	18
	1998–99	0	100	0	0	0	0	0	20
6A TOTAL	1994–95	0	45	16	12	9	14	4	69
	1995–96	0	60	2	5	4	19	11	57
	1996–97	0	59	22	12	6	0	0	49
	1997–98	0	75	14	4	7	0	0	28
	1998–99	0	76	15	6	3	0	0	33

Table 5 Continued

Unit	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	1994–95	11	68	20	0	0	0	0	44
	1995–96	7	30	40	13	10	0	0	30
	1996–97	9	68	18	5	0	0	0	22
	1997–98	-	-	-	-	-	-	-	0
	1998–99	13	87	0	0	0	0	0	23
6C	1994–95	0	46	54	0	0	0	0	35
	1995–96	0	43	24	24	10	0	0	21
	1996–97	0	65	13	9	13	0	0	23
	1997–98	0	43	43	9	4	0	0	23
	1998–99	0	58	4	29	8	0	0	24
6D	1994–95	0	100	0	0	0	0	0	1
	1995–96	0	0	0	0	0	0	0	0
	1996–97	0	100	0	0	0	0	0	1
	1997–98	0	0	0	0	0	0	0	0
	1998–99	0	0	0	0	0	0	0	0
Unit 6 TOTAL	1994–95	3	52	26	5	4	7	2	149
	1995–96	2	48	17	11	6	10	6	108
	1996–97	2	63	19	9	6	0	0	95
	1997–98	0	58	30	6	6	0	0	53
	1998–99	4	74	8	11	4	0	0	80

Table 6 Unit 6 moose harvest percent by transport method, 1994–98

Unit	Regulatory year	Airplane	Boat	3- or 4-wheeler	ORV	Highway Vehicle	*n*
6A (East)	1994–95	74	11	6	3	6	70
	1995–96	54	29	8	8	0	24
	1996–97	88	0	6	0	6	16
	1997–98	80	20	0	0	0	10
	1998–99	77	8	15	0	0	13
6A (West)	1994–95	40	60	0	0	0	30
	1995–96	19	81	0	0	0	32
	1996–97	30	70	0	0	0	33
	1997–98	39	55	0	0	0	18
	1998–99	25	75	0	0	0	20
6A TOTAL	1994–95	64	26	4	2	4	100
	1995–96	34	59	4	4	0	56
	1996–97	49	47	2	0	2	49
	1997–98	54	33	0	0	0	28
	1998–99	45	48	6	0	0	33

Table 6 Continued

Unit	Regulatory year	Airplane	Boat	3- or 4-wheeler	ORV	Highway Vehicle	*n*
6B	1994–95	7	79	0	2	12	42
	1995–96	30	57	0	0	13	30
	1996–97	27	73	0	0	0	22
	1997–98	0	0	0	0	0	0
	1998–99	22	56	0	0	13	23
6C	1994–95	0	32	0	3	65	34
	1995–96	0	20	0	5	75	20
	1996–97	0	43	0	0	57	23
	1997–98	0	35	0	0	65	23
	1998–99	0	37	4	4	54	24
6D	1994–95	100	0	0	0	0	1
	1995–96	0	0	0	0	100	2
	1996–97	0	0	0	0	100	1
	1997–98	0	0	0	0	100	2
	1998–99	0	0	0	0	0	0
Unit 6 TOTAL	1994–95	38	40	2	2	18	177
	1995–96	26	50	2	3	19	108
	1996–97	32	52	1	0	16	95
	1997–98	28	20	0	0	32	53
	1998–99	25	38	4	1	20	80

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 as predator densities stabilized and habitat succession progressed into less desirable climax stages.

Since 1980, spruce bark beetles (*Dendroctonus rufipennis*) have established in many old-growth spruce stands in Unit 7. Nearly half a million acres of land on the Kenai Peninsula were infected with spruce bark beetles in 1995 (Peterson 1996) and over 2 million acres by 1999. Salvage logging (harvest of dead and infested stands of trees) is ongoing throughout the Kenai (Steve Albert ADF&G personal communication). Reduction of old-growth forests may be beneficial to the moose population by enhancing nutritional quality and availability of winter food plants.

In 1997 a task force was established to evaluate the biological and sociological effects of selective harvest management in south central Alaska. Members of the task force included agency representatives from ADF&G and Fish and Wildlife Protection and representatives from the local Fish and Game Advisory Committees to bring in the public perspectives. Hundertmark and others (in press) and Fulton (in press) reported results of this task force.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVE

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

METHODS

All harvest data is collected and reported through the statewide harvest reporting system. Information is collected from hunters on area hunted, transportation used, amount of time spent afield and if successful size of the moose harvested.

Standard late fall composition surveys are completed is standard count areas. We completed aerial sex and age composition surveys in late November under favorable snow conditions. Because most of Unit 7 is mountainous, we surveyed moose by flying elevational contours. All information was entered in the Wildlife Information Data Base (WIDB) software.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Terrain features and extensive mature spruce forest prevent application of the moose census technique described by Gasaway et al. (1986). Standard sex and age aerial surveys combined with harvest reports indicate that the moose population has remained relatively stable since the mid-1980s. The 1997–98 winter was mild and calf survival was considered good. The 1998–99 winter was considered severe in most of the region with deep and persistent snow. Documented winter mortality was predominantly calves of the year however we suspect that some adult were also lost. Winter severity was reflected by the lower than average hunter harvest in 1999. We believe the moose population remained stable at approximately 1000 animals through 1998 but declined in 1999. No new population estimate has been attempted.

Population Composition

No surveys were completed in 1997 because of poor weather and lack of snow cover. Three of 32 count areas, excluding Portage and Placer River drainages, were surveyed during 1998 fall sex and age composition surveys. We surveyed 246 moose with ratios of 12 calves:100 cows and 43 bulls:100 cows (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 Twentymile River drainage. The bag limit was 1 moose by drawing permit only with up to 60 permits for antlered moose and up to 70 permits for antlerless moose. The remainder of Unit 7 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. During the spring 1999 meeting the BOG authorized a special permit hunt in the Kenai Mountains west of the resurrection creek trail for up to 25 permits.

Hunter Harvest. In 1997, 362 hunters reported hunting in Unit 7 during the 20 August–20 September season and harvested 69 bull moose (Tables 2 and 3). Twenty-four (35%) hunters reported taking spike/fork bulls (less than 35") compared with 44 (64%) hunters who harvested large bulls (greater than 39") defined as a 50-inch antler spread or having 3 brow tines on at least 1 antler. One additional moose was reported but not classified.

In 1998, 389 hunters reported hunting in Unit 7 during the 20 August–20 September season and harvested 46 bull moose. Eighteen (39%) hunters reported taking spike/fork bulls compared to 21 (45%) hunters whom harvested large bulls. Seven additional moose were reported but not classified.

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. Successful hunters averaged 4.2 and 6.7 days hunting in 1997 and 1998, respectively. Severe weather, rain with strong winds, may have accounted for the increase in successful hunter effort. Hunter success in 1997 was 19.0%. Twenty-four (35%) successful hunters were unit residents, 41 (59%) were nonunit residents, and 4 (6%) were nonresidents (Table 3). Residency reported for unsuccessful hunters was as follows: unit residents 144 (49%), nonunit residents 140 (48%), and nonresidents 9 (3%).

Hunter success in 1998 was 12%. Twenty-three (50%) successful hunters were unit residents, 20 (43%) were nonunit residents, and 3 (6%) were nonresidents (Table 3). Reported residency for unsuccessful hunters was as follows: unit residents 147 (43%), nonunit residents 182 (53%), and nonresidents 14 (4%).

Harvest Chronology. Beginning in 1993 the general open season for Unit 7 was 20 August–20 September (32 days). Harvest chronology indicates the highest percentage occurred during the first 5 and last 5 days of the season (Table 4). In 1998, however. more moose were taken during the period 11–15 September than at the end of the season. A few more moose were typically taken near the end of the season when moose were probably moving to alpine and subalpine rutting areas.

Transport Methods. In 1997, 49% of successful hunters reported highway vehicles as their means of transportation (Table 5). Horses were the second most common transportation means (17%) for successful hunters. Hunters using boats, aircraft and ATV's accounted for 13%, 9%, and 3%, respectively, of the reported harvest.

In 1998, 50% of successful hunters reported highway vehicles as their means of transportation (Table 5). The second most common transportation means for successful hunters was by horseback (20%). Hunters using boats, aircraft, and ATVs, accounted for 11%, 7%, and 4%, respectively, of the reported harvest. There was a slight decrease in the use of ATVs for moose hunting over previous years.

Other Mortality

In addition to reported harvest in Unit 7, 46 moose were killed, 18 by trains and 28 by motor vehicles during the 1997–98 winter. There were 7 reported train kills for the 1998–99 winter. At least 46 moose were killed in Unit 7 by motor vehicles during this same winter (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 less than 10% of the reported harvest.

Effects of predation by wolves and bears are 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.

HABITAT

Assessment

Reduction of some old-growth forest in response to spruce bark beetle infestations through logging and prescribed burning by the U.S. 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* sp.) will compete with both spruce and hardwood seedlings and habitat quality will decline.

CONCLUSIONS AND RECOMMENDATIONS

Winter conditions in Unit 7 during 1998–99 were moderately severe, and many calves were lost throughout the region, lowering harvest rates in 1999. The previous winter was mild with fair calf survival. Human-caused moose mortality, including road or train kills and harvest, represented approximately 10% of the estimated moose population of 900–1000.

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 bulls to cow ratios have been higher than the recommended minimum objective 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 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, We recommend no changes in regulations. If bull to cow ratios continue above objective levels, specific drainages may be designated for late season permit hunts. Additional funding for more intensive survey efforts would be necessary. 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, 1992–1999

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	moose observed	Moose /hour	population size
1992–93	34	7	18	12	218	248	24	1000
1993–94[a]	--	--	--	--	--	--	--	--
1994–95	34	18	31	19	367	453	40	1000
1995–96[a]	--	--	--	--	--	--	--	--
1996–97	41	4	13	9	181	198	23	1000
1997–98[a]	--	--	--	--	--	--	--	--
1998–99	43	8	12	8	227	246	36	900

[a] No surveys completed.

Table 2 Unit 7 moose harvest[a] and accidental death, 1992–99

Regulatory	Reported				Estimated			Accidental death			Grand
year	M	F	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	Total
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
1995–96	42	0	0	42			20	18	4	22	84
1996–97	61	0	0	61			20	27	8	35	116
1997–98	69	0	0	69			20	28	18	46	115
1998–99	46	0	0	46			20	46	7	53	119

[a]Excludes permit hunt harvest.

Table 3 Unit 7 moose hunter[a] residency and success, 1992–99

Regulatory year	Successful				Unsuccessful				Total Hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total[c](%)	Local[b] resident	Nonlocal resident	Nonresident	Total[c](%)	
1992–93	24	26	4	54 (12)	166	205	6	379 (88)	433
1993–94	19	28	14	62 (15)	156	185	5	351 (85)	413
1994–95	22	27	4	56 (13)	141	203	13	369 (87)	425
1995–96	21	17	4	42 (13)	148	133	6	289 (87)	331
1996–97	24	29	8	61 (18)	157	130	8	295 (82)	340
1997–98	24	41	4	69 (19)	144	140	9	293 (81)	362
1998–99	23	20	3	46 (12)	147	182	14	343 (88)	389

[a] Excludes hunters in permit hunts.
[b] Local = residents of Unit 7.
[c] Total columns include hunters that did not specify residency

Table 4 Unit 7 moose harvest[a] chronology percent by time period, 1992–99

Regulatory year	Harvest periods							*n*
	8/20–25	8/26–8/31	9/1–9/5	9/6–9/10	9/11–9/15	9/16–9/20	Unknown	
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
1995–96[c]	26	14	7	5	10	33	5	42
1996–97[c]	20	10	15	15	11	25	3	61
1997–98[c]	23	6	12	6	19	32	3	69
1998–99[c]	28	2	11	13	28	13	4	46

[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, 1992–99

Regulatory year	Percent of harvest Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
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
1995–96	5	19	5	7	0	0	57	7	42
1996–97	7	21	7	5	0	3	56	2	61
1997–98	9	17	13	3	0	1	49	7	69
1998–99	7	20	11	4	0	4	50	4	46

[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. The scarcity of suitable habitat south of Port Moller limited expansion 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 evident, and nutritional stress probably caused poor calf survival. 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 Unit 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

POPULATION 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; 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, 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 15 years. Very low moose densities and unreliable snow conditions in Unit 9A, 9D, 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 during caribou surveys south of Port Moller showed a modest expansion of moose in that area.

In March 1999, the Board of Game found that moose in Units 9B, 9C, and 9E met the criteria to be considered "important for providing high levels of human consumptive use" under the intensive management legislation.

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. There were approximately 2000 moose in Unit 9B. Units 9A and 9D probably contained about 300 and 100 moose, respectively.

Population Composition

During this reporting period, survey efforts in Unit 9B have been minimal (Table 1). The Nakeen trend area, a small, somewhat isolated "pocket" of moose between Naknek and Levelock in southwestern 9B, was surveyed in 1997, 1998, and 1999. This area receives heavy local hunting pressure, and has the lowest bull:cow ratio ($\bar{x}$ = 17 bulls:100 cows during 1997–1999) of any trend area in Unit 9. The Big Mountain trend area on the southeast side of Lake Iliamna was surveyed in 1998 and 1999. This area, despite increasing hunting pressure, continues to have the highest bull:cow ratio ($\bar{x}$= 103:100) in Unit 9. An aircraft mishap cancelled efforts to survey trend areas in northern 9B in 1998.

The 3 trend areas in Unit 9C were surveyed every year since 1995 except 1998(Table 2). Total counts and bull:cow ratios were relatively stable during this period. As else where in Unit 9, calf:cow ratios in Unit 9C were extremely low in 1999. This may be due in part to the very late spring in 1999.

Survey efforts were expanded in Unit 9E during 1998 and 1999 (Table 3) in cooperation with the FWS and NPS. In addition to surveying most traditional trend areas in 1998, the Pacific drainages from Amber Bay to Chignik Bay were covered for the first time ever. The bull:cow ratios in all areas surveyed exceeded the management objective of at least 40:100, with an overall ratio of 65 bulls:100 cows. The ratio of 20 calves:100 cows in 1998 was among the highest observed in Unit 9E in the past 25 years; however this ratio was only 10:100 in the limited area surveyed in 1999, which included the first coverage of Pacific drainages from Wide Bay to Nakalilok Bay. In 1998 and 1999 37% of all bulls seen (n = 257) had antlers with ≥50" spread. Total sample sizes and ratios from these areas indicate the population is relatively stable and harvests are not reducing the number of bulls below management objectives.

MORTALITY

Harvest

Seasons and Bag Limit. As federal subsistence management becomes more entrenched, the number of regulation changes and divergence of state and federal regulations is increasing. In

Unit 9A resident and nonresident hunters could hunt from 1–15 September, and the bag limit was 1 bull. In Unit 9B nonresidents could hunt from 5–15 September with a bag limit of 1 bull with ≥50-inch antlers or ≥4 brow tines (an increase from ≥3 brow tines in previous years), and resident hunters could hunt from 1–15 September and 1–31 December, with a bag limit of 1 bull. Effective in 1997, meat of moose taken in Unit 9B was required to remain on the bone until processed for human consumption. The federal subsistence season in Unit 9B is from 20 August–15 September and 1–31 December. The season dates in Unit 9C were the same as for Unit 9B; however, the nonresident bag limit remained at with ≥50-inch antlers or ≥3 brow tines. Within the southern portion of the Naknek drainage, the federal subsistence season was open during 20 August–15 September under a registration permit . During December, federal lands were only open to local rural residents and a subsistence registration 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. The state season for resident hunters in Unit 9E was 10–20 September and 1–31 December; the season for 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 ≥50 inches or at ≥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. There was no open season in Unit 9D.

Board of Game Actions and Emergency Orders. Several changes to both state and federal moose regulations were enacted for the 1999 regulatory year. The state's winter season in Unit 9B and that portion of Unit 9C outside the Naknek drainage was moved back to 15 December–15 January, and federal season was extended to 1 December–15 January. In Unit 9E, both the state and federal winter seasons were extended to 1 December–20 January. For the first time since Unit 9D was established, a moose hunt was authorized under a resident only drawing permit hunt conducted from December 15–20 January, with 10 permits issued.

Hunter Harvest. During 1997 hunters reported killing 232 moose, including 229 bulls and 3 cows (Table 4). In 1998 the reported harvest was 202 moose, including 195 bulls and 2 cows. Preliminary reports for 1999 totaled 239 moose, including 228 bulls and 6 cows. The Unit 9 harvest over the past 17 years has averaged 215 (range 173–300) and has been relatively stable in recent years.

Permit Hunts. 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 8 permits in 1997; 2 cows were killed. No data from federal hunts in 1998 or 1999 is available.

Twenty people applied for 10 available permits in the new DM312 moose hunt in Unit 9D. Because of the logistical problems in participating in a winter hunt in Unit 9D, the Board of Game stipulated that successful applicants had to notify the department by that they actually intended to hunt. Four people failed to confirm they were planning to hunt, so these permits were issued from an alternate list. Of the 10 people who got permits, 4 reported hunting and 1 bull 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 leveled off at a mean of 563 for the period 1990–96. In 1997, 1998 and 1999, 514, 525, and 524 moose hunters reported using Unit 9, respectively (Table 5). While there have been fluctuations in the proportion of the 3 residency categories, overall no group has shown an increase. 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 relatively stable but dropped slightly in 1995 and 1998 for all 3 residency groups. Nonresidents have a higher success rate (51%, range = 48–57%) than either residents of Unit 9 (35%, range = 27–43%) or other Alaska residents (32%, range = 29–38%) because virtually all of them flew out to hunt, and many of them employed guides.

Harvest Chronology. Since 1988 approximately 88% of the total moose harvest was during September. Harvest levels during the winter season have remained low, but during 1995–99 varied (range = 9–15% of total), depending on weather and travel conditions (Table 6).

Transportation Methods. Aircraft continued as the most common method of transportation in Unit 9; boats were the second most common transport mode (Table 7). No major change in transportation type has 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 to 1:10, and they were much higher than anywhere else within the indigenous range of moose. Conditions during the first half of the 1999–00 winter were more severe, with deep snow and heavy drifting, than occurred in the past 25 years. However, by February conditions moderated and winter mortality seemed insignificant.

CONCLUSIONS AND RECOMMENDATIONS

Hunting regulations have been restricted in all units, except the Branch River Drainage in 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 units to maintain bull:cow ratios at prescribed levels. Harvests have remained relatively stable for 17 years, despite major changes to moose regulations (i.e., the spite/fork-50" regulation) in other parts of Alaska. The recent average harvest of 225 moose per year appears to be within sustainable levels. Local residents in Units 9B and 9E would like to reinstitute cow hunts, but unless productivity improves, this request will be difficult to justify on biological grounds. Local residents have also voiced concern over what is perceived as increasing competition from other hunters, including a growing effort by air taxi operations during the December hunt, especially in Unit 9B. Also many local hunters preferred a later winter hunt when travel conditions are better for snowmachines. These allocation questions were addressed at the 1999 Board of Game meeting and resulted in the winter season being moved later in Unit 9B and the northern portion of Unit 9C and extended in Unit 9E.

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 drastic reduction in bear numbers would probably be opposed by a large segment of the public.

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Table 1 Moose composition counts in Unit 9B, 1995–1999

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour
1995	--	--	--	--	--	--	--
1996	--	--	--	--	--	--	--
1997	8	2	35	25	52	69	33
1998	48	7	19	11	189	213	19
1999	57	10	4	2	132	135	26

Table 2 Moose composition counts in Unit 9C, 1995–1999

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour
1995	40	9	25	15	459	542	58
1996	27	7	23	16	501	592	40
1997	44	7	14	9	467	512	44
1998	--	--	--	--	--	--	--
1999	37	3	9	6	516	550	38

Table 3 Moose composition counts in Unit 9E, 1995–1999

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour
1995	--	--	--	--	--	--	--
1996	50	11	28	15	281	331	36
1997	--	--	--	--	--	--	--
1998[a]	65	13	20	11	817	913	45
1999	48	6	10	6	154	164	43

[a] Includes some surveys by U.S. Fish and Wildlife Service.

Table 4 Annual moose harvest in Unit 9, 1995–1999

	Reported			Estimated			
Year	M	F	Total[a]	Unreported	Illegal	Total	Total
1995	184	5	190	100		100	290
1996	226	15	238	100		100	338
1997	229	3	232	100		100	332
1998	195	2	202	100		100	302
1999	228	6	239	100		100	339

[a] Includes unknown sex.

Table 5 Moose hunter residency and success in Unit 9, 1995–99

	Successful				Unsuccessful			
Year	Local resident	Nonlocal resident	Non resident	Total[a]	Local resident	Nonlocal resident	Non-resident	Total
1995	37	43	99	190	90	107	107	313
1996	54	58	121	238	100	111	119	333
1997	57	42	130	232	86	96	100	282
1998	33	48	119	202	89	115	117	323
1999	44	59	127	239	58	96	123	285

[a] Includes unknown residency.

Table 6 Moose harvest chronology (%) transport in Unit 9, 1995–99

Year	9/1-9/4	9/5-9/9	9/10-9/15	9/16-9/20	12/1-12/15	12/16-12/31	1/1-1/20
1995	7	21	42	20	3	6	--
1996	8	21	48	17	5	8	--
1997	7	16	42	20	8	7	--
1998	6	17	47	21	6	3	--
1999	3	21	45	17	5	5	4

Table 7 Successful moose hunter transport methods (%) in Unit 9, 1995–99

Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle
1995	65	0	25	9	0	0	2
1996	62	0	20	5	9	1	3
1997	63	0	20	4	11	0	3
1998	67	0	24	3	5	0	1
1999	67	0	18	3	10	0	3

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 only 12 moose per hour were observed during fall counts. Moose numbers stabilized, then started increasing in Unit 11 during the early to mid-1980s and were probably the highest in 1987 when we observed 55 moose per hour. Moose numbers declined between 1990 and 1991 following severe winters. Changes in moose abundance have not been detected in recent years.

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 cows composed up to 50% of the harvest. During this period, hunting seasons were long and split to provide for fall and winter hunting. The moose harvest and the total number of hunters peaked 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 was prohibited. Between 1975 and 1989, fall seasons remained 1–20 September. In 1990 the moose season was shortened in response to deep snow conditions and to align it with the Unit 13 season. The current season and bag limit was established in 1993.

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

- Allow the population to fluctuate as dictated by available habitat and predation rates

- Maintain a population with a posthunt minimum of 30 bulls:100 cows with 10–15 adult bulls:100 cows.

Human Use Objective

- Allow human harvest of bulls when it does not conflict with management goals for the unit or population objectives for the herd.

METHODS

An aerial survey was conducted every year during the late fall to determine sex and age composition and population trends on a count area along the western slopes of Mount Drum. We monitored harvests and hunting pressures through a harvest ticket reporting system; we also monitored the average reported antler spread 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 fire suppression zones where wildfire is allowed to burn. Unfavorable weather conditions for burning have occurred in recent years, and wildlife have impacted little or no habitat this reporting period.

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. Number of moose counted per hour declined 75% during this time period. Since 1992 counts have fluctuated yearly with no population trends evident. Moose movement is thought to account for much of the yearly variation in the count results, not actual changes in moose abundance.

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 1999 fall composition counts in CA-11 resulted in a density estimate of 0.4 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 5200 mi^2 of moose habitat in the unit was surveyed. Based on these density estimates, an extrapolated population estimate of 2500 was obtained. 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, personal communication).

Population Composition

A bull:cow ratio of 109:100 was obtained in CA-11 in 1999 (Table 1). The bull:cow ratio has averaged 103:100 for the 5 years between 1994 and 98. 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.

The calculated calf:cow ratio in CA-11 was 21:100 in 1999, up 40 percent from the 1998 figure of 15:100. Calf production in CA-11 during 1997 and 1998 was low. The current calf ratio is in excess of 20 calves:100 cows and is above average for Unit 11, based on recent trends in calf production and survival.

Distribution and Movement

Data from past fall composition and winter stratification surveys, field observations, and reports from the public indicate that the highest moose numbers in the unit are along the slopes of Mt. Sanford, Mt. Drum, and Mt. 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 to elevations as high as 4000 ft. Migrations to lower elevations are initiated by snowfall but usually do not occur until late November–early December. 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.

State		
Unit 11	20 Aug–20 Sep	1 bull with spike-fork antlers or 50-inch antlers or antlers with 3 or more brow tines on at least 1 side.
Federal Subsistence		
Unit 11	20 Aug–20 Sep	1 bull

Board of Game Actions and Emergency Orders. During the spring 1993 board meeting, the Unit 11 season was set at 20 August to 20 September, 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 the 1993 season. This action aligns the state moose season and bag limit in most game management units on the road system in Southcentral Alaska. In 1999 The Federal Subsistence Board changed the federal subsistence moose season to coincide with the State season by adding 5 days to the August opening. The federal bag limit is any bull for rural residents of Units 11 and 13.

Human-induced Mortality. Hunters reported killing 28 bull moose in 1998. The harvest has slowly been decreasing the last 2 years after peaking at 38 moose in 1996 (Table 2). Recent harvests have been below the average annual harvest of 51, reported during the last half of the 1980s. There were 108 individuals reported hunting in Unit 11 during 1998. Hunting pressure has been stable the last 3 years with slightly over 100 individuals reporting and is down slightly from the 1994–96 average of 118 hunters. The long-term hunting effort is down 45% from the late 1980s when an average of 187 individuals reported hunting moose in the unit. This is a 30% decrease compared to the previous 4-year (1989–92) average of 168 (range = 147–187).

The mean antler spread reported for bulls harvested during 1997 and 1998 was 44 and 46 inches, respectively. Both figures equal or 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 adequate numbers of mature bulls are 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. It is also unknown how many small moose are taken and reported as legal under federal subsistence. With 2 different bag limits enforced for the same area, it is impossible to limit the harvest of small bulls because they could be legal under the federal subsistence bag limit.

Hunter Residency and Success. Local residents accounted for 64 % ($n = 18$) of the moose harvest in 1998, nonlocal Alaskan residents took 29% ($n = 8$), while nonresidents took only 7% ($n = 2$) (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 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 current federal subsistence regulations, while nonlocals must take a spike-fork or 50-inch bull under state regulations.

The hunter success rate in 1998 was 26%. Hunter success has declined the last 2 years after peaking at 30% in 1996 but is still well above the 14% success rate reported in 1992 when severe weather restricted hunting effort. Successful hunters spent an average of 8.8 days to kill a moose in 1998, while unsuccessful hunters averaged 13.6 days in the field. The time spent hunting and the time needed to take a moose increased during this reporting period. From 1990 through 1994, successful hunters averaged 5.6 days hunting and unsuccessful hunters 7.1 days. Hunting effort data indicates it is more difficult to find and take a moose in Unit 11 in recent years.

Harvest Chronology. Chronology data indicate more moose are taken during the later portion of the season in Unit 11 (Table 4). Bull moose are more vulnerable in the latter part of the season because their movements increase at the onset of rut in mid-September, which is also during leaf fall.

Transportation Methods. Unit 11 moose hunters use 3-or 4-wheelers, aircraft and highway vehicles for access to hunting areas (Table 5). NPS regulations limit transportation methods in Unit 11. Aircraft cannot be used in portions of the unit designated as park, and all vehicle use for sport hunting is restricted to existing trails except by permit. Only subsistence hunters do not need a permit and are not limited to existing trails. These rules limit hunting opportunity in the more remote portions of the unit.

Natural 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 reports by hunters and trappers of suspected wolf predation, indicate 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. Predation can suppress moose populations at very low densities for long periods, especially when alternative prey such as caribou and sheep are available, as they are in Unit 11 (Gasaway and others. 1983).

HABITAT

Assessment

Fires occurred throughout much of Unit 11 before the mid-1940s when the Bureau of Land Management (BLM) instituted fire suppression activities. The beneficial effects of those fires in creating moose habitat have long since passed. Only one 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, many of which have been killed by spruce bark beetles and have limited value as moose habitat. Habitat types that moose commonly use are climax upland and riparian willow communities. Recent observations of light browse use on range transects indicate that moose are not limited by the amount of available browse.

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 were stable during this reporting period. The moose population in Unit 11 declined between 1990 and 1992 because of severe winters. The size of the Unit 11 moose population, based on moose per hour measurements, is lower than during the late 1980s before the decline. Calf production and/or survival to fall increased the last 2 years of this reporting period. Reasons for the increase in calf production and survival are unknown. Calf recruitment to fall during this reporting period did not increase enough, however, to cause a measurable increase in the Unit 11 moose population.

The moose harvest has declined over the last 2 years after peaking in 1996. Current harvests are well below the 50 bulls per year reported harvest 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 ever reported.

I recommend a research program be established to investigate factors limiting growth of the moose population. Unit 11 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, 1994–1999

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour	Density moose/mi^2
1994	91	8	25	11	101	114	24	0.4
1995	92	10	21	10	136	151	34	0.5
1996	92	11	21	10	121	134	30	0.5
1997	128	4	9	4	107	111	29	0.4
1998	111	9	15	7	97	104	24	0.4
1999	109	11	21	9	111	122	28	0.4

Table 2 Annual moose harvest in Unit 11, 1994–1998

	Reported			Estimated			
Year	M	F	Total[a]	Unreported	Illegal	Total	Total
1994	36	0	36	5	5	10	46
1995	37	0	38	5	5	10	48
1996	38	0	38	5	5	10	48
1997	34	0	34	5	5	10	44
1998	27	0	28	5	5	10	38

[a] Includes unknown sex.

Table 3 Moose hunter residency and success in Unit 11, 1994–1998

	Successful				Unsuccessful			
Year	Local resident	Nonlocal resident	Non resident	Total[a]	Local resident	Nonlocal resident	Non-resident	Total[a]
1994	20	11	5	36	45	38	6	89
1995	23	8	7	38	44	36	5	86
1996	18	15	5	38	53	6	2	62
1997	28	3	3	34	48	26	4	79
1998	18	8	2	28	65	13	1	80

[a] Includes unspecified residency.

Table 4 Moose harvest chronology percent by seasonal weeks in Unit 11, 1994–98

Year	Season dates	Week of Season 1st	2nd	3rd	4th	5th
1994	20 Aug–20 Sep	2	2	25	11	53
1995	20 Aug–20 Sep	8	0	11	40	40
1996	20 Aug–20 Sep	5	8	11	54	22
1997	20 Aug–20 Sep	3	3	9	23	62
1998	20 Aug–20 Sep	0	4	22	41	33

Table 5 Successful moose hunter transport methods (%) in Unit 11, 1994–98

Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown
1994	42	8	8	28	0	6	8	0
1995	42	3	0	15	0	3	34	3
1996	21	10	3	26	3	8	26	3
1997	21	6	0	26	0	12	21	15
1998	29	0	0	32	0	7	25	7

LOCATION

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

GEOGRAPHIC DESCRIPTION: Upper Tanana and White River drainages

BACKGROUND

The Unit 12 moose population irrupted during the 1950s through the mid-1960s and declined rapidly during the early 1970s, similar to populations in adjacent road accessible areas. Several severe winters, high wolf and grizzly bear predation, and high localized cow moose 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 yearling recruitment and a declining bull:cow ratio. Between the mid-1970s and early 1980s, the Unit 12 moose density was estimated between 0.2 and 0.4 moose/mi^2 (ADF&G, unpublished data).

In response to the declining moose populations, wolf control programs were conducted in adjacent Units 20D (1980), 20E (1981–1983), and extreme northern Unit 12 (1981–1983). Beginning in regulatory year (RY) 1982 (RY = 1 Jul–30 Jun, e.g., RY82 = 1 Jul 1982–30 Jun 1983), attempts were made to reduce the grizzly bear population by liberalizing harvest regulations. Moose habitat enhancement programs were conducted during the late 1980s. Between 1982 and 1989 the moose population in Unit 12 increased, probably due to a combination of these management programs and favorable climatic conditions that 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. It is also an important wildlife viewing area for tourists driving the Alaska Highway. The Upper Tanana Valley is the first area in Alaska visited by thousands of highway travelers who are here to view Alaska's wildlife. 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 has become restrictive and harvest has declined by over 40%. Moose watching has also declined and few tourists observe moose while travelling through 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.

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

MANAGEMENT OBJECTIVE

- 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

We estimated the moose population size in 1120 mi^2 in northwestern Unit 12 during November 1994 and October 1997. Methods followed standard Gasaway census techniques (Gasaway et al. 1986), except that the areas were stratified using historic count data collected during aerial contour counts or population estimation surveys. The area in northwestern Unit 12 was divided into 34 high and 42 low/medium strata sample units in 1994. Based on 1994 and 1996 survey results we restratified the area into 37 high and 39 low/medium strata sample units in 1997. We flew 24 random sample units (16 high; 8 low/medium) covering approximately 32% of the study area during 1994 and 27 random units (19 high; 9 low/medium) covering 37% of the area during 1997. Standard search intensity was about 4.25 min/mi^2 in 1994 and 3.45 min/mi^2 in 1997. Portions of 12 sample units (1994; 8 highs, 4 lows) and 14 units (1997; 9 highs, 5 lows) were resampled at a search intensity of 12 min/mi^2 to determine a sightability correction factor.

The National Park Service (NPS) conducted a "no-strat" population estimation survey (Dale et al. 1994) in a 352-mi^2 area in the vicinity of Chisana in southeast Unit 12 during October 1998 (NPS, Wrangell-St Elias National Park and Preserve, unpublished data).

We conducted aerial composition surveys in October and November 1993–1999. 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 [no brow separation] yearling bulls), cows without calves, cows with 1 calf, cows with 2 calves, lone calves, or unidentified moose. These data were used to estimate population and composition trends by comparing moose observed per hour and composition ratios between years.

HARVEST

Harvest was estimated using harvest report cards with the benefit of reminder letters. Information obtained from the reports was used to determine total harvest, hunter residency and success rates, harvest chronology, and transportation used. Harvest data were summarized by regulatory year. Estimates of potlatch take are obtained by interviewing residents and public safety officers of villages where the potlatches have taken place.

HABITAT ENHANCEMENT

During February and March 1997, 300 acres of decadent deciduous shrub species were mechanically crushed using a D6 tracked-dozer equipped with a flat blade. We made significant progress on developing a cooperative wildlife habitat logging plan with the Division of Forestry designed to increase the amount of deciduous browse and cover for wildlife and provide nursery structure for planted spruce seedlings.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Based on data collected during annual October/November aerial composition surveys and 5 area-specific population estimation surveys (1989, 1990, 1994, 1997, and 1998), the moose population in Unit 12 increased slowly from 1982–1989 and remained relatively stable from 1989–1993. Increased calf survival allowed the Unit 12 population to grow slightly during 1994–1997. The most apparent increase occurred in the northwest portion of the unit within the area affected by the Tok wildfire (155 mi^2). Census results indicate this area supported 0.19 moose/mi^2 in 1989 but increased to 0.6 moose/mi^2 by 1994 and about 1.0 moose/mi^2 in 1997. Within the population estimation survey area (1119 mi^2) in northwestern Unit 12, the estimated moose density was 0.9 moose/mi^2 (± 15%, 80% CI) in 1994 and 1.1 moose/mi^2 (± 15%, 80% CI) in 1997. During November 1998, the moose density in southeastern Unit 12 (Stuver Creek to the Yukon border north of the White River and south of the Wrangell-St Elias Preserve boundary was estimated at 0.8 moose/mi^2 (0.80–0.87, 95% CI). Overall, moose densities ranged from 0.03/mi^2 in the Northway Flats to 2.3/mi^2 along the north side of the Nutzotin Mountains. The 1997 population estimate in Unit 12 was 3500–4000 moose. Between 1997 and 1999, calf and yearling bull recruitment declined and the population was estimated to have remained stable or declined slightly. The 1999 estimated population range remained 3500–4000 moose. The estimated density was 0.6–0.7 moose/mi^2 of suitable moose habitat.

Localized moose harvest has caused declines in moose numbers near the villages and communities in Unit 12. Poaching and the taking of moose for funeral and ceremonial potlatches have had the greatest effect because most of that harvest was comprised of cow moose. The current Fish and Wildlife Protection officer conducted intensive public awareness campaigns explaining the limiting effects of poaching on local moose numbers. His efforts resulted in a noticeable reduction in the number of poaching cases during the past 4 years. We are currently working with the local villages to improve potlatch moose harvest reporting and, hopefully, we will develop a strategy that will limit this harvest to more sustainable levels.

The Alaska Board of Game has identified the moose population within Unit 12 as important for high levels of human consumptive use under the Intensive Management Law (AS 16.05.255[e]–[g]). This designation means that the board must consider intensive management if regulatory action to significantly reduce harvest becomes necessary because the population is depleted or has reduced productivity. The board will decide the population and harvest objectives for Unit 12 moose in March 2000. It appears, based on proposals submitted by the department and by the public, the moose population and harvest objectives will be higher than current levels. Based on modeling the trends of the Unit 12 moose population and hunter participation and harvest, current harvest restrictions are necessary to protect the bull population especially in the more accessible areas of the unit. Significantly increasing the moose population and sustainable harvest will require intensive management.

In an attempt to better predict the outcome of different methods of intensive management on Unit 12's moose population, I modeled the current population status and trend data for moose and their predators using the McNay and DeLong (1998) Predprey model. Past research found that predation by both wolves and bears was the primary factor maintaining the area moose populations at low densities (0.2–1.0 moose/mi^2, Gasaway et al. 1992; US Fish and Wildlife Service, unpublished data). The effects of wolves and bears vary between areas within Unit 12. In the Northway and Tetlin Flats, both calf mortality and predation rate studies indicated that wolves were the primary predator on calves and adult moose throughout the year. In contrast, along the Nutzotin Mountains calf recruitment to 5 months was substantially lower and was more indicative of grizzly bear predation. Modeling exercises using actual moose composition and predator kill rate data indicated the Unit 12 moose population continues to be primarily limited by wolves although grizzly bears are an important predator in portions of the unit. The model also predicted the Unit 12 moose population will remain at low densities for an extended period of time with little opportunity for increased harvest.

Assuming grizzly bear predation rates remain relatively constant during the next 5 years, the model predicted that the Unit 12 moose population would increase substantially if unit wolf numbers were reduced. A wolf population reduction of 80% was found to have caused moose and caribou population increases in other areas of Alaska and Yukon (Boertje et al. 1996). If the unit's wolf population is controlled at this level, the modeled moose population increases at 8–14% annually. However, wolf control is not an option on federal lands, which constitute a majority of Unit 12. If wolf control is conducted only on state and private lands, the modeled moose population increases at about 6–9%.

Because the moose population in the northwest portion of the unit increased as a result of the 1990 Tok wildfire and as a result of intense public hunting and trapping of predators, possibly other local moose population increases could occur in Unit 12 without government wolf control. These moose population increases would be moderate and would be eventually limited by predation. However increases would be enough to satisfy the potential intensive management objectives, assuming the number of moose hunters does not substantially increase. Because of landownership patterns in Unit 12, this will be the management direction taken during the next 5 years.

Population Composition

We conducted moose composition surveys in Unit 12 during fall 1988–1999 (Table 1). Composition data since 1994 are not directly comparable with previous years because sampling techniques have changed. Instead of annually counting all traditional count areas, we now conduct a population estimation survey over a much larger area every 3 years, as well as conduct annual aerial contour trend count surveys. The area in which we conduct the population estimation survey includes many of the traditional count areas. Benefits of the new survey schedule include confidence limits around composition estimates and, because more area and habitats are being sampled, there is less chance for weather anomalies to affect the count. The disadvantage is that a composition estimate for most of Unit 12 is not obtained annually. We conduct annual composition surveys to protect against missing a catastrophic decline in the area's moose population between population estimation surveys. In most years staff of the Tetlin National Wildlife Refuge annually conduct composition surveys in 2–4 traditional count areas along the north face of the Wrangell Mountains. Periodically staff of the Wrangell-St Elias National Park and Preserve either conduct composition or population surveys within the Chisana River and Beaver Creek drainages. We conduct 1–3 composition surveys on state land annually.

During the report period, bull:cow ratios ranged from about 20–25:100 along the north side of the Alaska Range and Tok River drainages to over 80:100 along the Nutzotin Mountains. The 1997 bull:cow ratio within the population estimation survey area in northwestern Unit 12 was 36:100 compared to 39:100 in 1994. The census area encompassed the Tok River drainages and the Front Range as well as other areas that were lightly harvested. Within the Tok River drainages, the bull:cow ratio remained between 22–26:100, down from the low 30s:100 in the late 1980s. The Unit 12 bull:cow ratios met the population objective but future management may be necessary to stop the decline in bull numbers in the Tok River valley and along the Front Range.

Primary factors reducing the bull:cow ratio in the Tok River drainage and along the Front Range were improved hunter access and low calf recruitment. Increases in hunter participation and in the number of access trails allowed harvest to reduce or limit bull numbers. In addition, even though calf survival to 5 months appeared adequate during 1996–1998 (17–41 calves:100 cows), yearling bull recruitment was low (7–11 yearling bulls:100 cows). Since few bulls are being recruited annually, harvest has an important impact on the bull population.

During 1999, calf survival to 5 months was low (17–23:100 cows) in Unit 12 and adjacent areas in Units 20D and 20E. Composition estimates were collected from only 2 areas in 1998. NPS observed 34 calves:100 cows while conducting a "no-strat" population estimation survey in a 352.1 mi^2 area in the vicinity of Chisana in the southeast portion of the unit. Calf survival along the Front Range in northwest Unit 12 was estimated to be 29:100 cows. Between 1994 and 1997, calf survival was 32–41:100 cows in northwestern Unit 12 and was 31:100 cows in southeastern Unit 12. Apparently, environmental conditions benefited calf survival unitwide during that period but were unfavorable during 1999.

Distribution and Movements

Moose are found throughout Unit 12 below an elevation of about 4500 feet. There is about 6000 mi^2 (15,540 km^2) of suitable habitat, and most moose 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 area burned by the 1990 Tok wildfire or to the

Tanana River during mid to late winter. In route to the Tok wildfire area during winter 1999, 10–30 moose were consistently observed using an area along the Tok River that was mechanically crushed in 1998. I observed this area during summer 1999 and found extensive stands of feltleaf willow (*Salix alaxensis*), a preferred moose browse species.

Moose distribution has changed in Unit 12 over the past 5 years. Very few resident moose now exist on the Northway Flats, in the vicinity of Tanacross, or north of Tok along the Tanana River. Year-round poaching and harvest for funeral or ceremonial potlatches contributed to the decline of resident moose in these lowland areas near human settlements. Also, some of these moose may now be spending more time in the 1990 Tok River burned area. Moose use of the Tok River valley and the Tetlin Hills has increased substantially since 1989. Densities have increased from 0.19 moose/mi^2 to about 1 moose/mi^2. Use of this area by moose occurs throughout the year. Increased use of this area is a result of improved habitat from the 1990 Tok River fire and moderate harvests of predators.

MORTALITY

Harvest

<u>Season and Bag Limit</u>. Seasons and bag limits in Unit 12 during RY99 were as follows:

Units and Bag Limits	Resident Open Season	Nonresident Open Season
1 bull with spike-fork antlers	15 Aug–28 Aug	No open season
Unit 12, that portion drained by the Little Tok River upstream from and including the first eastern tributary from the headwaters of Tuck Creek.		
1 bull with spike-fork antlers or 50-inch antlers or antlers with 4 or more brow tines on 1 side.	1 Sep–15 Sep	5 Sep–15 Sep
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 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side.	1 Sep–30 Sep	1 Sep–30 Sep

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Remainder of Unit 12.		
RESIDENT HUNTERS: 1 bull.	1 Sep–15 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side.		5 Sep–15 Sep

Board of Game Actions and Emergency Orders. In spring 1995 the board authorized a 20–28 August spike-fork season in Unit 12 for Alaska residents only. This early season was used by local residents but the harvest was low (1–2 spike/fork moose annually). During March 1998 the board extended the early spike/fork season by 5 days to 15–28 August to allow more opportunity to hunt this underutilized age class. Also during spring 1998, the board designated the Unit 12 moose population as important for high levels of human consumptive use under the Intensive Management Law. This designation means that the board must consider intensive management if regulatory action to significantly reduce harvest becomes necessary because the population is depleted or has reduced productivity. The board will establish the population and harvest objectives for Unit 12 moose in March 2000. They will also consider dividing the Unit 12 moose season into a 5-day August and a 10-day September season.

Hunter Harvest. Reported harvest in Unit 12 was 102 bulls in RY97 and 148 bulls and 1 cow in RY98 (Table 2). The 5-year average reported moose harvest was 116. During the preceding 5 years (RY89–RY94), the average harvest was 88 bulls. The preliminary harvest report for RY99 was 119 bulls.

During the report period, the highest number of hunters (151 and 161) and the greatest harvest (37 and 48) occurred in the Tok River valley. The other most intensively hunted area is between the Robertson River and Northway along the Alaska Highway or Tanana River. That area was hunted by 121 and 127 hunters during RY97 and RY98, and 13 and 26 bull moose were taken. Local residents comprised 55% and 56% of the hunters and took 46% and 50% of the harvest in the Tok River and 70 and 77% of the hunters and took 77% and 81% of the harvest along the Tanana River and Alaska Highway. Few nonresidents hunt these areas and annually take about 5% of the harvest. During the report period, most harvest that occurred along the Tetlin (10 and 18) and Chisana (18 and 24) Rivers was by nonresidents (48%). Since enacting antler size restrictions within most of the Little Tok River drainage in RY93, harvest declined to an average of 5 per year during RY94–RY96. It remained at 4 and 7 during RY97 and RY98 compared to 10 and 20 bulls per year during RY91 and RY92.

Reported harvest represented about 2.9–3.3% of the prehunt Unit 12 population and had little impact on population dynamics. Currently, the annual out-of-season take for funeral or ceremonial potlatches is 25–50 moose of either sex. Most of the potlatch harvest is comprised of cow moose. Eight to 10 years ago this take was probably as high as 60 moose annually because poaching was more of a problem and additive to the potlatch take. Most of the out of season harvest occurred near communities and along the road system. Thus, the annual Unit 12 harvest was probably closer to 4–5.5% of the population. Under this harvest rate and harvest distribution patterns, the moose population around Unit 12 villages and communities was maintained at very low levels.

During RY97 and RY98, antler size was reported for 97 and 135 harvested bulls, and the average size was 44.4 and 47.25 inches. The 5-year average was 45.9 inches. Of the 44 bull moose harvested in the Tok River drainage during RY98, 5 bulls (11%) were judged to be yearlings (antlers <30 inches), 18 (41%) were 2–4 years old (antler spread 30.0–49.9 inches), and 21 (48%) were mature bulls (antler spread >50 inches). Antler spreads were estimated for 131 bulls observed during aerial contour composition surveys in the Tok River drainage during October 1999 after the hunting season. Of these, 37% were yearlings, 42% were 2–4 year olds, and 21% were mature bulls. Seven of the 21 mature bulls harvested were taken under the regulation requiring bulls with antlers 50 inches or larger, which may partially explain the higher than expected mature bull harvest.

Based on conversations with many local hunters it is apparent that yearling bull moose movements and behavior patterns allow this age class to avoid hunters. Hunters are not passing up yearling bulls in favor of larger bulls.

Hunter Residency and Success. During the report period, local residents, nonlocal residents, and nonresidents accounted for an average of 59%, 32%, and 10% of the moose hunters in Unit 12. These percentages have been consistent the past 5 years. Local hunters harvested 43 and 68, (42% and 46%), nonlocals 29 and 46 (28% and 31%), and nonresidents 30 and 35 (29% and 23%) of the reported harvested bulls during the report period (Table 3). Local and nonlocal harvest has ranged between 42–50% and 28–33%, respectively, since RY94.

During RY97 and RY98, 492 and 510 hunters reported hunting moose in Unit 12. The 5-year average was 494 compared to the average of 412 between RY89–RY93. Increased participation and better reporting by local residents can explain most of the increase in hunters. The number of reports received by local residents has increased by 31% during the past 5 years. The area's human population has grown slightly during this period and many of the newcomers participated in moose hunting. The number of nonlocal residents has remained consistent but the composition changed during the past 2 years with more hunters from Southcentral Alaska and less from the other areas of the Interior. This is the same trend that is occurring in adjacent Unit 20E. The 5-year average success rate was 23%. Success rates were higher in RY98 in both Unit 12 (29%) and in adjacent Unit 20E (28%) for unknown reasons.

Harvest Chronology. In that portion of Unit 12 where the bull moose season was 1–15 September or 5–15 September (nonresident), the greatest moose harvest took place between 7 and 13 September (Table 4) and on 14 or 15 September. During RY98, 24 moose were taken during these last 2 days. During the August spike/fork season, only 1–2 were taken annually between RY95 and RY98. Preliminary harvest reports indicate that at least 10 spike/fork bulls were taken during the August season in RY99.

The number of hunters who used the 1–30 September season in southern Unit 12 and the total harvest for this season remained similar to those in past years. Most of these hunters are guided nonresidents or Chisana residents.

The Board of Game will act on a proposal during the March 2000 meeting to split the moose season in most of Unit 12 to 24–28 August and 8–17 September. The justifications for the proposal are to offer an August season allowing more families to hunt together prior to the beginning of the school year and to maintain harvest at current levels (about 115 bulls annually). The 2 openings will balance periods that historically have lower participation rates but differing success rates. The early season is expected to have a lower success rate compared to the 1–7 September portion of the current season and the later season is expected to have a higher success rate. During the past 5 years, 42% of the reported harvest between 1–15 September occurred between 1–7 September. I am expecting <40% of the take during the 5-day August season. Also, I expect increased success in the later opening because of an extra 2 days when success is typically elevated.

Transport Methods. During the past 5 years, the transportation type used by most hunters was highway vehicles (40%), followed by boats (17%), 3- or 4-wheelers (17%), airplanes (7%), other ORVs (7%), and horses (5%). Method of transport was unknown for 7% of the hunters. Hunters using highway vehicles had the lowest average success rate (14%), but traditionally took the greatest number of moose annually (Table 5). Hunters using horses had the highest success rate (68%). Horses are primarily used by guides to transport nonresident hunters into the most remote sections of the unit. Hunters using airplanes had a success rate of 46% during the past 5 years. Success rates for hunters using 4-wheelers (24%), ORVs (25%), or boats (23%) were similar and were near the unit's average success rate. These transportation types are not as useful to hunters in Unit 12 as compared to some other areas, because there are few areas accessible by these transportation types.

Other Mortality

Predation by wolves and grizzly bears has been the greatest source of mortality for moose in Unit 12 and has maintained the population at a low density (0.4–0.7 moose/mi^2) since the mid-1970s. In contrast with most other areas that contain sympatric moose, wolf, and grizzly bear populations, wolves, rather than bears, were the primary predator on moose calves on the Northway-Tetlin Flats, based on research conducted during the late 1980s (ADF&G unpublished data; US Fish and Wildlife Service, unpublished data). Wolf predation also appeared to be the greatest source of adult mortality. However, in some mountainous areas of Unit 12, fall composition data indicate that bear predation on moose neonates was high.

In much of Unit 12 the grizzly bear population is currently stable at a food-limited density that is typical for Interior Alaska bear populations (16–20 bears/1000 km^2). The grizzly bear population probably declined in portions of the unit since the mid-1980s due to increased harvest by hunters.

Wolf populations have increased in Unit 12 at least since 1989 when tens of thousands of Nelchina caribou started to winter in or migrate through Unit 12. Between 1989 and 1992, the fall Unit 12 wolf population increased 30–40%, and during 1992–1993, there were 230–243 wolves in a minimum of 28 packs.

During RY92 and RY93, the wolf population declined in Unit 12 due to increased harvest by trappers (Gardner 2000*a*). The estimated decline within the unit was about 25%, but most of the decline occurred within the western portion of the unit where over 40% of the harvest occurred and the estimated wolf population decline was 30–40%. Wolf harvest declined substantially (13–24% harvest rate) in RY94 through RY97 due to low pelt prices. The wolf population subsequently increased about 30% during those years.

Considering the population status and trends of wolves and grizzly bears in Unit 12, I expect the moose population to remain at low density (0.2–1.0 moose/mi^2) for an extended period. However, it appears that concentrated public wolf trapping and bear harvest can cause a local population of moose to increase especially in areas that have received habitat enhancement. The likely mechanism is improved calf survival. Adult mortality probably does not change much because trapping rarely takes entire packs. Modeling data and actual survey data support this hypothesis.

HABITAT

Assessment

Only about 6000 mi^2 in Unit 12 are moose habitat. However, excessive wildfire suppression for nearly 30 years has allowed vast areas of potentially good moose habitat to become choked with spruce forests that lack high-quality deciduous moose browse. However, we have conducted browse surveys periodically the past 15 years and have found that in most years use of preferred browse species is low in relation to availability. During deep snow winters, moose concentrated in areas along the Tok and Tanana Rivers and the browsing rate was much higher. In all years, disturbed sites with early successional species were being used far more heavily than adjacent undisturbed areas. Currently, habitat is not limiting the moose population in Unit 12 but medium to large scale creation of early seral species can likely cause the moose population to increase, as evidenced by the 1969 Ladue burn in eastern Unit 20E (Gardner 2000*b*), the 1990 Tok burn, and the Teslin burn in the Yukon (Boertje et al. 1995). Boertje et al. (1995) hypothesized that seral stages reduce predation efficiency in a variety of ways.

Enhancement

Habitat enhancement work has been conducted in Unit 12 since 1982. Over 1800 acres of old age, decadent willows have been intentionally disturbed to stimulate crown sprouting of new leaders. We estimated, using data collected during our browse surveys, that these habitat enhancement projects have produced over an estimated 2 million pounds of additional browse each year for wintering moose. In eastern Unit 12 the US Fish and Wildlife Service has completed several prescribed fires to benefit moose on the Tetlin National Wildlife Refuge. In 1998 we mechanically crushed 275 acres of decadent willow and aspen within the Tok River valley to stimulate crown growth. Since 1998 we have been working in cooperation with state forestry to determine suitable logging sites within a proposed 1000-acre timber sale area in the

Tok River valley. Potential cut areas are being selected based on numbers of marketable trees, historic winter moose use, and the potential to regenerate quality moose browse species. In addition we are assisting in designing and implementing scarification techniques that will promote willow and aspen regeneration following logging on these sites. Cut areas will be 80–200 acres in size.

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 (0.19 moose/mi^2 in 1990 to 1.0 moose/mi^2 by 1997). Excellent moose winter browse supplies are expected to exist for the next 15 to 20 years.

Local residents have observed the increase in moose in the area burned by the 1990 Tok wildfire. As a result, more residents, including Natives, are more receptive to using fire or other habitat enhancement techniques to benefit moose, as evidenced by a planned prescribe burn near Tanacross Village in 2001.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

Throughout most of Unit 12, moose densities are low and can support only limited harvest. However, we can increase hunter opportunity without negatively limiting the population's ability to grow. The greatest threat to the Unit 12 moose population from hunting is a rapid increase in harvest and hunter concentration. Concentrated harvest has caused the bull population to decline in several areas in Unit 12 and in adjacent Unit 20E. One possible management technique that may increase hunter satisfaction would be to split the hunting season into 2 periods. The first season would occur during 24–28 August. Benefits would be 1) most families could hunt together before school begins and 2) this time period is optimum for drying moose meat and would be appreciated by some Natives. Harvest would be reduced or maintained because success rates are normally lower this time of year because leaves are on the trees and because moose are generally solitary, quiet, and sedentary.

The second opening would be 8–17 September. This is the period of highest harvest success but historically the number of hunters in the field is lower than during the first week of the season. Mid to late September moose hunting is enjoyed and desired by many hunters, but normally cannot occur because of the high harvest that occurs in early September. A high-success hunt in mid-September is feasible under a split season because the reduced success rate of an August hunt.

CONCLUSIONS AND RECOMMENDATIONS

Moose are far less numerous in Unit 12 than they were in the 1960s. The population declined rapidly during the 1970s, increased during the late 1980s, stabilized or slightly declined during 1989–1993, increased slightly during 1994–1996, and remained stable or slightly declined since 1997. Moose numbers, especially in the vicinity of the road system, are very low which primarily affects subsistence hunters and nonconsumptive users. 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 out of season funeral and ceremonial take in certain areas is maintaining the moose population at low densities. Between 1991 and 1997 the moose population increased within the area affected by the Tok wildfire. Residents of Tetlin and Tok and a growing number of nonlocal residents have increased their use of the area and consequently legal and out of season harvest has stabilized moose population growth.

In more accessible areas of Unit 12 the bull:cow ratio has declined to 20–25:100 due to moderate harvest rates and low yearling recruitment. In the Little Tok River, an antler restriction regulation was adopted in an attempt to protect the bull:cow ratio, but still allow maximum hunter opportunity. Harvest may need to be restricted in a similar manner in the Tok River drainage and along the north face of the Alaska Range because of high harvest rates.

An August spike-fork season was implemented in RY95. Survey data indicated this antler configuration represented about 15% of the bull population annually but made up only 2% of the harvest. By offering a season strictly for spike-forks, more hunting opportunity was offered without limiting the population's ability to grow. Public support of the early season was high. The actual harvest during the early season was 1–10 spike-fork bulls. This season may be curtailed if the Board of Game decides to split the Unit 12 moose season into a 5-day August season for any bull and a 10-day mid-September season for any bull.

The Alaska Board of Game has identified the moose population within Unit 12 as important for high levels of human consumptive use under the Intensive Management Law. This designation means that the board must consider intensive management if regulatory action to significantly reduce harvest becomes necessary because the population is depleted or has reduced productivity. The board will decide the population and harvest objectives for Unit 12 moose in March 2000. Modeling indicated moderate increases in local moose populations could occur using intensive habitat management coupled with public predator harvest.

The Unit 12 moose goals and objectives were met this report period. Population trends were monitored and necessary changes to hunt structure were proposed. Habitat enhancement programs were implemented to benefit local moose populations. Hunting seasons and bag limits were established that allowed maximum hunting opportunity and met subsistence needs. Moose watching opportunities were shared with visitors and local residents, and several presentations were given to local schools and tourist groups annually.

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Table 1 Unit 12 aerial moose composition counts, fall 1988–1999

Year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1988	64	18	33	189	17	943	1133	40
1989[a]	50	13	30	223	17	1094	1317	44
1990	47	12	25	185	15	1071	1256	40
1991	49	12	24	200	14	1264	1472	44
1992	45	10	26	165	15	906	1071	32
1993[b]	26	7	36	187	22	662	850	57
1994[c]	38	16	39	87	21	327	414	
1994[d]	97	13	25	47	11	374	421	44
1995[d]	82	12	26	65	12	461	526	51
1996	39	9	32	236	23	1022	1258	57
1997[c]	36	11	41	138	23	458	596	
1997[d]	87	22	31	73	14	439	512	39
1998[e]	65	14	34	48	17	229	277	
1998[f]	38	7	29	26	17	124	150	54
1999[b]	22	8	17	102	12	721	823	65

[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.
[e] Based on population estimation results from the Chisana area, southwest Unit 12 using the "No-strat" technique.
[f] Only the north face of the Alaska Range sampled using the contour survey technique.

Table 2 Unit 12 moose harvest and accidental death, regulatory years 1990–1991 through 1998–1999

	Harvest by hunters									
	Reported				Estimated			Accidental death		
Regulatory year	M (%)	F (%)	Unk	Total	Unreported	Illegal	Total	Road	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
1995–1996	117 (100)	0 (0)	1	118	20–25	5–10	25–35	3–5	3–5	146–158
1996–1997	124 (100)	0 (0)	0	124	20–25	3–10	23–35	3–5	3–5	150–164
1997–1998	102 (100)	0 (0)	0	102	20–25	3–10	23–35	3–5	3–5	128–142
1998–1999	148 (99)	1 (1)	0	149	20–25	3–10	23–35	3–5	3–5	175–189

Table 3 Unit 12 moose hunter residency and success, regulatory years 1990–1991 through 1998–1999

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	
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
1995–1996	55	34	26	118 (24)	249	113	16	378 (76)	496
1996–1997	62	41	20	124 (24)	251	119	14	384 (76)	512
1997–1998	43	29	30	102 (21)	245	125	14	384 (78)	492
1998–1999	68	46	35	149 (29)	232	110	19	361 (71)	510

[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 month/day, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest chronology by month/day						
	8/15–8/28	9/1–9/6	9/7–9/13	9/14–9/20	9/21–9/27	9/28–10/5	Total[a]
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
1995–1996	2	33	52	17	5	6	118[b]
1996–1997	1	39	44	27	7	1	124[b]
1997–1998	1	30	38	19	10	1	102
1998–1999	2	41	65	30	5	1	149

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

[b] One moose was taken during a federal hunt in November 1995.

Table 5 Unit 12 moose harvest percent by transport method, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest percent by transport method								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1990–1991	17	15	21	11	0	6	23	5	98
1991–1992	10	14	10	25	0	14	25	2	110
1992–1993	18	23	10	11	0	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
1995–1996	10	13	28	17	0	6	22	4	118
1996–1997	13	9	22	19	0	7	28	2	124
1997–1998	15	21	16	20	0	3	24	1	102
1998–1999	16	12	17	20	0	11	22	1	149

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. For the next 10 years, moose numbers declined and reached a population low by 1975. 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 started to increase in 1978 and climbed at an average annual rate of 5% until 1987, when the population peaked again. Moose numbers started to decline again during the early 1990s because of a series of severe winters and increased predation.

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, we reduced harvests 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. 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. Starting in 1990, however, seasons were reduced in length in response to population declines attributed to severe winters. Moose seasons were again liberalized in 1993.

MANAGEMENT DIRECTION

POPULATION OBJECTIVE

Increase the unit moose population to between 20,000–25,000 moose with a minimum of 25–30 calves:100 cows in the fall.

HUMAN USE OBJECTIVE

Increase the yearly moose harvest of bulls and cows to a combined total between 1200 and 2000 animals.

METHODS

We conducted aerial surveys during fall to learn sex and age composition and population trends in count areas 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, and in late winter to determine over winter survival. Computer modeling of the moose population was completed to predict trends. We monitored harvests by requiring permit and harvest ticket reports from all hunters and monitored habitat conditions periodically by examining browse utilization transects in different parts 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 are allowed to burn. Work was completed on a controlled burn plan and plant composition data in the proposed burn area were collected. In addition, staff evaluated and responded to land-use proposals that could affect moose habitat.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Long-term population trends for moose are monitored by observing changes in the number of moose counted per hour of survey time during fall sex and age trend counts on established trend count areas. This population index is thought to be a reliable indicator of long-term trends in moose numbers because it is not influenced as much by moose movements and survey conditions as the total number of moose counted. Moose per hour data for the current reporting period are included in Table 1. The rate of moose counted per hour in Unit 13 declined 21% from 1988 to 1994. The 1999 totals of 46 moose per hour are 10% below the 1994-97 four-year average of 51 moose per hour. This indicates an overall decline in moose numbers in Unit 13 during the current reporting period. On a unit basis, 13A, B and E declined 10–15%, 13C declined 30%, while 13D increased 30%.

Moose censuses were conducted in the moose study area in 13A west during 1994, 1998 and 1999. Moose density in 1994 was 2.16 moose and 1.5 cows/mi^2 (Testa personal communication). In 1998 and 1999 the results were almost identical, and the average densities were 1.4 moose and 1.1 cows/mi^2. These data indicate a 31% decline in total moose and a 27% decline in cows between 1994 and 1999. Count conditions were good in all years and the results are thought to represent an actual decline in moose and not census variation (Testa personal communication).

We used the predator prey model developed by Mark McNay (ADF&G, PredPrey v. 1.0) to model moose, wolf and bear populations in the 13A study area west of Lake Louise. Modeling focused on this area because we have the most complete demographic data for moose, wolves and bears in this study area. We modeled forward from 1994 to the present and 10 years into the future. The model results closely fit observed historic trends for both moose and wolf numbers in 13A. Moose abundance declined at approximately 5% annually through 1999. Future trends predicted by the model include a continued steep decline in the moose population and an eventual decline in wolf densities once moose numbers drop.

Population Size

A unitwide population estimate for moose is not available. Density estimates from fall trend count areas range from a low of 0.5 moose/mi^2 in 13D to a high of 1.4 moose/mi^2 in 13C (Table 2). An average of 1.1 moose per mi^2 was observed within the tend count areas during 1999, down 15% from the 1.3 moose/mi^2 estimate in 1997. Current density estimates are down 45% unit-wide from the 1987 and 1988 highs of 2.0 moose/mi^2. The average density found on count areas cannot be extrapolated unit-wide to a population estimate, because count areas are located in fall concentration areas, and densities are not representative of the whole unit.

Population Composition

Population composition data collected during fall sex and age composition counts from 1994 through 1999 are presented in Table 1. The bull:cow ratio in Unit 13 was stable at around 18 bulls/100 cows between 1994 and 1998, then increased to 21 bulls/100 cows in 1999. Of all the trend count areas, the bull:cow ratios are lowest in 13A and E (Table 2). A breakdown of the bull:cow ratio by age class indicates that there were only 4–6 yearling bulls:100 cows observed during this reporting period (Table 1). Recruitment of yearling bulls is down about 66% from the 12 yearling bulls:100 cows observed in 1988. During the fall 1999 composition counts, classifying bulls by antler size resulted in a distribution that included 20% yearlings, 44% with antlers 30–39 inches, 28% with antlers 40–49 inches, and only 8% of bulls with >50-inch antlers. These data indicate that only 8% of the Unit 13 posthunt bull population left to breed were mature bulls. This is especially important because in portions of Unit 13 where bull:cow ratios are the lowest, the few remaining bulls are also the youngest.

Calf survival to fall in 1998 and 1999 was 14 calves:100 cows, the lowest ever observed in the unit (Table 1). Between 1978 and 1988 calf production and survival were high, varying from 22 to 31 calves:100 cows per year. The 26 calves:100 cows observed in 1996 was the only time during this reporting period that the calf/cow ratio approached ratios observed in the mid-1980s, when moose numbers were increasing in Unit 13.

The number of cows counted per hour of survey time during fall sex and age counts is also monitored. Trends in adult cow abundance are more sensitive to population changes because they are not currently hunted and are more resistant to climatic factors. Between 1986 and 1988 the fall sex and age composition data showed an average cow per hour figure of 47. The 1990–97 average estimate of cows per hour was 39, down by 17%. The cow per hour rate continued to decline in 1998 and 1999 to 35 and 34 cows per hour respectively, about an overall 12% drop. In addition to a decline in cow numbers, the average age of the remaining cows is getting older because of lower calf recruitment during most of the 1990s. As the population ages, cows become more susceptible to severe winters and predation, and mortality increases.

Productivity

In 13A West, radiocollared moose subjected to ultrasound pregnancy exams during November of 1994, 1995, and 1997 exhibited an average pregnancy rate of 88%, which was maintained until spring in all but 1 year (Testa 1997). These pregnancy rates approach those observed during the 1980s when calf recruitment to fall was higher. Fall inutero twinning rate was 27% for radiocollared cows in 13A that were pregnancy tested by ultrasound, while twinning rate at birth, based on calf observations, was 13%. Twinning for collared cows in 13A during the last few years increased to about 18%. Twinning rates are obtained in other units by aerial surveys in early June, just past the peak of parturition. Twinning rates show large yearly fluctuations that probably reflect small sample size more than reproductive change. In 13E twinning rates fell from a high of 39% in 1995 to a low of 12% in 1997. In

13C, rates vary from 33% to 17% while 13B had swings from 20% to 42%. For interior Alaska moose populations, twinning rates of 20% indicate average productivity.

Distribution and Movements

Data from fall composition surveys, censuses, and stratification flights indicated that in recent years moose densities were highest in Units 13A, 13B, and 13C (Table 2). Moose were most abundant along the southern slopes of the Alaska Range in 13B and 13C and the eastern Talkeetna Mountains in 13A. Unit 13D and the Lake Louise Flats have the lowest observed density. Fall rutting and postrutting concentrations are in subalpine habitats. The distribution of wintering moose depends on snow depth. Moose move down to wintering areas at lower elevations as snow depth increases. Known winter concentration areas include the upper Susitna River, the eastern foothills of the Talkeetna Mountains, the Tulsona Creek burn, and the Copper River floodplain in Unit 13C.

Mortality

Harvest

Season and Bag Limit. Season dates and bag limits for the general state moose hunt between 1993–98 were 20 August–20 September, and the bag limit was 1 bull with a spike/fork antler on 1 side or 3 brow tines on 1 side, or a spread of 50 inches or more. A Tier II subsistence permit hunt was established in 1995 with 150 Tier II permits issued. Permits are limited to 1 per household. The Tier II hunting season during this report period was 1–19 August. A federal subsistence hunt was established in 1990 for Unit 13 residents with only 1 permit issued per household, a bag limit of any bull and season dates of 20 August–20 September. This hunt has subsequently been expanded and residents of some communities in units 12 and 20 are now eligible and the season lengthened to 1 August–20 September.

Board of Game Actions and Emergency Orders. In 1993 the Board of Game standardized moose seasons and bag limits along the road system in Southcentral Alaska. Because of intensive management legislation in 1996 required for moose and caribou, the board changed 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 to 2000 moose per year. This range was adopted due to board findings that human consumption of moose is the preferred use of moose in Unit 13. Subsistence need was set at 600 moose each year. In 1999 the Board reduced the moose season by 10 days in Unit 13 with season dates of 1–20 September. In 1997 the board increased the Tier II season by 4 days, with season dates of 1–19 August, then in 1999 changed the season dates to 15–31 August. The 2000/01 moose season was reduced by emergency order in May 2000 for units 13A, B, and E, with season dates of 1–15 September, while 13C and D remained unchanged.

Hunter Harvest. In 1998–99 reported harvest for Unit 13 was 939 moose from the combined state and federal subsistence seasons (Table 3). Harvests have averaged 967 moose a year over the last 5 years with a declining trend. During 1998, 5433 hunters reported hunting in

Unit 13. Since 1995, when reported hunters peaked at 6215, hunting pressure has been declining (13%).

We gathered preliminary harvest data for the 1999 moose season by hand-tabulating harvest report forms. To date, 731 bull moose have been reported taken in Unit 13 during the 1999 season under the general state hunt. This figure is down from the prior year's take at this time, indicating the harvest may decline a little from that reported in 1998 due to the 10-day reduction in season length.

General Hunt. Harvest ticket returns from 1998 showed 860 bulls taken by 4943 hunters during the general state hunt (Table 4). Unit harvest for all hunters reporting harvest locations in this hunt during 1998 includes: 13A – 222; 13B – 236; 13C – 136; 13D – 57; 13E – 191. Harvests in all units except 13A declined. We determined antler measurements and the number of brow tines for bulls harvested under the general state hunt from harvest ticket returns. This antler composition data of the bull harvest is available through the 1998 season. In 1993, the first year under the spike-fork/50-inch regulation, 18% of the harvest was reported to be spike-forked bulls, 31% were bulls with antlers less than 50 inches, and 51% had antlers greater than 50-inch spreads. The latest antler composition data from 1998 indicate 33% of the harvest was spike-forked bulls, 40% <50 inches and 27% ≥50 inches. This indicates the harvest of large bulls has declined and young bulls now account for 73% of the bag. Brow tine data from large bulls indicate that 68% of the bulls with spreads >50 inch have 3 brow tines and only 32% have 4 or more tines. In bulls harvested with antler spreads <50 inches, 81% have 3 brow tines and only 19% have 4 or more. It is clear from this data that a much lower number of bulls in Unit 13 have 4 brow tines than have 3. This harvest composition data for harvested bulls support conclusions that the bull population is skewed against large, mature bulls because of the current selective harvest strategy.

Permit Hunts. The current federal subsistence hunt replaced a previous state registration subsistence hunt in 1990. The Bureau of Land Management (BLM) assumed management of subsistence moose hunting on federal land in 1990, following the McDowell decision. They issue registration permits to applicants who are rural residents of Unit 13, as well as residents of those communities in adjacent units that convinced the Federal Board that they needed to hunt in Unit 13. Only 2 small tracks of federal land in 13B and 13D are open to this hunt. Harvests under this permit hunt are presented in Table 5. This is a very popular hunt for Unit 13 residents, shown by the high number of households getting permits. Harvests are low and have been relatively stable the last 5 years with no trend evident. Since the amount of federal land open for this hunt is extremely limited, the any-bull bag limit has resulted in a low bull:cow ratio on federal lands surveyed; but because harvests are so concentrated, this hunt does not influence bull:cow ratios on state lands.

Cow moose hunts were held by drawing permit in 13A West in 1993 and 1994, and 36 and 39 cows were taken, respectively. Low calf recruitment has resulted in cancellations of this hunt since 1995.

A state subsistence moose hunt with 150 permits issued for any bull was initiated in 1995, with participation decided under the Tier II permitting system. The harvest in 1998 was 38 bulls (Table 5). This subsistence take is only 4% of the unit harvest, barely influencing age composition of bulls remaining after the hunting season. Antler composition data from this harvest show a smaller average size of harvested bulls than those taken under the general hunt.

Illegal Harvests. Unreported and illegal harvest estimates are given in Table 3. Estimates of illegal take are high, (and I believe could exceed 10% of the reported harvest) because of the spike-fork/50-inch regulation. A number of yearlings taken and reported as forks may actually be illegal because of the difficulty distinguishing small paddles and palms from forks. Also, I believe numerous sub-50-inch bulls are harvested because so few hunters (probably less than 10%) can tell a 50-inch bull from a 45-inch bull in the field. This assumption is based on 5 years of field experience monitoring this hunt as well as F&W Protection case reports. Many of the illegal bulls taken are honest mistakes. However, once an illegal bull is taken, I think most are subsequently reported as legal. This increased illegal take is important because it often comes from heavily hunted areas where very few legal bulls remain. Composition data confirm that illegal take has increased. Current bull:cow ratios in some areas, such as 13A, are lower than expected given the number of bulls that should be protected under a spike-fork/50-inch regulation.

Hunter Residency and Success. Local residents of Unit 13 accounted for between 8%-10% of the moose harvested under the general season, according to harvest ticket returns (Table 4). Nonresident moose hunters averaged 10% of the unit-wide moose harvest in 1998. Alaskans residing outside Unit 13 accounted for the remaining 80% of the harvest. During the last 2 years, under the Tier II permit hunt, unit residents harvested 78% of the moose.

The success rate for moose hunters in the Unit 13 general hunt has been between 16% and 17% since 1993 (Table 4). Hunter success for the 10-year period before 1993 averaged 24%. The hunter success rate for the Tier II subsistence permit hunt was 29% and 11% for the federal subsistence hunt (Table 5). Successful moose hunters in the general hunt reported spending an average of 8.2 days hunting both in 1998 and during the 5-year reporting period. Hunting effort is up 37% over the late 1980s when successful hunters spent only 6.0 days in the field. In 1989 harvest ticket returns show that 3,556 hunters reported an average of 5.9 days hunting for a total of 21,240 days hunting moose in Unit 13. Hunting effort peaked in 1995 when 5483 hunters spent an average of 10.2 days hunting for a total of 55,938 days afield. Hunting effort declined in 1998 to 50,660 man-days.

Harvest Chronology. Chronology data for the general hunt are presented in Table 6. The last 2 weeks of the season have accounted for more than half the harvest in every year since 1994. This harvest pattern is predictable because moose are more vulnerable later in September. Leaf fall starts occurring at this time and onset of the rut initiates calling and increased bull movements.

Transport Methods. During the last 5 years, 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 are the largest group of hunters and have averaged 60% of the total moose harvest. As a group, aircraft and ORV users other than 4-wheelers have the highest rate of success, while those using a 4-wheeler have a lower success rate.

Other Mortality

Brown bears are abundant in Unit 13 and are important predators of neonatal moose calves, taking up to 50% of the calves born within the first 6 weeks of life (Ballard et al. 1981). Although brown bears kill adult moose, the rate is much lower than calves. Because bears kill so many calves, a reduction in bear predation can result in increased calf survival that is carried over as spring recruitment (Ballard et al. 1987). Wolf numbers in Unit 13 started increasing in 1990. The fall 1998 and 1999 estimates exceed 500 wolves (11.7 wolves/1000km^2), the highest in over 25 years. In the 13A west study area, the fall 1999 moose/wolf ratio was 32:1. This ratio is so low that wolf predation alone could result in a decline in the moose population, especially since in Unit 13 wolves continue to take moose even when caribou are present (Ballard et al. 1987).

The winter severity index between 1996 and 1999 shows a period with mild to average snow depths. The unitwide winter severity index is based on snow depths from 17 snow courses throughout the unit. Moose numbers continued to decline during this period despite the favorable weather conditions. The winter of 2000 was severe and is the second worst winter recorded. Spring 2000 surveys suggest increased mortality resulted from deep snow conditions especially in 13E, which had record snow depths. Observations of winter mortality in Unit 13 over the years have led to the conclusion that moose mortality due to deep snow conditions has not been density dependent. Instead, there appears to be a threshold effect triggering increased calf mortality once snowfall reaches about 30 inches in depth. As the snow pack increases, 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, which increases predation mortality.

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. Current fire suppression policies are presented in the Copper River Fire Management Plan, which sets aside large portions of the unit as let-burn areas where wildfires will not be suppressed. However, this plan has often been ignored and some wildfires have been suppressed, even if they occurred in an area designated as limited suppression. The current level of fire suppression has resulted in fewer fires and reduced seral habitat available as moose browse. The effect has been to lower the moose carrying capacity over extensive portions of Unit 13. Because of the lack of fire-created seral plant communities, climax upland and riparian willow communities are the most important 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. Research continues on evaluating available browse and use by moose in 13A as part of an ongoing moose research project. Preliminary indications are that current browse utilization rates are sustainable (Collins 1997).

The use of prescribed fires to replace wildfires as a method of improving moose habitat has not been successful in Unit 13. The climate in Unit 13 typically limits the use of prescribed fire to only the driest years, when the danger of an escaped fire increases. Also, scattered cabins and private land ownership in the Basin increase the liability associated with the use of prescribed fire. In spite of problems associated with controlled burns, work with BLM and DNR is ongoing and a prescribed fire is scheduled for the summer of 2000 should the fire prescription be met. The area selected for the burn is the prior controlled burn site around Kelly Lake on the south slopes of the Alphabet Hills in Unit 13B. This area was actually lit in 1984, but the fire did not carry because it was too late in the season and ground moisture was too high.

Habitat improvement by mechanical methods such as crushing is an alternative to burning. To be effective, mechanical treatment must be done on riparian habitats where moose concentrate during critical winter months. However, mechanical treatment is expensive, and costs limit mechanical treatment to small but important concentration areas near the road system where access for heavy equipment is available. One such small site was crushed in 1993, and initial regeneration of willows is good. Additional sites for mechanical treatment have been identified along the Copper River in Unit 13C where moose winter during deep snow years. Work continues toward gaining permission from landowners to crush this area.

Because it appears that habitat improvement potential of wildfire is limited, evaluating present habitat conditions is imperative.

CONCLUSIONS AND RECOMMENDATIONS

Changes in moose per hour rates during fall moose counts indicate unit-wide moose numbers declined between 1994 and 1999. Census data from 1994, 1998 and 1999 indicate a 31% decline in Unit 13A. Declines occurred in all sex and age classes.

The calf:cow ratios during fall sex and age composition counts over the last two years are the lowest ever observed in Unit 13. The low counts are attributed to poor survival and are 25–30% below levels observed between 1978 and 1988. Initial calf production has changed little over 20 years, based on pregnancy and birth rates. Pregnancy rates during fall and early spring, coupled with birth rates for pregnancy-checked radiocollared cows, approached those observed in Unit 13 moose during periods of moose population growth. Twinning rates fluctuate between units and years, probably due mostly to small sample size, and are average for an interior moose population on mature range.

The decline in the number of cows observed during both fall counts and censuses continued during the relatively mild winters that occurred during this reporting period. Modeling of the moose population leads to the conclusion that cow abundance will continue to decline over the next few years. The rate of decline could accelerate due to an aging cow population. The decline in calf recruitment has led to a population with an older age structure. The risk of a major decline in cows during a severe winter increases every year because older moose are more susceptible to severe winters and the associated increased predation.

Increased human harvests under the spike-fork/50-inch regulation, predation and a decline in recruitment have reduced the bull:cow ratios from levels observed in the late 1980s. In some portions of the unit, the bull:cow ratio is as low as has ever been observed historically. In harvests under this regulation have greatly skewed the age structure of the Unit 13 bull population so that almost 80% of the bulls left to breed are estimated to be only 3 years of age or younger. Fall pregnancy rates in 13A indicate this low bull:cow ratio has not, as of yet, reduced productivity. However, long-term effects of breeding accomplished by very young bulls are unknown. It certainly has disrupted the normal rut pattern of Alaskan moose in which large, mature bulls exhibit rutting behavior that ensures an effective and efficient breeding season. Any harvest strategy that maintains most of the breeding bull population in the young cohorts should not be considered a suitable long-term management option.

Defining a legal animal by antler size and configuration, by changing season length and dates, and limiting ORV use, has controlled moose harvests in Unit 13. Between 1980 and 1989 the 36-inch regulation and 20-day season were probably insufficient in protecting enough bulls to ensure a bull:cow ratio above 20:100, despite fewer hunters and efficient 4-wheelers then. Moose management strategy changed in 1993 throughout Southcentral Alaska, including Unit 13, when the region adopted a uniform season and bag limit. By adopting a spike-fork/50-inch or 3-brow tine regulation, it was thought that enough bulls would be protected to maintain an adequate bull:cow ratio yet provide for greatly increased hunting opportunity. The season was extended 2 weeks. The Unit 13 moose harvest increased, in response to these liberalizations, to the harvest level observed during the late 1980s. There was also a dramatic increase in hunting pressure, both in the number of hunters in the field and the amount of time spent hunting. The use of ORVs, especially 4-wheelers that were now efficient and affordable, escalated to become the most important transportation method in terms of use and number of harvested moose. With the increased use of ORVs, new trails were developed and the unhunted portion of the unit that served as refugia for bulls during the hunting season diminished. Part of the reason Unit 13 saw such an increase in ORV use and hunting pressure is that the terrain is relatively open, compared to other units, allowing both easy travel and increased visibility. Relatively good visibility allows hunters a reasonable opportunity to determine if antlers are legal.

Based on current harvest and fall composition data, it appears that the spike-fork/50-inch bag limit is not effective in limiting the Unit 13 bull harvests enough to maintain either adequate bull numbers or an even age distribution of bulls. The desire to maintain similar moose regulations along the road system is not sufficient reason to allow any unit to be over-harvested. The current low bull:cow ratio and young age structure of the bulls left to breed after the hunting season are not acceptable long-term management objectives for the unit. Therefore, I recommend reducing the harvest until the bull:cow ratio increases to a minimum of 20 bulls:100 in all areas. I also recommend increasing the number of posthunt mature bulls left in the population to go through the rut.

To increase the number and even the age structure of bulls in Unit 13, I recommend establishing a permit hunt where the number of permits issued is based on a three-year average of recruitment. Permits and harvest quotas would be on a unit basis. The bag limit would be any bull. Moose hunting in Unit 13 is so popular and access so easy that without limiting participation we will always be dealing with over-harvesting of any legal class of bull. By going back to a non-selective harvest strategy we will be eliminating current concerns about genetic effects of the selective harvest strategy.

Alternative, but less effective, recommendations to reduce the harvest include changing the bag limit, shortening the season and redirecting hunter effort to other units. The bag limit should be changed to eliminate the forked yearling as a legal bull. This would provide for increased bull recruitment, especially during the current period of low calf recruitment. Maintaining a spike-yearling in the bag limit will allow some harvest of young bulls. This harvest would be even more focused on the poorer yearling, thus cropping poorer individuals from the gene pool in an attempt to address some concerns about the genetic effects of the selective harvest strategy. Also, enforcement problems would be greatly reduced because many of the illegal bulls taken are yearlings with paddles and palms that were mistaken for forked antlers.

I recommend a season reduction of 5 days unit wide with season dates of 1–15 September. Shortening the season is a successful management tool that lowers hunting pressure and reduces the harvest.

Hunters have concentrated in Unit 13 because it has more open habitat than other units, which are predominantly forested. ORV access is easier in non-forested areas and there are extensive ORV trail systems in Unit 13. But even more important is the effect of the spike-fork/50-inch regulation on concentrating hunters in the open habitats of Unit 13. When you combine increased visibility of moose with the opportunity to use a 4-wheeler, hunting effort increases. Because moose can be more visible in open habitats, a hunter has more opportunity to observe the antlers and determine if the bull is legal. The impact of the 50-inch regulation has been to discourage hunting in timbered areas because it is more difficult to get an unobstructed view of the antler to determine if a bull is legal. It may be necessary to redirect hunting pressure to units that have higher bull:cow ratios. Because hunting is more difficult in these areas, it will be necessary to adopt regulations that force hunters out of Unit 13 and into other areas. Requiring a drawing permit to hunt in Unit 13 would certainly accomplish this. Requiring a unit specific harvest may accomplish this as well. A hunter must choose which roadside unit he wants to hunt moose in that year, and only 1 harvest ticket would be issued for a road-accessible unit.

I also recommend adopting other management actions that would improve survival rates of moose calves that can then be recruited into the population. This action would reverse the downward population trend observed in the unit 13 moose population. Modeling efforts suggest that manipulation of both brown bear and wolf populations would have a significant positive effect on moose abundance. A 3% annual decrease in the brown bear population and a reduction of the wolf population to a density of 3-5 wolves/1000km^2 during the spring should result in a positive 2–5% annual growth rate of the moose population.

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Table 1 Unit 13 fall aerial moose composition counts and estimated population size, 1994–99

Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves %	Adults	Total moose observed	Moose /hour	Density moose mi^2 (range)
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)
1996/97	18	6	25	17	4972	6015	50	1.2 (0.2–3.0)
1997/98	18	6	19	14	5359	6209	56	1.4 (0.2–3.3)
1998/99	18	4	14	11	4904	5496	46	1.2 (0.5–2.1)
1999/2000	21	4	14	11	4234	4738	46	1.1 (0.2–1.8)

Table 2 Unit 13 fall aerial moose composition counts, 1999

Unit	Bulls: 100 Cows	Yearling Bulls:100 Cows	Calves: 100 Cows	Calves %	Total Moose Observed	Moose /hour	Density moose mi^2 (range)
13A	17	3	12	10	1062	47	1.1
13B	21	4	15	11	2141	50	1.4
13C	22	3	10	8	233	33	1.0
13D	65	14	13	7	172	26	0.5
13E	16	3	16	12	1061	47	0.8

Table 3 Unit 13 moose harvest[a] and accidental death, 1994–99

Regulatory year	Reported			Estimated			Accidental			Grand Total
	M	F	Total[b]	Unreported	Illegal	Total	Road	Train[c]	Total	
1994/95	904	40[d]	955	25	25	50	50	29	79	1084
1995/96	963	0	977	25	25	50	50	13	63	1090
1996/97	1018	1	1027	25	25	50	50	15	65	1142
1997/98	930	1	937	25	25	50	50	15	65	1052
1998/99	913	5	939	25	25	50	50	14	64	1053

[a] Includes permit hunt harvest, harvest tickets and federal subsistence hunts.
[b] Includes unknown sex.
[c] 13E – the Alaska Railroad.
[d] Drawing permit hunts in 13A.

Table 4 Unit 13 moose hunter residency and success for general harvest ticket hunt only, 1994–99

Regulatory Year	Successful				Unsuccessful				Total Hunters
	Local[a] Resident	Nonlocal Resident	Non-resident	Total[b]	Local[a] Resident	Nonlocal Resident	Non-resident	Total[b]	
1994/95	83	707	87	886	480	4077	160	765	5651
1995/96	90	716	90	908	414	4103	104	670	5578
1996/97	85	765	84	951	402	4099	122	676	5627
1997/98	66	709	88	869	395	4095	109	641	5510
1998/99	66	697	91	860	410	3523	124	083	4943

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

Table 5 Unit 13 moose harvest data by hunt, 1994–99

Hunt Nr	Regulatory year	Permits issued	Percent Did not Hunt	Percent Unsuccessful Hunters	Percent Successful Hunters	Bulls	Cows	Unknown	Harvest
Tier II	1995/96	150	15	78	22	26	0	0	26
TM300	1996/97	150	13	75	25	32	1	0	33
	1997/98	150	19	77	23	25	0	0	25
	1998/99	150	17	71	29	37	0	1	38
BLM Subsistence 913	1994/95	541	28	92	8	30	0	0	30
	1995/96	527	23	88	12	44	0	0	44
	1996/97	500	26	88	12	43	0	0	43
	1997/98	488	26	86	14	43	0	0	43
	1998/99	557	29	89	11	41	0	0	41

Table 6 Unit 13 moose harvest chronology percent by week for general harvest ticket hunt, 1994–99

Year	Season dates	Week of Season 1st	2nd	3rd	4th	5th	*n*
1994	20 Aug.-20 Sept.	17	10	19	27	27	841
1995	20 Aug.-20 Sept.	14	9	21	32	24	840
1996	20 Aug.-20 Sept.	10	9	21	35	25	910
1997	20 Aug.-20 Sept.	15	11	17	31	26	837
1998	20 Aug.-20 Sept.	13	11	21	30	24	834

Table 7 Unit 13 moose harvest percent by transport method for general harvest ticket hunt, 1994–99

	Percent of Harvest									
Regulatory Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway Vehicle	Airboat	Unknown	*n*
1994/95	15	3	8	36	0	21	16	0	1	886
1995/96	14	4	10	32	0	22	16	0	2	908
1996/97	12	3	7	36	0	23	17	0	1	951
1997/98	10	3	9	41	0	19	15	1	2	869
1998/99	10	4	7	40	0	20	17	1	1	860

LOCATION

GAME MANAGEMENT UNIT: 14A (2561 mi^2)

GEOGRAPHIC DESCRIPTION: Matanuska Valley

BACKGROUND

Moose were scarce in the Matanuska Valley as "colonists" arrived and settled during the 1930s (M. Sherrod personal communication) but probably grew to numbers approaching 7000 during the 1960s (Griese 1995). 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, following the deep snow winter of 1989–90, stabilized between 5000 and 6000 (posthunt).

In the 39 years following statehood (1960–99), hunters reported a harvest of more than 22,930 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 beginning in 1978. During 1978–1999 annual cow harvest has ranged from zero (1990) to 284. Annual harvest of bulls during 1979–1992 averaged 367 (range 201–530). During the period of antler restrictive bag limits, 1993–1997, bull harvest averaged 378 (range 233–554).

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 selective harvest strategy is referred to as "spike-fork-50-inch" (SF50). This strategy was to be evaluated after 5 years (Griese 1995).

Growth of the human population in the Matanuska Valley has been substantial during the past 20 years. Along with human settlement of boreal forests is associated soil and vegetation disturbance promoting dense stands of browse which have attracted moose to roadways and subdivisions and increased conflicts between man and moose. During the early 1980s nonhunting mortality became responsible for up to 25% of total annual moose mortality. Motorists were killing 100–250 moose on roadways annually. Trains killed 4–100 moose annually (100 moose were killed by trains in 1989–90). Illegal harvest was assumed to have increased proportionally to the human population (Griese and Masteller 1998). During the 1990s highway vehicles killed from 85 to 260 moose annually and trains killed 7–40.

Habitat enhancement efforts during the 1990s were aided by a major wildfire. An arsonist created a 37,000-acre fire during June 1996 that produced beneficial habitat changes for moose in the Big Lake area. In 1993 a successful cooperative effort between state agencies resulted in a 900-acre controlled burn to enhance wintering moose habitat near Willow (Collins 1996). The impact of the Big Lake burn politically restricted future prescribed burns.

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 posthunt population of 5000–5500 moose with a sex ratio of 20–25 bulls:100 cows.

Human-Use Objective

To achieve and maintain an average (3-year) annual hunter harvest of 600–700 moose.

METHODS

During 24 November–1 December 1998 we conducted a modified Becker type survey. We desk stratified the survey area and then surveyed 40 sample units previously selected and surveyed during the 1990 Gasaway et al. (1986) census and the 1993 Becker survey (E. Becker pers. commun.). We assumed similar moose distribution among years. We used simulated sightability correction factors (SCF) by strata to generate the population estimate and parameters using MOOSEPOP (D. Reed personal communication). SCFs were 1.78, 1.52, 1.21 and 1.18 for low, medium, high and super-high strata, respectively. During the survey we attempted to not only categorize antler size of bulls but also identify brow-tine counts on bulls with 30-inch or greater antlers.

During 2–18 November 1999 we subsampled 25 of the 40 SUs of the previous year and followed similar assumptions and simulations followed during the 1998 census. We used the SCFs of 1.50, 1.43, 1.22, and 1.18 for low, medium, high and super-high strata, respectively.

We aerially sampled a portion of the primary wintering habitat in the subunit during early March 1998 and 1999 to assess percent short-yearlings in the population and potential recruitment.

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

We collected moose incisors and antler characteristics (i.e., width, number of main palm points, and number of brow palm points) from successful any-bull permit holders and a small number of bulls harvested during the general season.

From a fixed-wing aircraft, we radiotracked and located moose previously captured and radio-tagged in March 1996 and February 1997 (Griese and Masteller, 1998). Moose were located 10 times between July 1997 and February 2000, delineating distribution during mid-winter, calving, midsummer, hunting, rutting and post-rutting seasons. Location data were collected using global positioning system equipment. Wildlife Forever, a hunter sponsored organization, provided $4000 to begin this project, and Safari Club International provided an additional $2500. Data were evaluated using ARCVIEW® GIS software. Results of the tagging and radio-relocation are presented as Appendix.

We participated in the biological evaluation of the SF50 selective harvest management strategy for southcentral Alaska. Results of this evaluation form the appendix of this report. (Biological evaluation of spike-fork/50" moose harvest in Southcentral Alaska, ADF&G unpublished report).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

We believe moose numbers in Unit 14A declined to below 5000 moose, posthunt, during fall 1998, but by the fall 1999 the post-hunt number once again rose to within objective levels (Table 1). We attributed the decline to a combination of higher than normal cow harvest and accidental mortality during 1996 and 1997 (Table 3) and an increase in wolf predation during the same period by a growing wolf population (Masteller 2000) as evidenced by a lower spring calf component (Table 2).

Population Size

We estimated the posthunt moose population at 4729 ± 530 (80% C.I.) during 1998 and 5348 ±721 during fall 1999 (Table 1).

Population Composition

During fall 1998 we observed 17 bulls/100 cows and during fall 1999 we observed 19 bulls:100 cows, both of which were below objective levels (20–25 bulls:100 cows) (Table 1). We hypothesize the low ratio is a product of higher calf mortality from wolves and a significant illegal harvest of sublegal bulls.

Distribution and Movements

See Appendix.

MORTALITY

Harvest

Season and Bag Limit. During 1998 the open season for resident and nonresident hunters included an archery-only season during 10–17 August, a general season from 20 August–20 September, any-bull and antlerless drawing permit hunts during 20 August–20 September and 1–15 November, and a general 'spike-fork-only' season during 20 November–15 December. During the archery-only and early fall 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 and 50 any-bull permits for the 20 August–20 September period, and 70 antlerless permits, and 20 any-bull permits for the 1–15 November hunt (Table 4).

During 1999 and 2000 the open season for resident and nonresident hunters was similar to 1998. The difference was the extension of the fall general season through 25 September and the reduction of the late spike-fork-only season to 5–15 December. The department did not issue any Unit 14A drawing permits for antlerless moose or for any-bull during 1999 or 2000.

Board of Game Actions and Emergency Orders. During the spring 1999 Board of Game meeting the Department presented the results of a Spike-Fork-50 Task Force (TF). The TF considered hunter satisfaction and the success of the SF50 strategy to meet biological and management objectives (see Appendix). The TF agreed that minor variations from the region-wide regulation were appropriate. For Unit 14A the TF considered the option to return to an any-antlered bull season but was concerned about excessive harvest from high hunter attraction to the area. The alternative was to allow more any-bull drawing permits or to lengthen the general season. Local advisory committees preferred the later thus the TF recommended the Board adopt the extended season to 25 September. The TF also agreed that the late spike-fork-only season was too long, creating unnecessary levels of moose disturbance and recommended a reduction by 15 days. Finally the TF recommended against issuing any-bull drawing permits in 14A until the bull:cow ratio recovered to objective levels.

The Department informed the Board our intent to not issue any antlerless moose drawing permits for 14A until the population exceeded the upper end of the population objective, i.e., >5500. This action came at the request of local advisory committees. The Board concurrently allocated all future antlerless moose permits for 14A to Alaska residents only.

Hunter Harvest. Hunters reported taking 30% fewer bull moose in the 1998 and 1999 general seasons than the 1996 and 1997 seasons (Table 5). The combined effect of the lower general season harvest and fewer drawing permits being issued is a 3-year (1997–1999) average harvest of 555 moose, which is below the human use objective. While hunters reported only slightly lower hunters success of 11% during this period hunter participation had also declined (Table 5).

While antler sizes of moose harvested during the general season suggest similar composition to previous years, a high level of noncooperation by hunters is indicated. Hunters failed to provide antler measurements on an alarming 35% of the harvest reports. It is uncertain if this statistic reflects a substantial increase in the harvest of sublegal bulls. Antler sizes reported by hunters for 1998 and 1999, combined, indicated bulls with less than a 35-inch antler spread (assumed to include all spike-fork yearlings) were 73% of the reported harvest (for which measurements were provided). Another 13% of the measured antlers were in the 35–49.9 inches category; most are assumed to have 3 or more brow tines on at least 1 side. Those antlers reaching or exceeding 50 inches in width were reported to be 14%.

Permit Hunts. The department issued drawing permits only during the 1998 season producing a harvest of 26 bulls and 208 cows (Table 4). Permittees hunting during the late season experienced a lower than average success rate due to lack of favorable snow conditions which would move moose to low elevations. Hunter success rates during the early seasons were typical for that period (Table 4).

Antler–age comparison. We added 74 age and antler configuration data points for a total N = 426 which effected little change to antler-age distribution reported previously (Griese and Masteller 1998).

Hunter Residency and Success. An average of 3100 hunters reported hunting in the subunit during 1998 and 1999 (Table 5). Hunter success decreased only slightly to 11%. Residency composition of hunters changed little from previous years.

Harvest Chronology. Modifications to the general season dispersed the chronology of harvest relatively evenly across all evaluation periods (Table 6). Although harvest during the early August archery-only season remained less than 10, the remaining periods showed a range in harvest of 14–71 moose.

Transport Methods. The most notable change to hunter transport methods was the declining component for snowmachines. Poor snow conditions, shortening of the late spike-fork-only season in 1999 and a general reduction in the availability of spike-forks were likely responsible. The component of hunters using 4-wheelers continued to increase and boats returned to previous levels.

Accidental and Illegal Mortality

Accidental human-caused moose mortality during the 5-year period 1995–1999 averaged 150 moose by highway vehicle and 18 by train (Table 3). This compares to 172 and 20 moose killed during the 1990–1994 period.

Adding to recent accidental mortality was a higher than normal "illegal harvest." The number of illegal moose, primarily bulls, has increased in units where the SF50 regulation has been in effect (Schwartz et al. 1992). Enforcement officers (C. Yoder, personal communication) indicated higher illegal bull harvests, especially with the additional spike-fork-only season. We subsequently increased our estimate of illegal kills (Griese and Masteller 1998) (Table 3).

Natural Mortality

We believe the late winter composition counts reflect an increasing influence on the subunit moose population by wolves. A lack of significant snow depth during winter 1998–99 was expected to produce near 20% calves, yet during both March 1999 and 2000 calves were represented by only 17% of the population (Table 2). Snowpack during winter 1999–00 was above average and may have been primarily responsible for the continued low calf survival.

HABITAT

Enhancement

We conducted no habitat enhancement activities during this period.

CONCLUSIONS AND RECOMMENDATIONS

The population fell below the size objective during 1998 but recovered in 1999.

Bull:cow ratios fell to just below objective levels. We believe that illegal /unreported harvest may be adversely affecting this ratio. Reduced recruitment and reduced harvest of cows may have also played a role.

The human-use objective (a 3-year-average of 600–700 moose harvested by hunters) fell below objectives during 1999, when it fell to 555 moose.

Modification to future hunting regulations should address the period when hunters on snowmachines intentionally or unintentionally harass moose during the November–December seasons. At that time of year, bulls are intent on recovering body weight lost during the rut while cows and calves gain nutrients and weight important in enhancing recruitment. Continual inspection of nonlegal moose by hunters may force moose from preferred feeding areas, especially those in the subalpine zone.

Research effort on identifying the impact of snowmachine disturbance, either by hunters or recreational users, is long overdue. Post-rut distribution of moose in the last 10-years has shifted dramatically in those areas prone to snowmachine use. One such area in 14A is the west end of Bald Mountain Ridge. This once high moose density area may need special legislative protection for moose during the early winter.

The population identity study initiated during 1994 has provided useful management information. We believe effective intensive management in this subunit calls for continued investigation into the distribution and movement of moose within the boundaries. The importance of the Pt. MacKenzie agricultural project and the 1996 Big Lake burn to moose and the influence of the high quality habitat on their movement and distribution should be the next study.

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Table 1 Unit 14A fall aerial moose composition surveys and censuses, 1991–99

Regulatory year	Bulls: 100 cows	Yearling Bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	.... moose observed	Moose /mi^2	Estimated Population size
1991–92 [a]	14	5	39	26	1110	1472	3.7	5885±706[b]
1992–93[c]	9	6	40	27	697	934	n/a	5200–6200
1993–94[d]	16	11	37	24	942	1232	3.6	5672±798[b]
1994–95[c]	21	8	35	22	1098	1398	n/a	5500–6500
1995–96[e]	--	--	--	--	--	--	--	5000–5500
1996–97[f]	23	6	42	25	1696	2290	n/a	5500–6500
1997–98[g]	14	5	30	21	611	774	n/a	5000–6000
1998–99[h]	17	7	33	22	1191	1509	3.0	4729±530 [b]
1999–00[h]	19	10	37	24	1021	1317	3.5	5348±721 [b]

[a] Gasaway, et al (1986) census.
[b] 80% confidence intervals.
[c] A sampling of 1991 surveyed units (Griese and Masteller,1996).
[d] Becker survey.
[e] No surveys flown.
[f] Combined results of "census" of Matanuska River drainage east of Moose Creek and composition surveys in CAs 1–7 &Pt. MacKenzie
[g] Incomplete Becker survey, cut short due to apparent antler drop.
[h] Modified Becker survey, i.e. non-random sampling but duplication of 1991 "Gasaway" sampling units.

Table 2 Unit 14A late winter aerial moose composition surveys, 1990–99

Regulatory year	Date	Count areas	Total moose	Calves[a]	Percent calves
1990–91	03–04–11	5,6&8	1348	167	12
1991–92	02/25	7	121	26	21
	04/10	3–6 & 8	546	76	14
1992–93	03/24	4–8	693	131	19
1993–94	03/05–09	4–8	981	175	18
1994–95	04/03–04	4–8 & Pt. McKenzie	518	75	14
1995–96	03/28	6 & Pt. McKenzie	471	85	18
1996–97	04/08–09	5,6,8 & Pt. MacKenzie	226	53	23
1997–98	no count				
1998–99	03/12–15	4–8 & Pt. MacKenzie	1178	201	17
1999–00	03/08–10	1,2,4–8 & Pt. MacKenzie	1291	222	17

[a] Calves = short yearlings

Table 3 Unit 14A moose harvest[a] and accidental death, 1990–99

Regulatory year	Reported			Estimated			Accidental deaths[e]			Grand total
	M	F	Total[b]	Unreported[c]	Illegal[d]	Total	Road	Train	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
1995–96	335	128	471	22	50	72	85	11	96	639
1996–97	554	284	846	35	50	85	185	17	202	1133
1997–98	488	249	741	33	55	83	168	16	184	1008
1998–99	376	212	596	25	55	80	129	14	143	819
1999–00	319	0	328	23	60	83	181	34	215	626

[a] Includes permit hunt harvest.
[b] Total includes moose of unknown sex.
[c] This estimate was derived by taking 5–7% 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 4 Moose harvest data by permit hunts in Unit 14A, 1990–99.

Hunt	Regulatory year	Applicants	Permits issued	Percent[a] did not hunt	Percent[a] unsuccessful hunters	Percent[a] successful hunters.	Bulls	Cows	Total
DM411 (Any bull–early fall)									
	1995–96	1521	70	16	54	29	20	0	20
	1996–97	1978	100	10	53	37	37	0	37
	1997–98	1414	50	6	70	24	12	0	12
	1998–99	1463	50	16	52	28	14	0	14
	1999–00	--	0	--	--	--	--	--	--
DM412 (Any bull – late fall)									
	1995–96	1078	20	5	35	60	12	0	12
	1996–97	1235	30	4	11	86	24	0	24
	1997–98	1162	20	20	25	55	11	0	11
	1998–99	1200	20	10	45	45	9	0	9
	1999–00	--	0	--	--	--	--	--	--
DM418 (Antlerless - late fall)									
	1993–94	3760	70	13	40	47	3	30	33
	1994–95	5464	100	10	13	77	5	71	76
	1995–96	4781	70	14	31	54	2	36	38
	1996–97	3866	70	14	0	86	2	58	60
	1997–98	3252	70	4	20	76	0	53	53
	1998–99	3740	70	11	49	40	2	26	28

Table 4 Continued

1999–00	---	0	---	---	---	---	---	---
DM419 & 420 (Antlerless–early fall)								
1990–91	0	0	---	---	---	---	---	---
1991–92	7057	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
1995–96	10,075	200	7	48	46	1	90	91
1996–97	10,447	500	8	44	48	3	225	231
1997–98	8675	450	8	48	44	1	195	197
1998–99	9230	400	8	46	46	1	182	183
1999–00	---	0	---	---	---	---	---	---

[a] Percent of permits issued.

Table 5 Unit 14A moose hunter[a] residency and success, 1990–99

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonres.	Unk.	Total (%)	Local[b] resident	Nonlocal resident	Nonres.	Unk.	Total (%)	
1990–91	242	3	8	6	259 (14)	1466	22	14	26	1528 (86)	1787
1991–92	469	11	9	6	495 (17)	2286	39	12	23	2360 (83)	2855
1992–93	500	12	12	15	539 (16)	2629	50	24	102	2805 (84)	3344
1993–94	215	4	1	6	226 (9)	2291	59	11	68	2429 (91)	2655
1994–95	274	6	1	1	282 (11)	2208	46	4	18	2286 (89)	2568
1995–96	294	11	2	3	310 (9)	2997	84	22	17	3120 (91)	3430
1996–97	471	11	11	1	494 (12)	3324	79	40	21	3464 (88)	3958
1997–98	435	21	5	7	468 (12)	3161	68	43	18	3299 (88)	3758
1998–99	332	16	11	3	362 (11)	2837	85	30	27	2979 (89)	3341
1999–00	311	9	5	0	325 (11)	2429	64	21	29	2543 (89)	2871

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

Table 6 Unit 14A moose harvest chronology[a] 1990–99

Regulatory	August			September				November	December			
year	10–17	20–26	27–31	1–7	8–14	15–20	21–25	20–30	1–7	8–15	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	17	24	37	68	--	--	--	--	6	227
1994–95[d]	--	63	31	50	44	87	--	--	--	--	16	279
1995–96[e]	3	69	20	47	31	45	--	41	8	36	20	310
1996–97[e]	8	88	20	43	50	66	--	133	30	39	17	494
1997–98[e]	3	85	22	35	41	61	--	110	41	51	19	468
1998–99[e]	2	71	25	43	39	57	--	46	21	45	13	362
1999–00[f]	6	57	14	32	25	43	52	--	35	50	14	328

[a] Does not include harvest from drawing permit hunts.

[b] Open season = Sep 1–10.

[c] Open season = Sep 1–20.

[d] Open season = Aug 20–Sep 20 (SF/50 –"spike-fork/50-inch").

[e] Open season = Aug 10–17 (Archery only), Aug 20–Sep 20 (Gen.SF/50), Nov 20–Dec 15 (SF).

[f] Open season = Aug 10–17 (Archery only), Aug 20–Sep 25 (Gen.SF/50), Dec 5–Dec 15 (SF).

Table 7 Unit 14A percent transport methods of successful moose hunters[a], 1990–99

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk.	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
1995–96	2	3	10	29	1	2	41	7	310
1996–97	2	3	7	21	16	7	40	4	494
1997–98	3	3	6	29	18	4	34	3	468
1998–99	4	4	8	35	6	5	33	5	362
1999–00	3	2	13	29	7	6	37	3	328

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

LOCATION

GAME MANAGEMENT UNIT: 14B (2152 mi^2)

GEOGRAPHIC DESCRIPTION: Western Talkeetna Mountains

BACKGROUND

The moose population in Unit 14B had increased since the mid-1900s because of predator control efforts and vegetation changes induced by human settlement (LeResche et al. 1974). The first calculated population estimate showed moose numbers reaching 2814 ± 248 (80% CI) in fall 1987 (Masteller 1995). The population declined about 35% following the deep-snow winter of 1989/90 (Masteller 1995). The population grew to 2336 ± 527 (80% CI) by the fall of 1994 but the severe winter of 1994–95 might have caused up to 15% mortality (Masteller 1998).

One of the primary moose wintering areas is associated with the main transportation route between Fairbanks and Anchorage. Mortality from motor vehicle and train collisions often exceeds hunter harvest in Unit 14B (Masteller 1995), especially during heavy snow years. During 1989/90, at least 411 moose died in auto/train collisions (Masteller 1995). Griese (1996) reported accidental deaths of at least 90 moose during the winter 1994–95. This high level of accidental mortality affects more than just the 14B population. Modafferi (1999) found a high proportion of moose from Unit 16A dispersed to other units during winter, thus exposing moose to crossing the transportation corridor in Unit 14B.

While hunter harvest of moose in Unit 14B has always been affected by poor hunter access, season and bag limit restrictions have caused large changes in harvest. From 1966 to 1970 hunters killed an average of 144 moose annually, predominantly bulls (Masteller 1998). 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. Since antler restrictions were enacted beginning fall 1993, harvests have averaged below 60 moose per year.

MANAGEMENT DIRECTION

MANAGEMENT GOAL

- Produce high yields of moose for humans
- Provide maximum opportunity to hunt moose

MANAGEMENT OBJECTIVE

- Manage 2500–2800 moose, with a sex ratio of no less than 20 bulls:100 cows during the rut
- Achieve and maintain an average (3-year) annual harvest of 200–300 moose

METHODS

We conducted a high-grade composition survey in November 1998. During October and November 1999, we generated a population estimate using the Gasaway et al. (1986) stratified random census technique.

The harvest was monitored with harvest reports and permits from Unit 14B hunters. Successful permit holders were required to provide antlers for measurement and lower front teeth for age determination. Antler-age data collected from any-bull permit hunts were evaluated and presented in the Unit 14A management report. The Alaska Railroad Corporation provided numbers of moose killed by trains, and the Department of Public Safety provided numbers of moose killed illegally by highway vehicles or in defense of life or property.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population size

During the October–November 1999 Gasaway survey, counting conditions were excellent. The resulting moose population estimate in Unit 14B was 1687 ± 244 (80%CI) (Table 1). However, the winter of 1999/00 had deep snow conditions that contributed to the highest number of road/railroad kills (100) since 1990 (Table 2). The moose population had decreased about 28% since the Becker survey of 1994, and was comparable to levels found in 1990 and 1992 prior to the impacts of the 1999–00 winter. We expect a 10–20% lower population in 2000–01.

Population Composition

In our November 1998 survey, we observed 38 bulls and 11 calves:100 cows with 8% of the sampled population being calves (Table 1). The fall 1999 survey estimated 40 bulls and 21 calves:100 cows with 13% of the sampled population as calves (Table 1). The yearling bull:cow ratio was 10:100 in 1998 and 12:100 in 1999.

MORTALITY

Harvest

Season and Bag Limit. The fall 1998 general open season was 10–17 August (for archery-only hunters), 20 August–20 September and 20 November–15 December for all resident and nonresident hunters. During the 2 early seasons, the bag limit was 1 bull with a spike or fork antler on at least 1 side or with an antler spread that measured at least 50 inches or with antlers that had 3 or more brow tines on at least 1 side (SF50). The late season bag limit was 1 bull with spike or fork antlers only. Drawing permits to take any bull were issued for the 20 August–20 September and 1–15 November periods. We issued 100 any-bull permits for the early hunt and 30 any-bull permits for the November hunt.

Board of Game Actions and Emergency Orders. The board adopted the SF50 selective harvest strategy beginning in fall 1993. The board and ADF&G agreed to test this management strategy for 5 years. In 1998, a SF50 Task Force was formed to review and evaluate the biological consequences of the regulation, evaluate hunter acceptance, and develop proposals to address biological issues and/or improve hunter satisfaction. Members of the Task Force included ADF&G staff, members of the public (through Advisory Committees), and Fish & Wildlife Protection (Appendix).

In response to recommendations made by the SF50 Task Force, the board extended the fall 1999 general season 5 days during September 20–25, for all resident and nonresident hunters. Bag limit and antler restrictions did not change. The late season spike/fork-only hunt was shortened to 5–15 December. Beginning in 1999–00, no any-bull permits for the August–September season were issued in response to recommendations from the SF50 Task Force. Any-bull drawing permits were limited to 1–15 November. Sixty drawing permits would be issued.

Hunter Harvest. Reported harvest has decreased since 90 bulls were taken during 1996–97 (Table 2). Hunters harvested 80 bulls in 1998/99 and 58 bulls in 1999–00. The proportion of the annual reported harvest from the any-bull drawing permit was relatively consistent, (34% in 1997–98, 24% in 1998–99, and 28% in 1999–00), even though the number of permits issued dropped from 130 in 1997–98 and 1998–99, to 60 in 1999–00 (Table 3).

Hunter Residency and Success. During 1999–00, only 245 hunters reported hunting in 14B which was down from 471 and 483 in 1997–98 and 1998–99, respectively (Table 4). This level of interest is far below the number of hunters reporting during the late 1980s (Figure 1). Unit residents were responsible for 88% of the reported harvest during the last 3 seasons (1997–1999), while nonresidents took 8%.

Combined resident and nonresident hunter success during the 7 years prior to the SF50 regulation (1986–1992) averaged 18% (Figure 1). Post-SF50 combined hunter success (1993–1999) averaged 11%. The relatively high hunter success in 1999–00 (17%) was most likely due to the low number of hunters in the field and a relatively high bull:cow ratio (Figure 1).

Harvest Chronology. During 1998/99, Unit 14B hunters reported taking an average of 2.3 moose/day during 15–20 September, their most productive period. The extended season (21–25 September) accounted for an additional 9 animals taken in 1999–00 (Table 5). The archery only season (10–17 August) accounted for an average of 1 bull/year from 1998–1999. The late spike/fork hunt harvested 15 moose in 1998/99 and 5 in the shortened 1999–00 season.

Transport Methods. During 1999–00 the only noticeable difference in transport methods used by successful hunters was the decline in boat use (Table 6). Four-wheelers have accounted for 27–41% of the transportation type used by successful hunters in the past 8 seasons (Table 6).

Other Mortality

Deep snow during 1999–00 contributed to the deaths of at least 100 moose from auto/train collisions (Table 2). This was the highest total since 1989–90 when 411 moose deaths were reported (Griese 1993). Residents reported several cases of calves and "small bulls" starving to death during the winter of 1999–00.

HABITAT

Enhancement

Although we had no enhancement projects, sites in Unit 14B hold possibilities for future controlled burns.

CONCLUSIONS AND RECOMMENDATIONS

Even before the winter of 1999/00, the moose population was far below the objective level of 2500–2800. The population may have fallen to half of the objective or less by spring 2000. The average annual harvest by hunters for the last 3 years was 71, far below the objective of 200–300. Even though the number of hunters drastically decreased in 1999–00 (Table 4), the number of any-bull drawing permit applicants for the November hunt (DM416) increased from 899 in 1998–99 to 3778 the following year (Table 3). The increase in applicants for DM416 is likely due to the elimination of the early any-bull permits (DM 415) in 1999–00 and also influenced by the elimination of antlerless moose permits in 14A in 1999–00.

Hunter harvest under the SF50 regulation is unlikely to reach 200 moose unless antler restrictions are relaxed or access opportunities substantially increase. The terrain and lack of roads and trails limit hunting opportunities. The current bull:cow ratio is 40:100, far above the minimum objective level of 20:100. An increase in the number of any-bull permits, or switching back to an any-bull bag limit with a shorter traditional season, may be options to increase hunter harvest.

The SF50 regulation was adopted for Unit 14B because it shared common boundaries with Units 13A and 14A. 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. Annual movements often carry moose across borders of Units 13E, 16A, 14A, and 14B (Modafferi 1999). Therefore, management decisions for Unit 14B should be made in conjunction with neighboring units.

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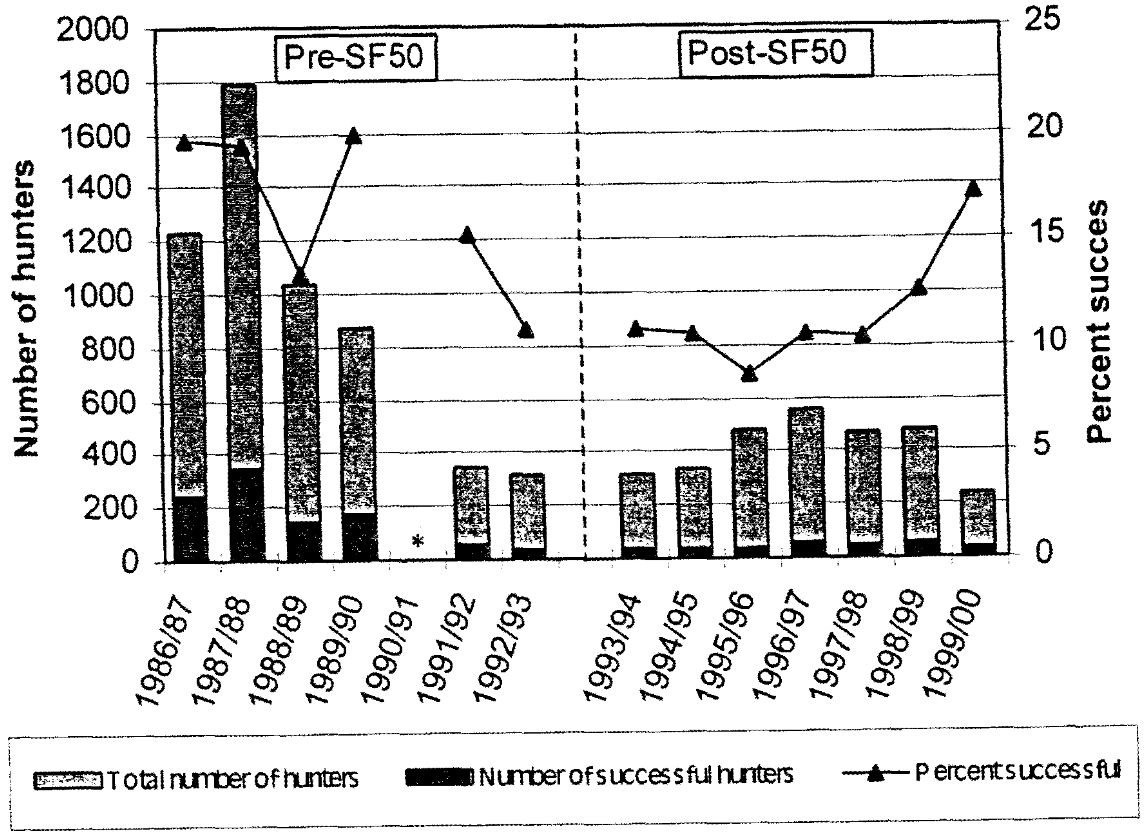

* No open season

Figure 1 Number of hunters and hunter success before and after implementation of the spike/fork-50 inch antler restriction (SF50)

Table 1 Unit 14B fall aerial moose composition surveys, 1992–1999

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Adults observed	Moose observed	Observable moose/mi^2	Population estimate
1992/93 [a]	27.2	4.4	21.7	14.5	580	659	1.5	1582 ± 178 [b]
1993/94 [c]	--	--	--	--	--	--	--	--
1994/95 [d]	31.1	8.2	17.3	12.0	862	969	2.2	2336 ± 527 [b]
1995/96 [c]	--	--	--	--	--	--	--	--
1996/97 [c]	--	--	--	--	--	--	--	--
1997/98 [c]	--	--	--	--	--	--	--	--
1998/99 [e]	37.5	9.5	11.1	7.5	407	440	--	--
1999/00 [f]	40.2	12.3	21.3	13.2	616	699	1.6	1687 ± 244 [b]

[a] 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.

[b] 80% CI

[c] No surveys conducted.

[d] These data derive 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.

[e] High-grade sex and age composition survey conducted 20 November, 1998.

[f] These data derived from "Gasaway Surveys" conducted in late October/early November. SCF estimated at 1.20, 1.33, 1.15, and 1.03 for low, medium-, high-, and s-high-density strata, respectively.

Table 2 Unit 14B annual moose harvest and accidental death, 1992–1999

Regulatory	Reported			Estimated			Accidental[d]			
year	M	F	Total[a]	Unreported[b]	Illegal[c]	Total	Road	Train	Total	Total
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	15	19	34	56	90	145
1995/96	55	0	55	5	20	25	6	21	27	107
1996/97	90	0	90	9	20	29	10	7	17	136
1997/98	72	2	74	7	20	27	13	14	27	128
1998/99	80	0	80	8	20	23	15	18	33	136
1999/00	58	0	58	6	20	21	20	80	100	179

[a] Total includes moose of unknown sex.

[b] This estimate was derived by taking 5% of the total reported kill prior to SF50 (1993) and up to 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 Unit 14B moose harvest data by permit hunt, 1992–99

Hunt	Regulatory year	Applicants	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	Cows	Total
DM415									
	1995/96	896	100	20	73	6	6	0	6
	1996/97	913	100	16	67	12	12	0	12
	1997/98	949	100	14	73	13	12	1	13
	1998/99	1100	100	20	71	9	7	0	7
	1999/00 [a]	--	--	--	--	--	--	--	--
DM416									
	1995/96	642	30	23	53	23	7	0	7
	1996/97	790	30	10	27	63	19	0	19
	1997/98	783	30	10	47	40	12	0	12
	1998/99	899	30	17	43	40	12	0	12
	1999/00	3778	60	12	60	27	16	0	16

[a] Early season any-bull permits were discontinued as a request by the SF50 Task Force.

Table 4 Unit 14B moose hunter residency and success 1992–99

	Successful					Unsuccessful					
Regulatory year	Local[a] resident	Nonlocal resident	Nonres.	Unk.	Total (%)	Local[a] resident	Nonlocal resident	Nonres.	Unk.	Total	Total hunters
1992/93	31	0	3	0	34 (11)	259	10	5	6	280	314
1993/94	27	1	2	1	31 (10)	279	3	2	11	295	326
1994/95	35	0	1	0	36 (11)	290	8	3	4	305	341
1995/96	36	1	2	3	42 (9)	411	13	5	12	441	483
1996/97	54	2	3	0	59 (11)	471	12	9	4	496	555
1997/98	43	1	5	0	49 (10)	393	18	9	2	422	471
1998/99	55	2	4	0	61 (13)	393	13	12	4	422	483
1999/00	36	1	3	2	42 (17)	175	7	7	14	203	245

[a] Unit 14 residents.

Table 5 Unit 14B moose harvest chronology[a], 1992–99

Regulatory	August			September				November	December			
year	10–17	20–26	27–31	1–7	8–14	15–20	21–25	20–30	1–7	8–15	Unknown	Total
1992/93[b]	--	--	--	24	5	--	--	--	--	--	5	34
1993/94[c]	--	5	2	5	6	12	--	--	--	--	1	31
1994/95[c]	--	8	1	1	5	19	--	--	--	--	2	36
1995/96[d]	2	3	0	4	9	13	--	2	2	7	0	42
1996/97[d]	0	15	2	3	8	12	--	9	1	8	1	59
1997/98[d]	1	7	1	6	11	9	--	3	3	6	2	49
1998/99[d]	2	6	5	6	6	16	--	4	4	7	3	61
1999/00[e]	0	6	2	2	5	12	9	--	3	2	1	42

[a] Does not include harvest from drawing permit hunts.
[b] Open season = Sep 1–10.
[c] Open season = Aug 20–Sep 20 (SF/50 –"spike-fork/ 50-inch").
[d] Open season = Aug 10–17 (Archery-only), Aug 20–Sep 20 (Gen.SF/50), Nov 20–Dec 15 (SF-only).
[e] Open season = Aug 10–17 (Archery-only), Aug 20–Sep 25 (Gen.SF/50), Dec 5–15 (SF-only).

Table 6 Transport method used by successful moose hunters in Unit 14B, 1992–99

Regulatory year	Percent of successful moose hunters: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk	Nr moose harvested
1992/93	26	0	0	41	0	15	15	3	34
1993/94	23	0	6	32	0	10	23	6	31
1994/95	8	6	6	36	0	14	25	6	36
1995/96	12	0	7	36	5	12	26	2	42
1996/97	12	0	5	32	20	6	22	5	59
1997/98	16	2	10	27	12	12	18	2	49
1998/99	8	2	5	36	15	10	20	5	61
1999/00	14	2	0	33	12	12	24	2	42

LOCATION

GAME MANAGEMENT UNIT: 14C (1912 mi^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 4 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. Parks, greenbelts, and residential areas in the Anchorage Bowl also contain browse. Quality riparian habitat abounds along area streams and rivers. Extensive stands of subalpine willow are on south-facing slopes in most drainages in the area. However, during the last 2 decades, overabundant moose have reduced the distribution and density of browse species.

Annual harvests have fluctuated dramatically in recent decades. A record harvest of nearly 500 moose (50% females) occurred in 1965, while hunters harvested only 18 moose in 1978. Diverse harvests were often due to changes in seasons and bag limits as much as changes in the moose population. Annual harvests increased steadily during the late 1980s and early 1990s but began to decline in 1992. The 5-year mean harvest during this reporting period is 111 moose (23% cows).

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVE

- Maintain a population of 2000 moose
- Maintain a posthunting sex ratio of no less than 25 bulls:100 cows.

METHODS

We conducted aerial surveys annually, except in 1995, in most hunt areas to estimate sex and age composition during fall and early winter (Table 1). Fall surveys were not flown in 1995 because snow cover was not adequate until late December or early January, after most bulls had shed antlers. Hunters were required to report their success on either harvest or permit reports, depending on whether they participated in the general season or a special permit hunt. The reports require information on days hunted, hired services, harvest date and location, sex of the animal taken, method of transportation, and antler configuration.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Moose populations were reasonably stable during the 1980s. Population stability was partially due to a series of mild winters beginning in 1979–80.

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). Mean snow depths in Anchorage area lowlands are not normally challenging to wintering moose. Since 1988, however, the Anchorage area has had a series of severe winters. Continued severe winters will exacerbate overbrowsing, which may result in substantial losses of moose in subsequent years.

Deep snows during the winter of 1994–95 caused a substantial decline in the unit's moose population. Vehicle collisions and starvation caused most of the known moose mortality. Vehicles and trains collided with moose more frequently than average in 1994–95 (Table 2) because moose were using cleared areas as movement corridors to avoid deeper than average snow. No aerial surveys were conducted in fall 1995. The fall 1996 surveys found the moose population 25–30% below the fall 1994 estimate. The unit's moose population has recovered to near or above the management objective of 2000 by reducing harvests.

Population Size

We estimate a fall 1998 population of 2100 moose in Unit 14C, including the Placer and Portage River drainages (Table 1). About 300 moose inhabit the Anchorage Management Area (excluding the Hillside count area). The population has rebounded since the decline of 1994–95.

Population Composition

The bull:cow ratio ranged from 33:100 to 44:100. It has increased in the Peters Creek and Knik River/Hunter Creek drainages (Table 1). The low bull:cow ratio in the Knik River and Hunter Creek drainages in 1994 was probably due to increased hunting pressure for bulls because all surrounding units adopted a spike-fork/50-inch bull regulation in 1993 while Unit 14C maintained an any bull season. When Unit 14C adopted the spike-fork/50-inch regulation in 1995, the bull:cow ratio increased in these count areas. The bull:cow ratio was intentionally reduced in the Twentymile, Portage, and Placer drainages to enhance winter survival of cows and calves. There is no clear trend in bull:cow ratios on Fort Richardson and the Hillside area. The percentage of calves in the population ranged from 17–19%. The unit had 9 yearling bulls per 100 cows.

Distribution and Movements

Moose are yearlong residents, ranging from sea level to an elevation of 3500 ft. During winters with substantial snow accumulation, most moose are at elevations below 1500 ft. 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 2 September–15 November and 15 December–15 January in 1997/98, and 8 September–15 November and 15 December–15 January in 1998/99. 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. We issued 75–96 archery permits for bulls and antlerless moose and 25 for muzzleloading rifle hunters. We issued an additional 15 drawing permits for both sexes for Elmendorf Air Force Base in 1997 and 1998. The bag limit was 1 moose, and the season was 2–30 September in 1997 and 8–30 September in 1998. 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 2–30 September in 1997 and 8–30 September in 1998. The bag limit was 1 moose by drawing permit and archery only; 15 permits were issued in 1997 and 1998. The open season for resident and nonresident hunters in the Eklutna Lake Management Area was 2–30 September in 1997 and 8–30 September in 1998. The bag limit was 1 bull by archery only. The hunt was administered by registration permit with a quota of 4 bulls. The open season for resident hunters in the remainder of Unit 14C was 2–20 September in 1997 and 8–20 September in 1998. The bag limit was 1 bull moose with spike-fork/50-inch antlers; however, hunters could take antlerless moose by drawing permit only (25 and 40 permits were issued in 1997 and 1998, respectively). The open season for the Twentymile River area was 20 August–30 September for bulls and 20 August–31 October for antlerless moose in 1997 and 1998. The bag limit was 1 moose by drawing permit with 40 permits for bulls and 5 permits for antlerless moose issued in 1997 and 50 permits for bulls in 1998.

Board of Game Actions and Emergency Orders. 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. In March 1997 the Board of Game considered several proposals for hunting with shotguns and muzzleloaders in Chugach State Park and bow hunts in several municipal parks. None was approved. However, the Board of Game finally adopted a moose hunt for the upper Campbell, Rabbit and Potter Creek drainages in March 1999. Beginning in 1998, only Alaska residents could obtain an antlerless moose permit in the remainder of Unit 14C. In March 1999 the Board of Game extended the season for the Eklutna Management Area to October 20 to allow bowhunting during the rut. All antlerless moose hunts were reauthorized annually. No emergency orders were issued during the past 5 years.

Hunter Harvest. During the 1997–98 and 1998–99 seasons, 95 and 97 moose were harvested, respectively, with a 2-year mean of 72 bulls and 24 cows (Table 2). Approximately 26% of the bulls were taken during the general season. The remaining moose were taken in permit hunts.

Permit Hunts. During the 1997–98 season, we issued 411 permits to hunt moose in Unit 14C. Of these, 75 hunters (23%) were successful. In 1998–99, 401 permits were issued and 80 hunters (26%) were successful (Table 4). Drawing permit hunts were very popular. In 1997, 5939 hunters applied for 220 drawing permits (2018 of the applications were for the 45 permits for the Placer/Twentymile hunts). In 1998, 5946 hunters applied for 240 drawing permits (1658 of the applications were for the 50 permits for the Placer/Twentymile hunts). Additionally 190 hunters in 1997 and 161 hunters in 1998 received registration permits for the Eklutna Valley archery hunt. Despite its popularity, the success rate for this hunt, 1–3% in the late 1990s (Table 4), remains low.

Hunter Residency and Success. Residents of Unit 14 accounted for 92% and 97% of the moose harvested in Unit 14C in 1997 and 1998, respectively (Table 3). Nonresidents accounted for 3% and 2% of the total harvest, respectively. As predicted, the regulation that reserved local drawing permits for Alaskan hunters beginning in 1998 did not affect success rates.

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 off-road vehicles in most of Chugach State Park.

Other Mortality

Moose killed by vehicles and trains accounted for 50–58% of known annual mortality during the reporting period. Vehicles killed at least 239 moose and trains killed 22 in 1994–95, a record high because of near-record snow depths that forced many moose into town. During this report period, a mean of at least 166 moose were killed in vehicle and train collisions annually (Table 2). These are conservative figures because not all collisions are reported and some moose, never found, die from injuries.

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

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 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 burning, the most cost-effective method, is difficult to do safely in a densely populated area. Habitat enhancement is not a desirable alternative in Chugach State Park. The Chugach National Forest enhanced 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 winter habitat.

CONCLUSIONS AND RECOMMENDATIONS

Both population objectives were met. The bull:cow ratio exceeded 25:100. The fall 1998 population was approximately 2100 moose.

Existing management programs were developed in cooperation 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.

Nuisance moose in residential areas remain a significant problem. A recent study by the Alaska Department of Transportation and Public Facilities estimated rural moose-vehicle collisions cost an average of $15,150 for vehicle repairs; emergency, medical, and legal services, and lost wages (ADOTPF 1995). Moose-vehicle collisions may cost Anchorage residents $2.4 million/year, 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. Some residents continue to feed local moose, despite the regulation prohibiting feeding, and when a handout is not immediately forthcoming, these moose can be unusually aggressive toward people. Area staff spend considerable time listening and responding to complaints about property damage, public safety concerns, and injured moose. On the other hand, residents tolerate much damage, and many residents and visitors consider moose a desirable species. Public education regarding moose behavior and biology may improve public tolerance and reduce conflicts.

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, was mailed a detailed survey of attitudes, experiences, and expectations about wildlife in Anchorage in 1996. Much of the survey focused on moose and possible changes in management. The response rate was 59%. Most residents enjoyed watching moose in Anchorage (96%), had moose eat their trees, shrubs, or gardens (89%), and most had been in a vehicle that swerved or braked to avoid hitting a moose (72%). Many residents have also been charged by a moose in their neighborhood (16%) or on a local trail (14%); others have been in a vehicle that hit a moose (11%) or had a pet injured or killed by a moose (4%). Residents were asked how often they saw moose in their neighborhood in an average winter. Only 2% never saw moose, 43% saw moose a few times per month, and 33% saw moose at least a few times a week. When asked how often they wanted to see moose in their neighborhood, 22% wanted fewer sightings, 53% were seeing what they wanted, and 25% wanted more. Forty-two percent believed there were an acceptable number of moose/vehicle collisions, but 54% believed there were too many collisions. Nearly two-thirds of the respondents believed the number of moose encounters on trails and in neighborhoods and the number of moose eating ornamental shrubs and gardens was acceptable.

Residents were asked several questions about moose hunting. Sixty-one percent would accept a new moose hunt near Anchorage to reduce the number of moose. Given specifics about a moose hunt in Chugach State Park adjacent to Hillside residential areas, 51% "voted" in favor of the hunt. People who supported the hypothetical hunt believed it would reduce the number of vehicle accidents, reduce the number of potentially dangerous encounters, keep moose below the carrying capacity, and provide good hunting opportunities for Anchorage hunters. People who opposed the hypothetical hunt believed it would generate conflict, cost a lot to administer, prevent nonhunters from using the park, and might injure a hunter or someone else. These data indicate that if the hunt is to be seriously considered, additional attention toward the cost, hunt safety, and temporary loss of park access might help allay some opponents' concerns. Hunt supporters strongly believe this hunt would prevent overpopulation; hunt opponents and undecided residents are only weakly convinced. Emphasizing the biological necessity for reducing the moose population would generate more support from some opponents and undecided residents.

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Table 1 Unit 14C fall aerial moose composition counts and estimated population size, 1994–98

Area	Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Moose observed	Moose/ hour	Estimated population size[a]
Twentymile River	1994–95	38	9	47	25	207	74	
Portage River	1995–96[b]	--	--	--	20	199	57	
Placer River	1996–97	37	11	40	23	168	56	250
	1997–98	30	9	47	27	173	57	
	1998–99	24	4	30	19	181	48	240
Hillside	1994–95	--	--	--	--	--	--	
	1995–96[b]	--	--	--	--	--	--	
	1996–97	30	11	40	23	90	47	125
	1997–98	44	5	38	21	212	77	
	1998–99	29	13	36	22	213	70	280
Anchorage Bowl	1994–95	--	--	--	--	--	--	
(except Hillside)	1995–96[b]	--	--	--	--	--	--	
	1996–97	--	--	--	--	--	--	200[c]
	1997–98	--	--	--	--	--	--	
	1998–99	--	--	--	--	--	--	300[c]
Fort Richardson	1994–95	40	16	28	17	401	--	
Elmendorf AFB	1995–96[b]	--	--	--	--	--	--	
Off-base Ship Cr.	1996–97	57	10	31	16	294	24	340
	1997–98	59	12	33	17	356	36	
	1998–99	42	13	32	18	386	32	500

Table 1 Continued

Area	Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Moose observed	Moose/ hour	Estimated population size[a]
Eagle River	1994–95	--	--	--	--	--	--	
	1995–96[b]	--	--	--	--	--	--	
	1996–97	--	--	--	--	--	--	120
	1997–98	--	--	--	--	--	--	
	1998–99	36	6	22	14	101		130
Peters Creek	1994–95	21	3	29	19	57	43	
	1995–96[b]	--	--	--	--	--	--	
	1996–97	44	11	39	21	33	19	50
	1997–98	52	4	11	7	45	25	
	1998–99	73	16	16	9	69	24	90
Eklutna River Thunderbird Cr.	1994–95	--	--	--	--	--	--	
	1995–96[b]	--	--	--	--	--	--	
	1996–97	--	--	--	--	--	--	110
	1997–98	--	--	--	--	--	--	
	1998–99	18	0	24	17	48	13	60
Bird Creek Indian River	1994–95	--	--	--	--	--	--	
	1995–96[b]	--	--	--	--	--	--	
	1996–97	--	--	--	--	--	--	100[d]
	1997–98	--	--	--	--	--	--	
	1998–99	--	--	--	--	--	--	150[d]

Table 1 Continued

Area	Regulatory Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Moose observed	Moose/ hour	Estimated population size[a]
Hunter Creek	1994–95	11	4	18	14	150	39	
Knik River	1995–96[b]	--	--	--	--	--	--	
	1996–97	27	6	15	13	112	45	150
	1997–98	33	12	16	10	165	47	
	1998–99	36	0	27	16	104	52	140
Lake George	1994–95	--	--	--	--	--	--	
	1995–96	--	--	--	--	--	--	
	1996–97	--	--	--	--	--	--	
	1997–98	43	6	14	9	132	--	
	1998–99	--	--	--	--	--	--	165
Unit 14C	1994–95	33	11	31	19	846	41	
Total	1995–96[b]	--	--	--	--	--	--	
	1996–97	42	10	31	18	697	32	1450
	1997–98	44	9	30	17	1083	45	
	1998–99	36	9	30	18	1102	35	2100

[a] Estimate based on most recent count, using sightability index of 0.77 (based on Fort Richardson estimate calculated with MOOSPOP).

[b] Fall surveys not conducted due to lack of snow; aerial survey of Twentymile/Portage/Placer on March 8 not comparable to other years.

[c] No aerial surveys; estimate is best guess.

[d] Last surveyed in 1988.

Table 2 Unit 14C moose harvest and accidental death, 1994–1998

Regulatory year	Hunter harvest: Reported M (%)	Reported F (%)	Reported Total[a]	Estimated Unreported	Estimated Illegal	Estimated Total	Accidental death[b] Road	Train	Total	**Total**
1994–95	132 (80)	33 (20)	166	10	10	20	239	22	261	447
1995–96	62 (65)	33 (35)	95	10	10	20	114	2	116	231
1996–97	88 (85)	16 (15)	104	10	10	20	136	11	147	271
1997–98	72 (76)	23 (24)	95	10	10	20	137	10	147	262
1998–99	72 (74)	25 (26)	97	10	10	20	152	6	158	275

[a] Includes those with unreported sex.

[b] Reported deaths only.

Table 3 Unit 14C moose hunter residency and success, 1994–98

Regulatory year	Successful				Unsuccessful				Total hunters
	Local resident[a]	Nonlocal resident	Nonresident	Total (%)[b]	Local resident[a]	Nonlocal resident	Nonresident	Total (%)[b]	
1994–95	154	9	2	166 (24)	488	20	6	519 (76)	685
1995–96	83	10	1	95 (20)	352	16	3	372 (80)	467
1996–97	86	14	2	104 (21)	352	22	4	381 (79)	485
1997–98	87	5	3	95 (21)	345	20	4	369 (79)	464
1998–99	94	1	2	97 (19)	418	7	3	428 (81)	525

[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, 1994–98

Hunt no. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Total harvest[a]
DM210, 211	1994–95	50	6	52	48	68	32	22
Twentymile	1995–96	50	22	46	54	76	24	21
Portage	1996–97	50	10	47	53	88	12	24
Placer	1997–98	45	9	54	46	79	21	19
	1998–99	50	16	57	43	100	0	18
DM424,425,427	1994–95	77	16	41	59	58	42	38
Fort Richardson	1995–96	75	12	59	41	56	44	27
(archery only)	1996–97	85	7	65	35	89	11	28
	1997–98	96	10	50	50	72	28	43
	1998–99	95	14	61	39	75	25	32
DM422,423	1994–95	25	13	38	62	69	31	13
Fort Richardson	1995–96	25	24	32	68	62	38	13
(muzzleloader)	1996–97	25	0	68	32	88	12	8
	1997–98	25	24	100	0	--	--	0
	1998–99	25	20	72	28	67	33	6
RM445[b]	1994–95	234	22	99	1	100	0	2
Eklutna	1995–96	187	27	99	1	100	0	1
(archery only)	1996–97	182	29	97	3	100	0	4
	1997–98	190	33	99	1	100	0	1
	1998–99	161	35	97	3	100	0	3

Table 4 Continued

Hunt no. /Area	Regulatory Year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Total harvest[a]
DM441	1994–95	5	20	100	0	0	0	0
Hunter	1995–96	5	20	25	75	0	100	3
Knik	1996–97	5	0	40	60	0	100	3
	1997–98	5	0	100	0	--	--	0
	1998–99	20	15	59	41	17	83	7
DM428, 429	1994–95	15	13	8	92	67	33	12
Elmendorf AFB	1995–96	15	7	14	86	67	33	12
(archery only)	1996–97	15	7	14	86	67	33	12
	1997–98	15	0	33	67	50	50	10
	1998–99	15	7	43	57	50	50	8
DM442	1994–95	10	40	100	0	0	0	0
Ship	1995–96	10	30	57	43	0	100	3
	1996–/97	10	20	88	12	0	100	1
	1997–98	10	30	86	14	0	100	1
	1998–99	10	50	80	20	0	100	1
DM443	1994–95	10	20	88	12	0	100	1
Peters and	1995–96	10	20	100	0	0	0	0
Little Peters	1996–97	10	30	86	14	0	100	1
	1997–98	10	30	100	0	--	--	0
	1998–99	10	10	78	22	0	100	2

Table 4 Continued

Hunt no. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Total harvest[a]
DM448, 449	1994–95	15	20	67	33	75	25	4
Birchwood[c]	1995–96	15	13	85	15	50	50	2
(archery only)	1996–97	15	33	90	10	100	0	1
	1997–98	15	20	92	8	0	100	1
	1998–99	15	7	79	21	33	67	3
Totals for all	1994–95	441	18	72	28	63	37	92
permit hunts	1995–96	392	22	73	27	60	40	82
	1996–97	397	19	75	25	81	19	82
	1997–98	411	22	77	23	69	31	75
	1998–99	401	23	74	26	69	31	80

[a] Includes moose with unspecified sex.

[b] Registration hunt.

[c] Formerly Peters Creek Management Area.

Table 5 Unit 14C moose harvest[a] chronology, 1994–98

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*
1994–95[b]	26	32	42	--	--	69
1995–96[c]	46	36	18	--	--	11
1996–97[d]	24	48	29	--	--	21
1997–98[e]	30	40	30	--	--	20
1998–99[f]	--	56	44	--	--	16

[a] Excludes permit hunt harvests.
[b] Season 9/6–9/20
[c] Season 9/5–9/20
[d] Season 9/3–9/20
[e] Season 9/2–9/20
[f] Season 9/8–9/20

Table 6 Unit 14C moose harvest percent by transport method, 1994–98

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Off-road vehicle	Highway vehicle	Unknown	*n*
1994–95	7	6	10	2	0	1	71	3	154
1995–96	1	3	21	1	0	2	68	3	95
1996–97	8	4	24	1	0	0	63	1	104
1997–98	6	3	18	1	1	2	66	3	97
1998–99	2	5	10	2	0	6	71	3	87

LOCATION

GAME MANAGEMENT UNIT: 15A (1314 mi^2)

GEOGRAPHIC DESCRIPTION: Northern Kenai Peninsula

BACKGROUND

Historical records and reports from residents indicate moose were abundant throughout the century in Unit 15A. The most recent population peak occurred 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 75% of these estimates, a decline from 5900 to 2500 moose. By 1982 the moose population estimate for 15A had increased to 3000.

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 stable near the lower limit of this range due to recent severe winters.

No large wildfires have occurred since the fires in 1947 and 1969 on the Kenai Peninsula. Consequently, less browse associated with successional forest stages was available to moose and a gradual decline in moose population size is anticipated during normal winters. Small wildfires and intentional habitat improvement efforts have temporarily reversed this general trend in local areas.

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 hunters in 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 in 1992, and a 10-year evaluation is scheduled for completion in 1999.

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).

Primary moose management objectives in Skilak Loop Wildlife Management Area (SLWMA) are listed:

- 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.
- Achieve and maintain the resident population at 130 animals or a density of 1.8 to 2.0 moose per mi^2. Resident moose in excess of 130 will be available for harvest.
- Increase the bull to cow ratio to at least 40 bulls:100 cows.

In addition to the resident population, moose from surrounding areas commonly winter in SLWMA. Winter populations reach 300 animals. Habitat will be managed to provide for 130 resident and up to 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 1997 weather conditions were not suitable to conduct fall sex and age composition surveys. In 1998 we counted 6 of 13 count areas in Unit 15A.

A population estimate for Unit 15A was developed from data collected in February 1990. The techniques used were described in Gasaway (1986). The first estimate using these techniques was conducted in 1987. The 1987 results were not strictly comparable with the 1990 estimates. Poor weather prevented us from 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% CI. The 1987 estimate was 2702 ± 9.6% (2441–2963) at the 90% CI. 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 the estimate of 3014–3850 moose more accurate. The current population size is probably between 3000 and 3800 moose in Unit 15A.

Population Composition

Poor weather prevented us from completing a fall sex and age composition survey in 1997. In 1998 we observed 1528 moose in fall composition surveys, compared to 1467 in 1996 (Table 1). Calves composed 17% of the 1998 sample and occurred in the proportion of 27:100 cows. Calf composition data declined compared to data from 1992 to 1996; however, calf survival was high the previous year. Subsequently, there were a substantial number of nonproductive yearling cows in 1998. Bulls were observed at a ratio of 31:100 cows, 5 bulls:100 cows more than in 1996. Yearling bulls increased from 8:100 in 1996 to 11:100 in 1998, after the mild winter of 1997–98. The winter of 1998–99 was extremely harsh: 161 moose, primarily calves, died from starvation, part of a large number of animals that succumbed to the winter.

MORATLITY

Harvest

Season and Bag Limit. The general open season in Unit 15A was from August 20 to September 20. In spring of 1995 the Board of Game approved an archery season for Unit 15A with a season from August 10 to 17. Archery hunters were restricted to the same bag limit used during the general season. The bag limit was 1 bull with spike/fork or 50-inch antlers or at least 3 brow tines on 1 antler. Forty permits were issued in a drawing permit hunt in Skilak Loop Wildlife Management Area for antlerless moose in 1998–99 and 20 for spike/fork bulls in 1997. The antlerless season was from September 15–30 and the spike/fork bull season from September 21–30. The bag limit for the antlerless season prohibited harvesting of calves and females with calves.

Board of Game Actions and Emergency Orders. There was no Board of Game action taken during this reporting period.

Hunter Harvest. In 1997, 1331 hunters harvested 191 moose (187 bulls and 4 of unreported sex) during the nonpermit seasons (Tables 2 and 5). The 1997 harvest declined by 27%, when compared to the 1996 harvest of 260 moose. This reduction in harvest reflects severe winter losses sustained by the 15A moose population from deep snows during the winter of 1996–97.

In 1998, 1418 hunters harvested 271 moose (264 bulls and 7 of unspecified sex) during the nonpermit seasons. The 1998 harvest increased by 30% compared to 1997. The winter of 1997–98 was mild, resulting in high moose survival.

Results of an August 10–17 archery season were included in the total harvest figures for Unit 15A. However, information requested on harvest ticket reports did not include the time spent hunting by unsuccessful hunters; therefore, it was not possible to determine how many hunters went afield during the archery season. Data collected at field checkstations were used to estimate hunter participation. An estimated 200 to 250 archery hunters participated during the 10–17 August 1997 and 1998 archery-only hunts in 15A. They reported a harvest of 38 (20%) and 47 (17%) bulls for the years 1997 and 1998, respectively. Archers, hunting under the spike/fork-50-inch antler restriction, harvested primarily bulls in the spike/fork category.

Of the 191 moose harvested in 1997, 176 (92%) were reported with antler-spread data. Because the current bag limit was designed to focus harvest on a portion of the yearlings and on mature bulls, we assumed that bulls <35-inch antler spread met the yearling (spike/fork) requirement and $\geq$ 35-inch spreads were mature bulls (having 3 brow tines or an antler spread >50 in.). Sixty-one percent (N = 108) of the harvest was spike/fork bulls and 39 percent (N = 68) were mature bulls. Twenty-two percent (N = 39) of the reported harvest was bulls with an antler spread $\geq$ 50-inches. In 1998 the harvest comprised 124 (63%) yearlings and 73 (37%) mature bulls.

Federal subsistence hunters, whose season began on 18 August, harvested no moose during the August 18 and 19 season in either of these years.

Permit Hunts. The antlerless permit hunt in SLWMA was not held in 1997 but was allowed in 1998. There were 990 applicants for 40 permits to hunt antlerless moose, and 36 of the permit winners hunted, harvesting 11 moose (Table 3). There were 598 applicants for 20 permits for spike/fork bulls in SLWMA in 1997; the season was not open in 1998. Thirteen permit holders hunted in 1997, harvesting 1 spike/fork bull (Table 4). All moose harvested in the antlerless hunt were females.

Hunter Residency and Success. The 1997 hunter success was 14%, compared to 19% in 1996. In 1997, 163 (86%) successful hunters were unit residents, 24 (13%) were non-unit residents, and 2 (1%) were nonresidents (N = 189). Two (1%, N = 191) successful hunters failed to report residency. Residency reported for unsuccessful hunters was as follows: unit residents 974, non-unit state residents 144, nonresidents 18, and unspecified residency 4 (Table 5). Successful hunters averaged 7.4 days, compared to 8.0 days for all hunters.

The 1998 hunter success was 19%, compared to 14% in 1997. In 1998, 239 (89%) successful hunters were unit residents, 26 (10%) were nonunit residents, and 3 (1%) were nonresidents (N = 268). Two (1%, N = 271) successful hunters failed to report residency. Residency reported for unsuccessful hunters was as follows: unit residents 988, nonunit state residents 138, nonresidents 17, and unspecified residency 4 (Table 5). Successful hunters averaged 6.9 days, compared to 8.9 days for all hunters.

Transport Methods. Sixty-nine percent of the 1997 successful hunters reported highway vehicles as their primary means of transportation. Boats were the second most common (14%) means of transportation. Hunters using either 4-wheelers, ORVs, or horses accounted for 13% of the reported harvest. Three percent of the successful hunters used aircraft as their means of access. The 1998 transportation data compared closely with 1997, when 72% of successful hunters reported using highway vehicles (Table 6). In 1998, aircraft were used by 3%, compared to 13% for 4-wheelers, ORVs, and horses.

Harvest Chronology. Twenty percent of the 1997 and 17% of the 1998 harvest occurred during the August 10–17 archery season (Table 7). Twenty-four percent of the 1997 and 23% of the 1998 harvest occurred during the first 5 days of the general hunt season. The highest percentage of harvest in 1997 and 1998 occurred during the first 5 days of the general season.

Other Mortality

Crippling loss by hunters and loss to predation was unknown. In 1997, 143 moose were reported killed in 15A by vehicle/wildlife accidents, compared to 138 in 1998. About 50% of moose killed by vehicles each year are calves. Between 1992 and 1998, an average of 131 moose were killed in wildlife/vehicle accidents in Unit 15A. A public awareness program, begun in 1990 to reduce the number of vehicle/wildlife collisions (Del Frate and Spraker 1991), has failed to demonstrate a significant reduction in accidents.

HABITAT

Assessment

The 1969 burn (85,000 acres) 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 compose only 10–15% of moose habitat in the unit. The remaining moose habitat is unproductive due to forest succession and browse heights not optimal for moose.

Enhancement

In May 1991 approximately 8320 acres burned in the southeastern portion of 15A near Pothole Lake. This burn is expected to increase available moose habitat; however, this may only benefit animals in the immediate area of the burn due to its small size. Substantial statewide publicity regarding beneficial effects of wildfire for forest succession wildlife stemmed from the Pothole Lake fire.

A 10,369-acre area in the Mystery Creek Road vicinity was to be burned by U.S. Fish and Wildlife Service in the fall of 1991. Unfavorable weather conditions and other factors have prevented this prescribed burn project. Approximately 40% of this area was scheduled to be left untreated as scattered islands for wildlife cover and seed source for revegetation.

CONCLUSIONS AND RECOMMENDATIONS

A 10-year review of the selective harvest strategy is scheduled for completion in 1999. 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 1992 following the severe winter of 1991–92. In 1994–95 the ratio rebounded to 24:100 and remained relatively stable at 26:100 in the 1996 and 1997 fall composition surveys. In 1998 the ratio increased to 31:100. Over the past 5 years, hunter effort has averaged 1347 hunters per season, ranging from 1135 to 1425. The interest in archery hunting has increased with the archers taking 20% and 17% of the harvest in the past 2 years, respectively.

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

During the past 8 years, 4 severe winters, 1991–92, 1994–95, 1996–97 and 1998–99, have impacted moose in Unit 15A. The number of available bulls following these winters declined, as did the harvest. In 1997–98, the harvest declined by 27%, compared to the previous year. In 1998–99, following an extremely mild winter and high survival, the harvest rebounded to the highest reported harvest since selective harvest started in 1987. In 1997, hunter success decreased (14%) because very few yearling moose were available to hunters. The number of moose killed by automobiles has declined and remained stable for 4 years, following the severe winter of 1994–95. The reduction may have been partially caused by weather and reduced moose population size.

Unlike other game management units in Alaska, no emergency reduction in the 1996–97 moose season or bag limit was necessary due to effects of the previous winter. In addition to a reduction in harvest after a severe winter, the number of hunters has also decreased. The conservative nature of the spike-fork/50-inch bag limit on the Kenai Peninsula allowed the department to continue to offer the same recreational opportunity as in previous years. No changes in management objectives or bag limits are recommended at this time.

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Table 1 Unit 15A aerial moose composition counts and estimated population size, 1992–98

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1992–93	16	5	36	23	1019	1331	--	
1993–94[a]								
1994–95	24	9	32	20	955	1199	--	
1995–96[a]								
1996–97	26	8	39	24	1120	1467	--	
1997–98[a]								
1998–99	31	11	27	17	1269	1528	--	3000–3800

[a] No data available.

Table 2 Unit 15A moose harvest[a] and accidental death, 1992–98

	Hunter Harvest										
Regulatory	Reported				Estimated			Accidental death			Grand
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	total
1992–93	141	2	0	143			40	99	0	99	282
1993–94	229	2	1	232			40	119	0	119	391
1994–95	233	2	3	238			40	168	0	346[b]	584
1995–96	115	0	2	117			40	90	0	90	247
1996–97	257	0	3	260			40	160	0	160	460
1997–98	187	0	4	191			40	143	0	143	374
1998–99	264	0	7	271			40	138	0	138	449

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

Table 3 Unit 15A harvest data by permit hunt DM524, Skilak Loop Antlerless Moose, 1990–98

Hunt No. /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
Antlerless	1993–94	30	7	62	38	0	10	0	10
	1994–95	30	13	50	50	0	13	0	13
	1995–96	40	20	78	22	0	7	0	7
	1996–97	No	Season						
	1997–98	No	Season						
	1998–99	40	10	69	31	0	11	0	11

Table 4 Unit 15A harvest data by permit hunt DM526, Skilak Loop Spike/Fork Moose, 1995–98

Hunt Nr /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
Skilak	1995–96[a]	20	35	92	8	1	0	0	1
Loop	1996–97	No	Season						
Spike/	1997–98	20	35	92	8	1	0	0	1
Fork	1998–99	No	Season						

[a] First year of Spike/Fork season in Skilak Loop.

Table 5 Unit 15A moose hunter[a] residency and success, 1992–98

	Successful				Unsuccessful				
Regulatory year	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	Total hunters
1992–93	121	14	2	143 (12)	874	171	15	1064	1207
1993–94	193	27	8	232 (16)	968	193	13	1195	1427
1994–95	197	30	5	238 (17)	943	204	15	1187	1425
1995–96	99	13	4	117 (10)	871	133	11	1018	1135
1996–97	208	41	9	260 (19)	1005	136	19	1164	1424
1997–98	163	24	2	191(14)	974	144	18	1140	1331
1998–99	239	26	3	271(19)	988	138	17	1147	1418

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

Table 6 Unit 15A moose harvest[a] percent by transport method, 1992–98

	Percent of harvest								
Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
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
1995–96	9	3	17	8	0	2	57	4	117
1996–97	6	3	11	8	0	2	66	4	260
1997–98	3	2	14	7	0	4	69	2	191
1998–99	3	1	7	9	0	3	72	6	271

[a] Excludes permit hunt harvest.

Table 7 Unit 15A moose harvest[a] chronology percent by harvest periods, 1992–98

Regulatory year	Harvest periods 8/10–8/19	8/20–25	8/26–8/31	9/1–9/5	9/6–9/10	9/11–9/15	9/16–9/20	Unk	n
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
1995–96	11[e]	20	10	10	9	15	21	5	117
1996–97	12[e]	26	10	6	7	18	18	4	260
1997–98	20[e]	24	5	6	7	16	17	5	191
1998–99	17[e]	23	8	8	8	15	13	8	271

[a] Excludes permit hunt harvest.
[b] Archery season - 8/25–29, 92; 8/10–17, 95 and 96, S/F-50".
[c] General open season Sep 1–Sep 20; S/F-50".
[d] General open season Aug 20–Sep 20, S/F-50"; archery season (Aug 25–29) was closed in 1993 and 1994.
[e] Archery season August 10–17, S/F-50", general open season Aug 20-Sep 20.

LOCATION

GAME MANAGEMENT UNIT: 15B (1121 mi^2)

GEOGRAPHIC DESCRIPTION: Kenai Peninsula

BACKGROUND

Historical records and reports from Kenai Peninsula residents indicate moose in Unit 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 mi^2 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, and the winter of 1998–99 was also severe. 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, placing the current moose population at 1042. Predation effects are unchanged, and the current population is believed to be stable. Habitat conditions are generally declining with plant succession.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Central Kenai Peninsula

- Maintain a population of moose with a bull to cow ratio of 15:100
- Allow for 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
- Provide for the opportunity to harvest a large antlered bull under aesthetically pleasing conditions

METHODS

We aerial survey 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% confidence interval ranging from 779 to 1305 or $\pm$ 25%. The estimated mean density was 1.2 moose/mi^2, with a range of 0.3 to 3.0. Because the census was conducted during February, after most bulls had shed their antlers, composition by sex was not determined. However, we completed age composition of the population, and calves comprised 9.5% of the population. The range for estimated percent calves of the population was 6.8–12.2% or ± 28% at 90% CI.

This estimate indicates a slight increase in population size, compared to 843 animals estimated in 1975. Winters have been normal or mild since the mid-seventies with the exceptions of 1989–90, 1994–95 and 1998–99 when record snow depths were reported and 1991–92 when slightly higher than normal snow depths were recorded. Although a census has not been completed since 1990, the moose density in 15B is believed to be stable.

Population Composition

We collected insufficient data during this reporting period to determine sex and age composition for the entire unit. Aerial surveys were completed in the 4 count areas in 15B West in 1996, and we observed 224 moose (Table 1). Composition for this 15B West count was 39 calves and 33 bulls per 100 cows, and calves comprised 23% of moose observed (Table 1).

MORTALITY

Harvest

<u>Season and Bag Limit</u>

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

Board of Game Actions and Emergency Orders. No Board of Game action or emergency orders were issued during this reporting period.

Hunter Harvest. In Unit 15B West, 337 hunters hunted, harvesting 67 bull moose in 1997. In 1998, 329 hunters harvested 57 bull moose (Table 2 and 4). The mean harvest during this 2-year period (62) represents a 24% increase when compared to the mean harvest (46) from 1995 to 1996.

Of the 67 moose reported by hunters in 1997, 58 (87%) included antler spread data. Because 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 38 (65%) spike-fork and 20 (35%) mature bulls. Successful hunters averaged 5.6 days afield.

Forty-one (72%) of the 57 moose harvested in 1998 were reported with an antler spread. Thirty-one (76%) of these were yearling and 10 (24%) were mature bulls. Six (19%) of these bulls had an antler spread 50 inches or larger. Successful hunters averaged 5.3 days afield.

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 two separate seasons. A total of 1609 and 1839 applications were received during 1997 and 1998, respectively. Permittees reported harvesting 26 bull moose in 1997 and 19 in 1998 (Table 3). In 1997, 68 (68%) of the 100 permit holders hunted, yielding a success rate for hunters of 38 percent. In 1998, 63 (63%) of the permit holders hunted, resulting in a success rate for hunters of 30 percent. The mean antler spread from bulls harvested during 1997 was 53.0 inches with a range of 39.5 to 67.0 ($n = 24$). Seventy-five percent (18 of 24) of these bulls had an antler spread of 50 inches or larger and 13% (3 of 24) were 60 inches or larger. The average antler of a bull harvested in 1998 was 52.3 inches with a range of 39.0 to 64.75. Seventy-one percent (12 of 17) of the bulls taken had an antler spread of 50 inches or larger and 18% (3 of 17) had a spread 60 inches or more. In 1997 and 1998, successful hunters averaged hunting 5.0 days and observed an average of 3 sublegal and 5 legal bulls per hunt.

Hunter Residency and Success. Fifty-nine (88%) of the 67 successful Unit 15B West hunters in 1997 were unit residents, 7 (10%) nonunit residents and 1 (2%) was a nonresident (Table 4). Unsuccessful hunters comprised 253 (94%) unit residents, 14 (5%) nonunit residents, and 3 (1%) nonresidents. Hunter success was 20 % ($n = 67$).

In 1998, 55 (97%) of 57 successful hunters were unit residents and 2 (4%) nonunit residents. 272 hunters reported as unsuccessful, with similar residency percentages as unsuccessful hunters in 1997. Hunter success was 17% for 1998, ($n = 57$).

Transport Methods. In Unit 15B West, 69 and 65% of successful hunters reported highway vehicles as their primary means of transportation in 1997 and 1998, respectively (Table 5). The second most common transportation means was horses, at 10% in 1997 and 4-wheelers at 9% in 1998. One successful hunter used aircraft in 1997 and none in 1998. 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. Fifty-two percent of 1997 and 42 percent of 1998 harvest occurred during the first 5 days of the season (Table 6). In 1997 the second highest harvest (16%) occurred between September 11 and 15. In 1998 the second highest harvest (16%) 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 alone is believed to be controlling moose numbers at this time. Mortality from starvation was minimal during 1997–98. Thirty-nine moose, primarily calves, were known to have starved in 1998–99.

Sixty-eight moose were reported killed in 15B West by vehicles from July 1, 1997 to June 30, 1998. In the same period for 1998–99, 74 moose were killed in vehicle/wildlife accidents. Moose killed by vehicles comprised 50% calves, 40% cows, and 10% bulls.

HABITAT

Assessment and Enhancement

The last large-acreage habitat enhancement occurred when a wildfire burned most of the unit 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 unit since 1890. The U.S. Fish and Wildlife Service enhanced approximately 3700 acres of predominantly winter habitat using a variety of mechanical tree removal techniques in 1968. Since 1968, 5 wildfires and 1 controlled burn have occurred, resulting in 11,500 acres burned, or 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 in the wood cutting areas, I believe these small logged areas provide additional moose browse. However, by and large the quality of moose habitat in Unit 15B is relatively poor and declining due to natural plant succession.

CONCLUSIONS AND RECOMMENDATIONS

The reported harvest in Unit 15B West of 67 moose in 1997 and 57 in 1998 indicates an increased harvest when compared with a mean of 48 moose killed annually from 1992 to 1996. The mean annual harvest since the initiation of the selective harvest program in 1987 to 1998 was 50, ranging from 39 to 67. A mean of 72 bulls was 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 31% in harvest during the first 12 years of the program. A similar comparison of hunting effort shows a decline from a mean of 389 (range = 258–487) for the 5 years before selective harvest to a 12-year mean of 307 (range = 272–350) once the program began. A population modeling effort using estimated recruitment and mortality parameters predicted the harvest would approach the 72 moose mean harvest reported before the selective harvest program by 1991. The current level with no upward trend suggests this harvest objective will not be met. One possible explanation was moderate to severe winters resulting in high calf mortality during 1987–88, 1989–90, 1991–92, 1994–95 and 1998–99. 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 reduced harvest.

The permit hunt in 15B East continues to provide excellent hunting opportunities and is popular among resident hunters. The harvest of 26 bulls during 1997 and 19 in 1998 (mean = 23) indicates a stable harvest when compared with the mean harvest from the previous 5 years of 24 moose. A decline in harvest began in 1992, following the moderately severe winter of 1991–92 and continued through 1998. This decline was the result of 2 factors: the loss of mature bulls during the severe winters and the increased price charged by outfitters to transport hunters into the area. Because only older bulls can be harvested in this area, the loss of bulls in these older age classes take several years to replace. The only practical means of access into this area is by horse, but the cost of contracting with a local outfitter has increased beyond what most hunters are willing to pay. Although the number of hunters reported going afield has not declined, the number of hunters hunting in areas accessible by horse has declined. These 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 to 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 that 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 range on the Kenai National Wildlife Refuge in Unit 15B continue to deteriorate due to wilderness lands management policies that favor advanced forest succession. The department and U.S. Fish and Wildlife Service 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, 1992–98

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Moose observed	Moose/ hour	Estimated population size
1992–93[a]	50	--	20	12	126	143	--	1042
1993–94[b]								
1994–95[a]	57	15	29	15	414	489	--	
1995–96[c]								
1996–97	33	17	39	23	173	224	--	1052
1997–98[b]								
1998–99[b]								

[a] Survey data from 15B East permit area only.

[b] No surveys completed this year.

[c] Late winter Gasaway Census completed (90% CI 733-1370). No composition data available.

Table 2 Unit 15B moose harvest[a] and accidental death, 1992–98

Regulatory year	Hunter Harvest: Reported M (%)	F (%)	Unk.	Total	Estimated: Unreported	Illegal	Total	Accidental death: Road	Other	Total	**Total**
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	--	59	135
1995–96	35	0	0	35			20	70	--	70	125
1996–97	55	0	1	56			20	80	--	80	156
1997–98	67	0	0	67			20	68	--	68	135
1998–99	57	0	0	57			20	74	--	74	131

[a] Excludes permit hunt harvest.

Table 3 Unit 15B East moose harvest data by permit hunt, 1990–98

Hunt Nr/ Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
Totals for	1990–91	100	29	56	44	31(100)	0	0	31
all permit	1991–92	100	34	42	58	38(100)	0	0	38
hunts	1992–93	100	24	66	34	26(100)	0	0	26
DM530-DM539	1993–94	100	31	65	35	24(100)	0	0	24
	1994–95	100	34	68	32	21(100)	0	0	21
	1995–96	100	35	65	35	23(100)	0	0	23
	1996–97	100	31	61	39	27(100)	0	0	27
	1997–98	100	32	62	38	26(100)	0	0	26
	1998–99	100	37	70	30	19(100)	0	0	19

Table 4 Unit 15B West moose hunter[a] residency and success, 1992–98

	Successful				Unsuccessful				
Regulatory year	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total	Total hunters
1992–93	40	6	1	48 (15)	247	24	1	272	320
1993–94	39	6	1	46 (13)	269	32	1	304	350
1994–95	46	4	1	56 (17)	222	31	2	267	323
1995–96	34	0	1	35 (12)	215	26	8	249	284
1996–97	46	8	1	56 (17)	248	17	2	268	324
1997–98	59	7	1	67 (20)	253	14	3	270	337
1998–99	55	2	0	57 (17)	239	31	2	272	329

[a] Excludes hunters in permit hunts.

[b] Local = residents of Unit 15.

Table 5 Unit 15B West moose harvest[a] percent by transport method, 1992–98

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
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
1995–96	0	20	0	11	0	0	60	9	35
1996–97	0	13	5	4	0	2	66	11	56
1997–98	1	10	3	3	0	0	69	13	67
1998–99	0	5	5	9	0	5	65	11	57

[a] Excludes permit hunt harvest.

Table 6 Unit 15B moose harvest[a] chronology percent by harvest period, 1992–98

Regulatory year	Harvest periods						Unknown	*n*
	8/20-25	8/26-8/31	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20		
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
1995–96[c]	20	9	9	6	17	40	0	35
1996–97[c]	33	2	11	15	13	19	7	56
1997–98[c]	52	4	9	3	16	12	3	67
1998–99[c]	42	9	4	11	12	16	7	57

[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: 15C (2441 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.

Spruce bark beetles (*Dendroctonus rufipennis*) have established in many old-growth spruce stands in Unit 15. Nearly half a million acres of land on the Kenai Peninsula were infected with spruce bark beetles in 1995 (Peterson 1996) with over 2 million acres infested to date. Salvage logging (harvest of dead and infested stands of trees) is ongoing throughout the Kenai (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 OBJECTIVES

- Maintain a population of 3000 moose
- Maintain a minimum posthunting sex ratio of 15 bulls:100 cows.

METHODS

All harvest data is collected and reported through the statewide harvest reporting system. Information is collected from hunters on area hunted, transportation used, amount of time spent afield and if successful, size of the moose harvested.

We documented winter moose mortalities by reports from the public and coincident with ADF&G field activities. 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.

Standard late fall composition surveys are completed in standard count areas. We completed aerial sex and age composition surveys in late November under favorable snow conditions. All information was entered in the Wildlife Information Data Base (WIDB) software.

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. Both the 1997–98 and the 1998–99 winters were considered severe in most of the region with deep and persistent snow. Documented winter mortality was predominantly calves of the year; however, we suspect that some adults were also lost. Winter severity was reflected by the lower-than-average hunter harvest in subsequent years. We believe the moose population declined slightly during this reporting period and may be at the lower end of the estimated 2500–3000 animals.

Population Size

A complete Gasaway (1986) style census was completed during late winter of 1992 under optimal snow conditions. The lowland portion of Unit 15C (1190 mi^2) was censused, and a population estimate of 2079 moose was calculated from survey results. Confidence intervals around the estimated population ranged from $\pm$ 19.81% for 80% CI (1677–2491) to $\pm$ 31.48% for 95% CI (1425–2734). Low sightings of moose caused the 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

Standard composition surveys were completed in 2 trend areas in Unit 15C during 1997 and only one partial survey in 1998. We classified 877 moose in 1997 with ratios of 46 calves:100 cows and 31 bulls:100 cows. Calf percentage was 26%, reflecting good neonatal survival in this unit where predation is normally high (Table 1). In the 1998 partial survey we classified 104 moose with ratios of 31 calves:100 cows and 61 bulls:100 cows. Poor snow conditions in lower elevations precluded further surveys.

MORTALITY

Harvest

Season and Bag Limit. In 1993 the moose season was extended from the 1 September–20 September season to 20 August–20 September. The bag limit is 1 bull with spike-fork antlers or 50-inch antlers or antlers with 3 or more brow tines on at least 1 side. The 5-year average harvest for 15C was 296 moose (Table 2).

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 amended the proposal and allowed a 2-day “window” during the last 10 days of the general season for hunters to use motorized vehicles. Subsequent proposals to further change or eliminate the CUA have failed.

A limited entry antlerless moose season was proposed for the Spring 1993 meeting. The local advisory committee failed to support this hunt; therefore, the board did not 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. With input from the Advisory committees, the board has reauthorized the antlerless hunts each year with only moderate changes.

Hunter Harvest. In 1997, 1392 hunters harvested 351 moose during the general season (Table 4). Two hundred twenty five (64%) hunters reported taking spike/fork bulls (<35 inches) compared to 111 (32%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Fifteen (4%) indicated either unknown size or illegal classification.

In 1998 1315 hunters harvested 283 moose during the general season (Table 4). One hundred eighty seven (66%) hunters reported taking spike-fork bulls compared to 48 (17%) hunters who harvested bulls with antler spreads of at least 50 inches or with 3 brow tines on at least 1 antler. Forty-eight reports (17%) indicated either unknown size or illegal classification.

Permit Hunts. There was a Tier II subsistence season 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. Since 1993 an average of 1 moose has been taken annually. There were no moose harvested in 1997 and 2 moose in 1998 for hunt TM549 (Table 3).

Beginning in 1995, the Board of Game authorized limited drawing permit hunts for antlerless moose near Homer. In 1995 hunters had to be assisted by department personnel. Thirty permits were divided into 8 hunting periods with 3–4 permits between 20 October and 19 November. Hunters could not take calves or cows accompanied by calves. In 1996 the department assistance program was discontinued and the hunts restructured. Forty permits were divided between 2 hunt periods during the same dates as above. In 1998 the number of permits was increased to 50 (Table 3). The remainder of Unit 15C moose season was 20 August–20 September for 1 bull with spike-fork or 50-inch antlers.

Twenty one antlerless moose were taken in 1997 from DM549 and DM550 with a 62% success rate. Eleven antlerless moose were taken in 1998 from DM549 and DM550 with a 29% success rate. The reduced success rate was primarily due to poor weather conditions during most of the season.

Hunter Residency and Success. Hunter success in 1997 was 25%, which was the highest success rate reported in the last 7 years. Three hundred sixteen (90%) successful hunters were Unit 15 residents, 26 (7%) were nonunit residents, and 9 (3%) were nonresidents (Table 4). Residency reported for unsuccessful hunters was 914 (88%) unit residents, 106 (10%) nonunit residents, and 16 (2%) nonresidents.

Hunter success in 1998 was 22%. Two hundred fifty six (90%) successful hunters were unit residents, 24 (8%) were nonunit residents, and 2 (<1%) were nonresidents (Table 4). Residency reported for unsuccessful hunters was 903 (88%) unit residents, 110 (11%) nonunit residents, and 15 (1%) nonresidents.

Harvest Chronology. Reported chronology of harvest reveals the highest percentage of moose harvested occurred during the first 6 days of the season in all years. When the season began 20 August, this trend did not change (Table 5).

Transport Methods. In 1997 both ATV's (ORVs and 4- wheelers) and highway vehicles were reported as the primary means (42% each) of transportation used by successful hunters (Table 6). Hunters using horses (7%), boats (3%) or aircraft (1%), were the least common transport modes. For the first time a successful hunter reported using an airboat in Unit 15C.

In 1998 44% of successful hunters reported highway vehicles as their means of transportation (Table 6). The number of hunters using highway vehicles increased in both years, possibly a result of the increased use of logging roads in this unit. The second most common transportation mode for successful hunters was ATVs (41%). Hunters using horses (6%), boats (2%), or aircraft (1%) were least common.

Other Mortality

In addition to reported harvest, a minimum of 84 moose was killed in Unit 15C by motor vehicles during 1997. At least 76 moose were killed in 1998 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.

Both the 1997–98 and 1998–99 winters were considered poor with deep and persistent snow in Unit 15C. Fifty-three winter related mortalities were reported in 1997–98 and 66 in 1998–99. The number of moose killed in defense of life or property also increased during these hard winters because moose were concentrated in developed areas. The moose population that winters on the Homer Bench continues to be at or above carrying capacity. Additional winter mortality is expected under normal or poor winter conditions.

HABITAT

Assessment

Reduction of some old-growth forest in response to spruce bark beetle infestations through logging has been underway in Unit 15C for over 10 years. 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 early seral stage 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, 3 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 (1 each) from ADF&G, AEA, and the Homer Fish and Game Advisory Committee. Trustees continue to struggle to maximize the trust to benefit lower peninsula moose. Future land acquisitions of quality moose habitat are being considered. During this period the trust funded an informational booklet *Living in Harmony With Moose.*

As part of an Eagle Scout project, the department cooperated in the construction of a wildlife viewing platform near the Homer Airport. This platform is near the head of Beluga Lake where moose tend to concentrate during late winter and early spring. This project has been well received by the public and community.

CONCLUSIONS AND RECOMMENDATIONS

Both the 1997–98 and 1998–99 winters were considered severe with highly documented mortality. We suspect that the moose population may have declined during this reporting period. Human-caused moose mortality, including road kills and harvest, represented 16–19% of the estimated moose population of 2500.

We identified 2 solutions to address the problems of declining habitat quality and starvation of moose in the Homer area. Habitat enhancement and population reduction within the affected areas would achieve these results. We believe both should occur simultaneously. Approximately $195,000 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.

In 1995 during their spring meeting, the Board of Game authorized a moose hunt 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. We recommend that the program continue until the wintering population is approximately 360 animals.

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 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.

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). Bull to cow ratios during fall composition surveys varied, depending on the units surveyed and if animals were still in postrut aggregations. Overall 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.

Hunter numbers have increased during the last 10 years. Some hunters have complained of overcrowded hunting conditions. 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 Units 15 and 7.

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Table 1 Unit 15C fall aerial moose composition counts and estimated population size, 1992–99

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total Moose observed	Moose /hour	Estimated Population size
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
1995–96[a]								
1996–97	29	11	37	22	285	343	73	2500
1997–98	31	13	46	26	649	877	60	2500
1998–99[b]	61	6	31	16	87	104	37	2300

[a] No surveys conducted.

[b] Partial survey

Table 2 Unit 15C moose harvest[a] and accidental death, 1992–99

Regulatory year	Hunter Harvest: Reported M	Reported F	Reported Unk.	Reported Total	Estimated Unreported	Estimated Illegal	Estimated Total	Accidental death Road	Accidental death Train	Accidental death Total	Total
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
1995–96	192	0	0	192			30	63	--	63	285
1996–97	347	0	0	347			30	44	--	44	421
1997–98	351	0	0	351			30	84	--	84	465
1998–99	283	0	0	283			30	76	--	76	389

[a]Excludes permit hunt harvest.

Table 3 Unit 15C moose harvest data by permit hunt, 1992–99

Hunt Nr. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
TM549	1992–93	8	12	50	38	3	0	0	3
Point	1993–94	5	0	80	20	1	0	0	1
Pogibshi	1994–95	5	20	75	25	1	0	0	1
	1995–96	4	0	75	25	1	0	0	1
	1996–97	4	25	66	33	1	0	0	1
	1997–98	4	25	100	0	0	0	0	0
	1998–99	4	0	50	50	2	0	0	2
DM541 DM548[b]	1995–96	30	10	41	59	0	16	0	16
DM549	1996–97	20	15	47	53	0	9	0	9
	1997–98	20	20	69	31	0	5	0	5
	1998–99	20	30	79	21	0	3	0	3
DM550	1996–97	20	15	24	76	0	13	0	13
	1997–98	20	10	11	89	0	16	0	16
	1998–99	30	20	66	33	0	8	0	8

[a] Tier II moose hunt 940T changed to TM549.

[b] DM541-DM548 was for antlerless moose however cows accompanied by calves or calves were protected. Hunt was split to allow for department personnel to assist hunters. DM541-546 had 3 permits each and DM547-DM548 4 permits each

[c] DM549-DM550 was for antlerless moose however cows accompanied by calves or calves were protected.

Table 4 Unit 15C moose hunter[a] residency and success, 1992–99

Regulatory year	Successful				Unsuccessful				
	Local[b] resident	Nonlocal resident	Nonresident	Total[c] (%)	Local[b] resident	Nonlocal resident	Nonresident	Total[c](%)	Total hunters
1992–93	163	13	7	185 (16)	850	127	7	988 (84)	1171
1993–94	230	28	6	270 (21)	854	159	8	1044 (79)	1314
1994–95	252	31	9	307 (22)	910	143	21	1120 (78)	1427
1995–96	171	17	4	192 (20)	696	77	4	781 (80)	973
1996–97	303	33	11	347 (24)	993	100	12	1112 (76)	1459
1997–98	316	26	9	351 (25)	914	106	16	1041 (75)	1392
1998–99	256	24	2	283 (22)	903	110	15	1032 (78)	1315

[a] Excludes hunters in permit hunts.
[b] Local = residents of Unit 15.
[c] Total columns include hunters that did not specify residency.

Table 5 Unit 15C moose harvest[a] chronology percent by harvest periods, 1992–97

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*
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
1995–96[c]	26	10	10	13	14	21	6	192
1996–97[c]	33	12	11	14	9	14	4	347
1997–98[c]	32	12	8	12	13	17	7	351
1998–99[c]	31	11	12	13	12	17	5	283

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

Table 6 Unit 15C moose harvest[a] percent by transport method, 1992–99

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
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
1995–96	4	7	5	33	0	7	40	4	192
1996–97	3	7	4	37	0	8	39	2	347
1997–98[b]	1	7	3	36	0	6	42	5	351
1998–99	1	6	2	35	0	6	44	5	283

[a] Excludes permit hunt harvest.
[b] One hunter reported using an airboat to harvest a moose.

LOCATION

GAME MANAGEMENT UNIT: 16A (1850 mi^2)

GEOGRAPHIC DESCRIPTION: West side Susitna River (Kahiltna River to Chulitna River)

BACKGROUND

Moose in Unit 16A are a subpopulation of the Matanuska-Lower Susitna Valley moose population. Griese (1995) described a low-density, pre-1940 subpopulation that responded to habitat changes and reduced predator populations by substantially increasing densities only to be negatively influenced by periodic deep-snow winters. Significant winter die-offs occurred at least once each decade beginning with the 1950s. The most recent die-off was during 1989–90, when 30–40% of 4000–5000 moose died from starvation and accidents on highways and adjacent railroad. Recovery from the resulting low density was slowed by subsequent deep-snow winters of 1990–91, 1992–93 and 1994–95 and by increasing predation because of growing brown bear and wolf populations.

After the unit was separated from Unit 16B in 1973, historical annual hunter harvest fluctuated as a result of annual moose densities, bag limits, and improving hunter access. Since establishment of the unit, harvest did not exceed 308 moose (52 cows), reported for 1984–85 (Griese 1995). Harvest declined to 37 bulls during a 10-day season in 1990–91, but annual harvest rose to nearly 140 moose as the 2 subsequent fall seasons were increased to 15 days. Harvest once again fell below 100 bulls with enactment of the spike-fork-50-inch selective harvest strategy (SF50) during fall 1993. During 1993–1994 harvest was divided between the SF50 general season (66–70 bulls) and a late any-bull permit hunt (28–49 bulls). Beginning in 1995–96, a 20 November–15 December spike-fork-only general season generated an additional 24 bulls on average to the early general season and permit harvest, producing a harvest ranging from 182 to 251 bulls.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Produce moderate, sustainable levels of moose for humans, while allowing sustainable harvest levels of predators to meet desirable predator–prey ratios
- Enhance wildlife viewing opportunities within state and national parks

MANAGEMENT OBJECTIVES

- Maintain a posthunt population of 3500–4000 moose, with a sex ratio of 20–25 bulls:100 cows during the rut
- Achieve a minimum 3-year-average annual harvest of 300 moose

METHODS

During this report period we did not conduct aerial moose surveys. We monitored harvest of moose with harvest reports and permit reports from any person who reported hunting in the unit. Bulls taken by permittees were required to provide antlers for measurement and lower front teeth for age determination. We measured antler width, number of points per brow palm, and number of points per main palm on each side. The Department of Public Safety (DPS) provided numbers of moose killed illegally, by highway vehicles, or in defense of life or property (DLP).

Antler-age data collected from any-bull permit hunts were evaluated and presented in the Unit 14A management report. We evaluated harvest composition from the Unit 16A general season harvest by antler width class. We used 34.9 inches as the separation between spike-fork antlered bulls and those larger bulls with 3 or more brow tines.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

The subpopulation of moose in Unit 16A is expected to show a significant decline during 2000–01 due to deep snow conditions observed during winter 1999–00. It had shown evidence of steady recovery through 1996–97, reaching population objective levels. Average winter conditions during 1997–1999 should have allowed stability or continued growth. We suspect that the rapidly increasing wolf population (Masteller 2000) has compounded the impacts of this winter.

Population Size

The population size previously reported for 1996 (Griese 1998) was actually the estimate generated for November 1997. During that fall the moose population was estimated at 3636 ± 614 (80% CI) (Table 1). We have not generated new estimates.

Population Composition

Population composition reported for 1996 (Griese 1998) was the composition measured in November 1997. The composition included 33 bulls and 35 calves:100 cows (Table 1). We collected no additional composition during this report period.

MORTALITY

Harvest

Season and Bag Limit. During falls 1998 the general open season was 20 August–20 September and 20 November–15 December for all resident and nonresident hunters. During the early season the bag limit was 1 bull with a spike or fork antler on at least 1 side or with an antler spread that measured at least 50 inches or with antlers that had 3 or more brow tines on at least 1 side. The late season bag limit was 1 bull with spike or fork antlers only. Drawing permits to take any bull were issued for the 20 August–20 September and 1–15 November special hunt periods. We issued 100 any-bull permits for the early hunt (DM552) and 100 any-bull permits for the November hunt (DM556).

During fall 1999 the general open season was 20 August–25 September and 5–15 December for all resident and nonresident hunters. During the early season the bag limit was 1 bull with a spike or fork antler on at least 1 side or with an antler spread that measured at least 50 inches or with antlers that had 3 or more brow tines on at least 1 side. The late season bag limit was 1 bull with spike or fork antlers only. Drawing permits to take any bull were issued only for the 1–15 November special hunt period (DM552). We issued 100 any-bull permits.

Board of Game Actions and Emergency Orders. During the spring 1999 Board of Game meeting the department presented the results of a Spike-Fork-50 Task Force (See appendix and the Unit 14A report in this volume). The Board of Game adopted the Task Force's recommendation to add 21–25 September and eliminate 20 November–4 December from the late spike-fork-only season. The early any-bull drawing permit hunt was also dropped.

Hunter Harvest. The 1997–1999 reported average annual harvest was 179, which was 60% of the human-use objectives for the unit.

Hunters reported an average harvest of 170 bulls during 1998–1999. This level of reported harvest was 14% of the previous 2-year average (Table 2). During 1998–1999, the any-bull permit harvest averaged 39 (Table 3). The lower harvest was in response to 100 fewer permits being issued during fall 1999

Harvest of the 50-inch or greater antlered bulls remained strong during this period. Of the 221 reports with antler size presented, 38% were in this size class. The spike-fork class (1.0–34.99 inches) composed 33% of the reported harvest. The bulls qualifying as legal with 3 brow tines with less than 50-inch antler widths composed 30% of the harvest.

Hunter Residency and Success. The number of hunters seeking moose in Unit 16A averaged 816 during 1998–1999 (Table 4). During 1988–1989, Unit 16A hunters numbered 1172–1292 (Griese 1995).

During 1998–1999 Unit 16 residents composed 7% of general season hunters, and nonresidents were 3% (Table 4). Unit residents were responsible for 7% of the harvest, while nonresidents 4%, indicating similar hunter success.

Combined hunter success was 16% during 1995–1999 (Table 4). This compares to a combined hunter success of 11% during 1993–1994, the first 2 years of SF50, and 24% reported for 1988–1989, population and hunter number peaks (Griese 1995).

Harvest Chronology. Adding the 21–25 September period appeared to produce additive harvest in 16A. The pattern of harvest chronology observed during1999 was relatively consistent with that seen during 1995–1998 (Table 5). During 1995–1998, Unit 16A hunters reported taking an average 6.4 moose/day during 15–20 September, which was their most productive period. During 21–25 September 1999 hunters harvested moose also at 6.4 moose/day.

Transport Methods. The hunters that harvested moose reported a notable increase in the percentage using boats and 4-wheelers and a decrease of ORVs and snowmachines. During 1998–1999 the percentage of successful hunters using boats returned to greater than 20% (Table

6). The shorter late spike-fork-only hunt was likely responsible for the reduction in the percent of hunters reporting the use of snowmachines during 1999.

Other Mortality

We believe the level of illegal harvest has reached higher than normal levels caused by the SF50 bag limit restriction. We have adjusted the estimate of illegal harvest accordingly (Table 2).

During 1998–1999 DPS reported 26 moose killed on the highways in Unit 16A (Table 2). These levels, while not high compared to those typically observed in Units 14A and 14B, are equal to the number reported in Unit 16A during the harsh 1989–90 winter. Roadkill statistics within Unit 16A may not be used as verification of winter severity (Modafferi 1991).

The winter of 1999–00 was severe for moose. Midwinter, we observed moose floundering in snow depths exceeding 5 feet. As the winter progressed, rain fell, giving the surface an ice crust that facilitated easy wolf travel while further complicating moose locomotion. We expect high levels of mortality on calves, yearlings, and older adults.

HABITAT

Enhancement

An 18,000-acre area east of the lower end of Kroto Creek (Deshka River) has been prepared for a controlled burn since 1994 (W. Collins pers. commun.). The prescribed burn continues to be delayed because of concern for public criticism in the wake of the 1995 Miller's Reach/Big Lake wild fire. In addition, ideal conditions for such a burn have not coincided with fire crew presence.

CONCLUSIONS AND RECOMMENDATIONS

We suspect that the declining trend of hunter harvest reflects a decline in the moose population but we were unable to assess the level in relation to population objective levels. Further, we believe the winter of 1999–00 has caused a substantial decline in the 16A moose subpopulation.

Hunter harvest under the SF50 regulation, even when adding any-bull permits and additional hunting days to the late SF-only general season, is unlikely to reach the current human-use objective of 300 moose. The moose subpopulation estimate for 1997 had a surplus of bulls that, if harvested by hunters, would bring human-use levels to a 3-year average of only 250 moose. Upon reaching a subpopulation level of 4000 moose, the opportunity to issue cow permits would allow human use to possibly reach or exceed 300 moose annually, if future winters had no more than moderate snow-depths and no greater predator influence. To allow hunters to take the existing surplus would require relaxation of antler restrictions or a substantial increase in access opportunities.

The highest priority management activity for Unit 16A is the 18,000-acre controlled burn planned for the area east of the Deshka River. This project no longer has funds available.

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Table 1 Unit 16A fall aerial moose composition counts and estimated subpopulation sizes, 1990–1999

Regulatory year	Bull: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Percent calves	Adults observed	Total moose observed	Moose observed:mi^2	Population estimate
1990–91 [a]	27	7	31	29	1105	1366	1.8	3123±289 [b]
1991–92 [c]	--	--	--	--	--	--	--	--
1992–93 [d]	36	11	32	19	779	963	1.7	2900 ± 564 [b]
1993–94 [d]	24	10	24	16	698	828	1.9	3284 ± 903 [b]
1994–95 [e]	36	11	33	19	804	981	--	3000–3,600
1995–96 [c]	--	--	--	--	--	--	--	--
1996–97 [c]	--	--	--	--	--	--	--	--
1997–98 [d]	33	12	35	21	974	1234	2.1	3636 ± 614 [b]
1998–99 [c]	--	--	--	--	--	--	--	--
1999–00 [c]	--	--	--	--	--	--	--	--

[a] Gasaway et. al. (1986) census methodology. SCF pooled across all strata.

[b] 80% C.I.

[d] No surveys conducted.

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

[e] These 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, 1990–99

Regulatory	Reported			Estimated			Accidental[d]			Grand
year	M	F	Total[a]	Unreported[b]	Illegal[c]	Total	Road	Other	Total	Total
1990–91	37	0	37	2	10	12	6	0	6	55
1991–92	135	0	138	7	15	22	15	0	15	175
1992–93	136	0	138	7	15	22	9	0	9	169
1993–94	96	0	98	10	20	30	9	0	9	137
1994–95	115	0	115	10	20	30	4	0	4	149
1995–96	134	0	134	8	25	33	15	0	15	182
1996–97	197	1	199	14	25	39	4	0	4	242
1997–98	198	0	198	14	25	39	14	0	14	251
1998–99	169	1	169	12	25	37	10	0	10	216
1999–00	168	0	171	12	25	37	16	0	16	224

[a] Total includes moose of unknown sex.

[b] This estimate was derived by taking 5–10% of the reported kill.

[c] Includes moose taken in defense of life or property.

[d] Roadkill is minimum number; in most years actual kill was probably higher. While there is no RR in the unit up to 60% of moose killed on RR in Unit 14B is from Unit 16A.

Table 3 Unit 16A moose harvest data by permit hunt, 1990–99

Hunt No.	Regulatory year	Applicants	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Harvest		
							Bulls	Cows	Total
DM554 and DM556 (1–15 Nov.)	1993–94	1310	100	20	64	36	28	0	28
	1994–95	1715	100	12	51	49	49	0	49
	1995–96[a]	1349	100	17	53	30	30	0	30
	1996–97[a]	1188	100	17	39	44	44	0	44
	1997–98[a]	1192	99	11	48	41	40	0	40
	1998–99[a]	1489	100	17	58	24	24	0	24
	1999–00[a]	3068	100	11	59	30	29	0	29
DM552 (20 Aug.–20 Sept)	1995–96	711	100	22	53	25	25	0	25
	1996–97	774	100	15	65	20	19	0	19
	1997–98	652	99	10	72	18	16	0	17
	1998–99	965	100	13	63	25	24	0	24
	1999–00	--	0	--	--	--	--	--	--

[a] DM556 only.

Table 4 Unit 16A moose hunter residency and success, 1990–99

Regulatory year	Successful						Unsuccessful					
	Local [a] resident	Nonlocal resident	Non-resident	Unk	Total	(%)	Local [a] resident	Nonlocal resident	Non-resident	Unk	Total	Total hunters
1990–91	4	35	1	1	37	(7)	23	448	9	16	473	510
1991–92	9	123	4	2	138	(16)	28	673	12	8	721	859
1992–93	7	126	4	1	138	(16)	34	630	24	21	709	847
1993–94	5	62	1	2	70	(11)	37	529	6	13	548	618
1994–95	6	57	2	1	66	(12)	32	488	8	4	500	566
1995–96	7	65	6	1	79	(12)	62	516	16	6	600	679
1996–97	14	116	4	3	136	(19)	53	513	12	8	586	725
1997–98	16	113	11	1	141	(18)	54	598	25	3	626	767
1998–99	5	112	2	2	121	(16)	56	572	19	7	654	775
1999–00	14	115	9	4	142	(17)	41	643	18	10	715	857

[a] Unit 16 residents.

Table 5 Unit 16A moose harvest chronology[a] by months of season, 1990–99

	August		September				November	December			
Year	20–26	27–31	1–7	8–14	15–20	21–25	20–30	1–7	8–15	Unknown	Total
1990–91	--	--	21	11	--	--	--	--	--	5	37
[b]1991–92[c]	--	--	72	53	7	--	--	--	--	6	138
1992–93[c]	--	--	75	51	6	--	--	--	--	5	138
1993–94	13	4	8	19	24	--	--	--	--	2	70
[d]1994–95	6	4	11	13	29	--	--	--	--	1	64
[d]1995–96[e]	8	1	11	12	35	--	5	1	4	2	79
1996–97[e]	5	5	19	25	41	--	18	6	10	7	136
1997–98[e]	20	7	11	29	36	--	17	4	8	9	141
1998–99[e]	9	5	13	22	41	--	11	4	13	3	121
1999–00[f]	7	8	15	21	38	32	--	2	15	3	142

[a] Does not include harvest from drawing permit hunts.
[b] Open season = Sep 1–10.
[c] Open season = Sep 1–15.
[d] Open season = Aug 20–Sep 20 (Gen.SF/50).
[e] Open season = Aug 20–Sep 20 (Gen.SF/50), Nov 20–Dec 15 (Gen.SF-only).
[f] Open season = Aug 20–Sep 25 (Gen.SF/50), Dec 1–15 (Gen.SF-only).

Table 6 Transport method used by successful moose hunters[a] in Unit 16A, 1990–99

Regulatory year	Percent of successful moose hunters								Nr. moose harvested
	Airplane	Horse	Boat	3- or 4-Wheeler	Snowmachine	ORV	Highway vehicle	Unk	
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	64
1995–96	7	0	16	24	7	12	32	1	79
1996–97	9	0	19	30	17	6	15	4	136
1997–98	9	0	16	34	16	6	15	4	141
1998–99	10	1	21	21	16	7	22	2	121
1999–00	8	1	26	39	6	3	16	2	142

[a] Does not include harvest from drawing permit hunts.

LOCATION

GAME MANAGEMENT UNIT: 16B (10,405 mi^2)

GEOGRAPHIC DESCRIPTION: West Side of Cook Inlet and Kalgin Island

BACKGROUND

Griese (1996) has described the recent history of the Unit 16B moose population. Moose were uncommon before 1940 but grew to peak densities during the 1950s, the late 1960s, late 1970s, and mid 1980s. Their numbers were primarily controlled by winter die-offs occurring in response to deep snow. The most significant die-offs occurred during the winters of 1971–72 and 1989–90. Harkness (1993) implied the mainland population before the winter of 1989–90 was probably at 8500–9500. It is likely the number of moose exceeded 10,000 during the early 1980s.

Following the 15–20% decline (Harkness 1993) from the severe winter of 1989–90, moose numbers in the unit continued to decline in response to continued deep snow winters and growing predator influence. Faro (1989) implied that predation on neonatal moose calves by bears influenced recruitment and caused the current declining trend. Masteller (1996) identified a growing wolf population, estimated at 60–80 wolves in 11–13 packs during 1994, that influenced moose numbers. The moose:wolf ratio had declined to less than 100:1.

Since 1972, when Unit 16B was separated from 16A, hunter harvest of moose has declined from a high of 842 in 1973 to only 99 moose during a short 1990 season. For the period 1972–1992, annual reported harvest averaged 426 moose. Peaks in harvest also occurred during 1978 (589 total and 147 cows) and 1984 (616 total and 173 cows). Harvest after the 1984 peak reflected a general population decline. During fall 1989 the harvest was 345 moose, including 32 cows, and not until 1997 did harvest again approach that level. A third of the 1997 harvest was during the winter Tier II hunts (Griese 1998).

Hunting seasons for 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. Through 1989, except 1975, up to a 20-day antlerless moose hunt was held during September, but 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, registration permits were issued in the unit or, in later years, as Tier II permits. During 1992 the Board of Game adopted antler restrictions for bull moose beginning fall 1993 for most of Southcentral Alaska, including mainland Unit 16B (Griese 1995).

The Kalgin Island moose population resulted from a translocation of calves during 1957–59. Numbers grew to a peak density of 7 moose/mi^2 during 1981 (Taylor 1983) but was reduced to 1 moose/mi^2 by 1985. High moose densities severely degraded habitat and caused the adoption of restrictive population objectives that maintained moose densities at less than 1 moose/mi^2 while vegetation recovered (Faro 1990). During fall 1991 harvest was restricted to bulls only, but the Board of Game again authorized cow hunts by permit only in 1995–96 (Griese 1996).

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Produce high yields of moose for humans and provide maximum opportunity to hunt moose

POPULATION OBJECTIVES

Unit 16B (excluding Kalgin Island)

- Maintain a minimum late-fall moose population of 6500 with a sex ratio of 20–25 bulls:100 cows

Kalgin Island

- Maintain a posthunt population of 20–40 moose with a sex ratio of no less than 15 bulls:100 cows

HUMAN USE OBJECTIVES

- Achieve and maintain a minimum 3-year average harvest of 300 moose by 1999.

METHODS

During 22–27 November 1999, we conducted a Gasaway et.al. (1986) census in the middle portion of Unit 16B, north of the Beluga River and Beluga Lake and south of the upper Yenta River drainage. We sampled 31 of 177 sample units and calculated the estimated subpopulation size and composition using MOOSEPOP (D. Reed, personal communication). We applied sightability correction factors (SCF) calculated by strata.

During 22 November 1998 and again during 22–27 November 1999 we conducted a sex and age composition survey of the unit's southern subpopulation, which includes the mainland drainages south of Beluga River and Beluga Lake. Portions of existing trend count areas were surveyed at 2–4 min./mi^2.

Research staff surveyed Kalgin Island on 7 December 1998 at nearly 8 min./mi^2. They repeated the same intensity survey the following winter during 5 January 1999.

We collected harvest and hunter effort data from harvest and Tier II permit reports.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population size

We estimated the middle Unit 16B subpopulation at 3314 ± 489 (80% C.I.) during fall 1999 (Table 1). This population point estimate equates to a density of 1.3 moose/mi^2. The intensive survey of Kalgin Island indicated a population of 60–80 moose, or a density of 2.6–3.5 moose/mi^2. The estimate for Kalgin Island was as high as 150 moose during fall 1998.

Our best estimate of the Unit 16B late fall 1999–00 population is 5800–6100 moose. We combined the Kalgin Island and middle subpopulation estimates for 1999 with approximately 90% of the 1996 estimate for the northern subpopulation and approximately 80% of the 1995 estimate from the southern subpopulation (Table 1). A reliable range estimate of the number of moose in the unit is hampered by the absence of recent survey data from the northern and southern subpopulations.

The prolonged deep snow winter of 1999–00 is expected to produce a mainland-16B moose population substantially lower than the current population objective. We expect the population to range between 4000 and 5000 by winter 2000–01.

Trend. We believe the mainland moose subpopulations declined steadily during 1995–1999 responding to increased predation by a rapidly growing wolf population (Masteller 2000). Field activities during the winter of 1998–99 revealed a wolf population substantially larger than previously estimated. The 1998–99 minimum estimate was near 90 wolves but may be as high as 100–110. The newly estimated moose to wolf ratio is approaching 60:1. The estimated mainland population of moose is estimated to have declined approximately 20% during the 1990s. The effect of the 1999–00 winter is expected to duplicate that amount of decline.

Kalgin Island declined between 1998 and 1999 in response to an intensive harvest of 80 moose (RM572-Table 4). The population reduction was intentional to bring the number of moose to within the objective density of 1.0–2.0 moose/mi^2.

Population Composition

Bull:cow ratios depicted in Table 1 indicate all surveyed subpopulations during 1998–99 exceeded population objectives of 20–25 bulls:100 cows. Ratios of bulls:cows observed during this period ranged from 27:100 on Kalgin Island in 1998 to 38:100 in the southern subpopulation during 1999.

Recruitment of yearling bulls into the mainland subpopulations appeared to reach record lows during fall 1999. We observed 2–4 yearling bulls:100 cows in the middle and southern subpopulations (Table 1).

The extremely low yearling bull was a product of the low calf survival the previous year. We observed only 8–9 calves:100 cows in the middle and southern subpopulations during 1998–

1999 (Table 1). These record low levels for Unit 16B clearly indicate predation can be expected to drive the population to low levels unless their influence on moose is abated.

MORTALITY

Harvest

Season and Bag Limit. During 1998–99, the resident and nonresident open season on Kalgin Island was 20 August–20 September with a bag limit of 1 bull or 1 antlerless moose by drawing permit only. We issued 40 permits.

During 1998–99 and 1999–00 within that portion of the unit including the mainland drainages south and west of Beluga River, Beluga Lake and Triumvirate Glacier the season for resident hunters was 20 August–30 September with a bag limit of 1 bull with SF50 antlers. A resident-only Tier II permit hunt During 15 November–28 February allowed the harvest of any bull. We issued 60 permits in both years. The nonresident season was closed in this portion of the unit.

Within the remaining northern 2/3 of the unit the resident and nonresident season was 20 August–30 September with a bag limit of 1 bull with SF50 antlers. In addition, residents could hunt during 15 November–28 February by Tier II permit for any bull. We issued 200 permits for 2 hunt areas (TM565 and TM567).

During 1998–1999 the federal government offered a more liberal bag limit for qualified rural residents of the unit. Qualified residents could obtain a permit to take any moose during 25–30 September or 1 December–28 February. The permit allowed an alternative bag limit, not an additional moose. Registration permits were unlimited.

Board of Game Actions and Emergency Orders. At the March 1997 meeting, the board adopted regulations combining the two 'southern' hunt areas and further liberalized seasons in the unit. Seasons and bag limits in 16B South were made uniform. All Tier II hunts in the unit were given the same season dates, which reduced confusion and, because of the length, should eliminate the need for future emergency orders. Because of the actions for 16B South, the board was required to establish new findings.

The board adopted new findings for 16B South during April 1997. Those findings were that the subpopulation was near 1200 moose with a harvestable surplus of 105 bulls. The 1993 findings for a subsistence harvest of 39–47 moose was adequate and below the harvestable surplus, and recent season increases would enhance the opportunity for subsistence hunters to be successful. Again, the board found that by nature of differences in antler formation or lack of antlers during winter that the winter and fall hunts were being directed at 2 unique portions of the subpopulation.

During the March 1999 meeting, the board adopted a department proposal to make moose hunting on Kalgin Island a registration hunt for any-moose from 20 August to 30 September. There were no changes to the mainland moose regulations. The board adopted liberalized seasons for brown bears (10 August–25 May) and black bear baiting (15 April–June 30) in response to increasing predation on moose.

Hunter Harvest. Reported hunter harvest during the general season declined during 1998–1999. While the general season harvest reached 229 during 1997–98 it had declined to 164 by 1999–00 (Table 3). We believe the decline reflects a decline in availability of moose. Winter permit harvest was responsible for more than a third of the total harvest during 1998–1999. The hunter harvest for the unit (Table 2) was not as indicative of the decline in mainland moose due to the increased harvest on Kalgin Island. Hunters took advantage of the liberal season and bag limit on Kalgin Island and reported harvesting 80 moose (RM572-Table 4).

Hunter Residency and Success. General season hunter success decreased during 1998–1999. Hunter success declined from 32% during 1997–98 to 22% during 1999–00, the lowest reported since the 1990–91 10-day season (Table 3). The number of hunters increased to an average of 755 during 1998–1999. Nonresident harvest remained stable, although numbers of nonresident hunters increased to 100 during 1999–00.

Permit Hunts. The Kalgin Island any moose registration hunt attracted 437 permittees and produced a 30% permittee success rate (Table 4). We intended this new hunt to reduce the moose density on the island within 2 years.

Tier II winter hunts for any-bull have produced an average of 80 successful hunters since 1993 (Table 4). Success and participation in the individual hunts has been consistent.

Harvest Chronology. Harvest chronology in the general harvest for 1998–1999 reflected the higher moose vulnerability during the 25–30 September period. Hunters harvest moose at a rate of 8–9 moose/day during this report period (Table 5).

Transport Methods. The lack of road accessibility to the unit is reflected by the dominance of aircraft and boat transportation used by successful hunters. An average of 58% of successful hunters accessed their Unit 16B hunt areas by aircraft while 22% used boat.

Other Mortality

The winter following the fall surveys of 1999–00 was considered severe for moose. In mid-winter we observed moose floundering in snow depths exceeding 5 feet. As the winter progressed, rain fell giving the surface an ice crust that facilitated easy wolf travel while further complicating moose locomotion. We expect high levels of mortality on calves, yearlings, and older adults.

Effects of predation by wolves and bears continue to be apparent on mainland 16B. During 1998–1999 we observed record low calf:cow and yearling bull:cow ratios for the unit (Table 1).

CONCLUSIONS AND RECOMMENDATIONS

Moose population levels in Unit 16B had fallen outside of objective levels by the fall of 1999–00. Our estimate of 5800–6100 moose is below the minimum objective of 6500. The prolonged deep snow winter of 1999–00 may have caused a 20–30% decline from this estimate.

Although the Kalgin Island population remains above the maximum desired density of 1.0–2.0 moose/mi^2, we believe continuation of the current registration permit hunt will draw adequate hunter interest to reach the objective within 2 years.

Current season and bag limit structure is adequate to allow bull:cow ratios to remain above minimum objective levels. As the moose density declines, we should be cautious to maintain bull:cow ratios at or above 25 bulls:100 cows.

> "Since the 1980s (Faro 1989), we have known that bear populations influence fall calf numbers in Unit 16B. Recently, wolf numbers have increased, and few effective harvest options are available for limiting their numbers (Griese 1996). Growing numbers of wolves reduce the likelihood of future moose population growth. A severe deep-snow winter could place the moose population in Unit 16B at a level that may not recover to objective levels, given current levels of predation." Griese (1998)

The winter of 1999–2000 may have precipitated this expected decline, one that may drive the mainland 16B moose population to levels that are unrecoverable, given the lack of political interest in managing wolf numbers.

We should continue to consider prescribed burns on the mainland. For 5 years we have identified a potential controlled burn site near Sucker Creek on the north side of Mount Susitna. Our lack of success in getting approval for a prescribed burn in Unit 16A may indicate the potential for this burn.

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Table 1 Unit 16B fall aerial moose composition counts and estimated subpopulation sizes, 1990–1999

Reg. year	Area	Date	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Percent calves	Adults	Total moose observed	Moose observed: mi^2	Population estimate
1990–91	Northern[a]	11/21–27	32	9	23	15	650	745	1.4	2650±412[b]
	Middle[a]	12/08–21	34	5	25	16	673	789	1.4	3824±314[b]
1991–92[c]			--	--	--	--	--	--	--	--
1992–93	Southern[d]	12/15	36	5	12	12	109	124	--	--
1993–94	Northern[e]	11/15–20	50	10	16	10	374	416	1.1	2006±432[b]
	Middle[e]	11/28–12/3	21	9	25	17	391	463	1.4	3653±1965[b]
1994–95	Northern[f]	11/13–18	42	10	12	7	405	431	1.0	--
	Middle[f]	11/18–25	26	4	24	16	314	374	--	--
	Southern[g]	11/29–12/2	25	5	25	17	220	261	1.0	810–1210
	Kalgin Is.[h]	11/18	35	15	65	33	27	40	1.7	55–75
1995–96	Northern[d]	2/27–28	--	--	--	7	298	321	--	--
	Middle[d]	2/27–28	--	--	--	12	855	969	--	--
	Southern[d]	2/29–3/3	--	--	--	6	505	537	0.8	1081±145[b]
	Kalgin Is.[f]	2/09	--	--	--	28	26	36	1.5	60–90

Table 1 Continued

1996–97	Northern[i]	11/1–2	38	7	23	14	422	484	1.2	1912±325
	Southern[d]	11/8–9	32	7	14	10	305	338	--	--
	Kalgin Is.[f]	11/8	67	27	60	26	25	35	1.5	80–110
1997–98	Southern[d]	11/25, 12/3	37	8	13	9	544	591	--	--
	Kalgin Is[f]	2/27	--	--	--	23	17	22	0.9	100–130
1998–99	Southern[d]	11/22	35	7	8	6	337	357	--	--
	Kalgin Is.[h]	12/7	27	9	36	29	82	116	5.0	130–150
1999–00	Middle[j]	11/22–27	28	2	9	7	587	631	1.3	3314±489[b]
	Southern[d]	11/15–22	38	4	8	6	432	458	--	--
	Kalgin Is.[h]	01/5	--	--	--	24	38	50	2.2	60–80

[a] Data from a Gasaway, et al (1986) random stratified survey. SCF pooled across strata.

[b] 80% confidence intervals

[c] No count

[d] Data from trend area composition survey (2–4 min./mi^2)

[e] Data from Becker survey.

[f] Data from sex and age composition survey (4–6 min./mi^2).

[g] 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.

[h] Data from sex and age composition survey (6–8 min./mi^2)

[i] Data from modified Gasaway, et al (1986), i.e. using 1990 sample units and simulated SCF.

[j] Data from a Gasaway, et al (1986) random stratified survey. SCF by strata.

Table 2 Unit 16B annual moose harvest and accidental death, 1990–99

Regulatory	Reported				Estimated			Accidental			Grand
year	M	F	Unk	Total	Unreported	Illegal[a]	Total	Road	Other	Total	Total
1990–91	93	5	1	99	10	25	35	2	0	2	136
1991–92	262	0	0	262	15	25	40	1	0	1	303
1992–93	234	1	3	238	15	25	40	0	0	0	278
1993–94	155	21	0	176	10	35	45	0	0	0	221
1994–95	230	0	0	230	15	35	50	2	3	5	285
1995–96	187	11	2	200	10	25	35	0	0	0	235
1996–97	293	9	3	305	20	25	45	1	0	1	351
1997–98	314	13	1	328	20	25	45	1	0	1	374
1998–99	288	7	1	296	20	30	50	0	0	0	346
1999–00	266	2	4	272	20	25	45	0	0	0	317

[a] Includes moose taken in defense of life or property.

Table 3 Unit 16B moose hunter[a] residency and success 1990–99

Regulatory year	Successful: Local resident[a]	Successful: Nonlocal resident	Successful: Nonresident	Successful: Total	Successful: (%)	Unsuccessful: Local resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Total	Unsuccessful: (%)[b]	Total hunters
1990–91	3	64	2	69	(16)	24	325	1	350	(840	419
1991–92	13	153	35	201	(26)	24	514	41	579	(74)	780
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
1995–96	4	116	38	161	(25)	28	406	44	485	(75)	646
1996–97	11	145	39	199	(30)	24	410	31	465	(70)	664
1997–98	12	165	48	229	(32)	21	419	36	479	(68)	708
1998–99	7	152	37	196	(25)	25	497	53	575	(75)	771
1999–00	7	117	40	164	(22)	27	486	62	575	(78)	739

[a] Does not include individuals participating in permit hunts.

[b] Unit 16 residents.

Table 4 Unit 16B moose harvest data by permit hunt, 1990–99

Hunt Nr. [a]	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Harvest		
						Bulls	Cows	Total
979T	1990–91	141	45	34	21	30	0	30
	1991–92	151	34	23	34	51	0	51
	1992–93	150	29	41	29	43	0	43
DM571	1995–96	50	34	48	18	0	9	9
	1996–97	60	35	47	17	2	8	10
	1997–98	61	53	28	19	0	11	11
	1998–99	40	58	25	18	0	7	7
RM572	1999–00	437	37	42	18	30	50	80
TM565	1993–94	30	13	10	73	7	15	22
	1994–95	138	32	23	40	55	0	55
	1995–96	140	40	46	10	14	0	14
	1996–97	141	26	38	35	49	0	49
	1997–98	139	30	32	37	50	1	51
	1998–99	140	21	39	37	52	0	52
	1999–00	140	22	31	41	57	0	57
TM567	1993–94	15	33	0	67	4	6	10
	1994–95	59	19	14	66	39	0	39
	1995–96	60	30	58	7	4	0	4
	1996–97	60	18	30	49	30	0	30
	1997–98	59	12	38	48	29	0	29
	1998–99	60	17	37	42	25	0	25
	1999–00	60	13	18	58	35	0	35

Table 4 Continued

Hunt Nr.	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Harvest		
						Bulls	Cows	Total
TM569	1993–94	60	45	35	20	12	0	12
	1994–95	58	43	29	17	10	0	10
	1995–96	60	32	47	18	8	1	11
	1996–97	60	45	25	28	16	0	17
	1997–98	59	53	24	17	9	1	10
	1998–99	60	30	42	25	15	0	15
	1999–00	60	35	37	20	12	0	12
Total all State permit hunts	1990–91	141	45	34	21	30	0	30
	1991–92	161	38	24	37	52	0	52
	1992–93	150	29	41	29	43	0	43
	1993–94	105	35	23	42	23	21	44
	1994–95	255	33	24	43	104	0	104
	1995–96	310	37	51	13	26	10	38
	1996–97	322	30	36	34	97	8	106
	1997–98	319	35	32	33	88	13	101
	1998–99	300	27	38	34	92	7	99
	1999–00	697	35	39	26	134	50	184
Federal	1991–92	10	60	10	30	1	0	1
	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
	1995–96	4	25	50	25	0	1	1
	1996–97	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	1997–98	2	50	50	0	0	0	0
	1998–99	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	1999–00	n/a	n/a	n/a	n/a	n/a	n/a	

[a] T&TM = Tier II permit, DM = drawing permit, RM = registration permit

Table 5 Unit 16B moose harvest chronology[a] by months of season, 1990–99

	August		September					January		
Year	20–25	26–31	1–6	7–12	13–18	19–24	25–30	10–23	Unknown	Total
1990–91	--	--	40	17	--	--	--	--	12	69
[b]1991–92[c]	--	--	56	33	80	27	--	--	8	204
1992–93[c]	--	--	45	52	58	28	--	--	9	192
1993–94	10	6	9	24	46	20	--	9	7	131
[d]1994–95[e]	16	11	11	36	36	12	--	--	4	126
1995–96[f]	13	7	14	20	31	32	40	--	3	160
1996–97[f]	8	17	16	20	40	42	51	--	5	199
1997–98[f]	11	12	20	16	52	53	56	--	9	229
1998–99[f]	12	10	14	20	31	44	59	--	7	197
1999–00	5	1	8	17	34	45	51	--	8	169

[a] Does not include harvest from permit hunts.
[b] Open season = Sep 1-10.
[c] Open season = Sep 1–20.
[d] Open season = Aug 20–Sep 20 (Gen.SF/50), Jan 10-23 (SF/50 – Res. only)
[e] Open season = Aug 20–Sep 20 (Gen.SF/50)
[f] Open season = Aug 20–Sep 30 (Gen.SF/50); Kalgin Island = Aug 20–Sep 20 (Any bull)
[g] Open season = Aug 20–Sep 30 (Gen.SF/50)

Table 6 Transport method used by successful moose hunters[a] in Unit 16B, 1990–99

Regulatory year	Percent of successful moose hunters								Nr moose harvested
	Airplane	Horse	Boat	3-or 4-Wheeler	Snowmachine	ORV	Highway vehicle	Unk	
1990–91	65	0	19	1	3	3	4	4	69
1991–92	68	1	22	4	0	1	2	2	204
1992–93	64	3	19	4	0	3	2	5	192
1993–94	56	11	21	1	6	1	0	4	131
1994–95	60	11	17	3	1	1	1	6	126
1995–96	67	9	19	3	0	1	0	1	160
1996–97	61	9	18	6	1	3	1	3	199
1997–98	62	6	19	4	0	2	3	3	229
1998–99	55	7	25	8	0	2	1	2	197
1999–00	60	5	19	9	0	2	2	2	169

[a] Does not include harvest from permit hunts.

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, bears, and beaver were historically the main sources of game meat. The department began collecting data on the Game Management 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. In the past, a general disregard for seasons and bag limits by unit residents was suspected to be the principal factor contributing to historically low densities of moose in the unit (Taylor 1990).

In the last decade moose populations throughout Unit 17 have increased substantially 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 as the Mulchatna caribou herd grew and extended their range (Van Daele 1995).

Moose are now common along the Nushagak/Mulchatna Rivers and all of their major tributaries. They also are throughout the Wood/Tikchik Lakes area. Moose have successfully extended their range westward into the Togiak and Kulukak River drainages of Unit 17A. Within the past 5 years, a viable population has become established in 17A.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Unit 17A

Establish a minimum population of 100 moose and a maximum population of 600–1000 moose

Unit 17B

Achieve and maintain a density of 1 moose/mi^2 on habitat considered good moose range

Unit 17C

Maintain a minimum density of 0.5 moose/mi^2

METHODS

Aerial surveys of trend count areas in Units 17B and 17C have been 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 are established on their winter ranges, and bulls still retain their antlers. In most years, however, suitable weather, 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). Movements along the border of Units 17A and 17C were monitored during a radiotelemetry study from 1989 to 1994. In March 1998, 36 moose were radiocollared in Unit 17A to study movements and population parameters (Aderman, et. al.1999). Late winter aerial surveys of the Unit 17A were conducted during this reporting period.

Moose population estimation surveys have been attempted 5 times in portions of Units 17B and 17C. A portion of Unit 17C was surveyed in 1983. In 1987 the upper Mulchatna River area in Unit 17B was surveyed, and in 1995 western 17C and most of 17A were surveyed. In March 1999, a population estimation survey for entire 17C was completed using a spatial statistics stratification model.

We collected harvest data by means of harvest ticket reports and registration permit reports. Nonreporting hunters were contacted by telephone and were sent 1 reminder letter. We monitored harvest and cooperated with enforcement efforts of Fish and Wildlife Protection during the hunting season.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Aderman and others (1995) estimated there were approximately 100 moose in Unit 17A and the portion of Unit 17C surveyed in 1995. In March 1999, department staff worked with TNWR staff to survey the moose population in Unit 17A, east of and including the Matogak River drainage and north of the Nushagak Peninsula. The present population size in Unit 17A exceeds 500 moose (Aderman et. al. 1999). We have seen a continued increase in the number of moose in the unit since the early surveys.

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 unit is "good moose habitat," we established the management goal for the unit at 4900 moose. Survey data for this unit 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 population estimation surveys were the only objective method of assessing trends. Lacking such information, we initiated late winter surveys of major drainages to investigate population trends (Tables 1–2). From the available data, it appeared the moose population size in the unit was stable to increasing. Lacking population estimation survey data, we cannot evaluate how close we are to 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 unit is about 1750 moose. In March 1999 I conducted a moose population estimation survey for Unit 17C north of the Igushik River. One hundred and three (103) of 774 sample units were surveyed, yielding an extrapolated estimate of 2955 (± 488 at 90% CI) moose, including 435 (± 76 at 90% CI) calves (14.7% of moose).

Population Composition

Bull:cow ratios in all areas of Unit 17 have historically been high, but no composition data were collected during this reporting period. Calf production and survival have fluctuated between areas and years. In 1997–98, late winter survey data indicated minimum calf percentages of 19.4% in the Mulchatna drainages and 24.9% in the upper Nushagak drainages.

Distribution and Movements

Much of Unit 17 is wet or alpine tundra, and moose are predominantly along the riparian areas. We know little about specific movement patterns, except that 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 radiotelemetry study indicated that most moose radiocollared in western Unit 17C stayed in that area, but there was some movement into Unit 17A. One radiocollared moose and her calf moved from Weary River to Kulukak River (Jemison 1994). During the February 1995 population estimation survey, 29 moose moved into 17A from the upper Sunshine Valley in 17C (Aderman et al. 1995). Aderman and others (1999) found that in Unit 17A, some radiocollared moose remained in the same range during winter and summer, while other radiocollared moose used different ranges during those seasons.

MORTALITY

Harvest

Season and Bag Limit. Unit 17A was open to resident/subsistence hunters only by registration permit August 20 to September 15 (RM573). Registration permit holders could take 1 bull, regardless of antler size.

Unit 17B was divided into 2 sections: the Mulchatna River drainage upstream and including the Chilchitna River and the remainder of the unit. The upstream section was open for resident hunters from September 1–15 and nonresident hunters from September 5–15. The remainder of Unit 17B was open to resident hunters during September 1–15, September 5-15 for nonresidents, and for resident hunters with a registration permit from August 20 to September 15 (RM583) and during December 1–31 (RM585). The nonresident bag limit was 1 bull with 50" or greater antler spread or with 4 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 unit west of the Wood River and south of Aleknagik Lake and the remainder of the unit. Open season for resident hunters was from September 1–15 throughout the unit. An additional resident-only registration permit hunting season was open in the remainder of the unit from August 20 to September 15 (RM583) and during December 1–31 (RM585). Nonresidents were prohibited from hunting in Unit 17C. The bag limits in 17C were the same as in 17B.

Registration hunt RM 573 permits were valid only in Unit 17A, and were available to any Alaska resident who applied in person at Togiak (August 5–September 15). Registration hunt RM583 and RM585 permits were valid for both 17B and 17C. Permits were available to any Alaska resident who applied in person at Dillingham (RM583: July 15–August 31, RM585: October 25–December 31).

Board of Game Actions and Emergency Orders. In March 1998 the Board of Game amended the requirement that all meat of the legs and ribs of moose taken in Unit 17 remain on the bone until removed from the area or processed for human consumption. The board deleted the requirement for retaining the meat on the ribs and changed the requirement that meat of the forequarters and hindquarters must remain on the bones only for moose taken before October 1.

During the March 1999 Board of Game meeting, the board identified moose in Units 17B and 17C as being populations important for providing high levels of harvest for human consumption. The board considered but did not identify the population of moose in Unit 17A as being important for providing high levels of harvest for human consumption.

Beginning in December 1997, the fall and winter registration hunts were separated into 2 different registration hunts. Prior to December 1997, hunters received a permit valid for both the August 20–September 15 hunt and the December 1–31 hunt. The change required that hunters apply for each of the registration permits. Hunters who were successful in the fall hunt were not eligible to receive a permit for the December hunt.

Hunter Harvest. Because of a three-fold increase in hunters afield since 1983 (1983/84–293; 1998/99–1053), reported moose harvests in Unit 17 have nearly tripled during the past 16 years (1983/84–127; 1998/99–389). The total harvest in the past 5 years in Unit 17B has ranged from 167 to 207, with an annual average harvest of 180 moose. In Unit 17C the 5-year mean annual harvest was 123, with a range of 94 to 171 moose (Table 3).

Hunters continued to harvest moose with large antlers throughout this reporting period. During each of the last 7 seasons, over 55% of the reported 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 4).

General Hunt. The general moose hunt in Units 17B and 17C is of shorter duration and with more restrictive bag limits than the registration hunts. Greater numbers of nonlocal Alaska residents and nonresidents hunt moose during this hunt than local (Unit 17) Alaska residents (Table 5). Unit 17A has not had an open general moose hunting season since 1980–81; however, 10–25 moose of both sexes were probably killed annually (Table 6). The reported harvest in the past 5 years for the general moose season in Unit 17B has ranged from 127 to 171, with a mean annual harvest of 143 moose (Table 7). In Unit 17C, the 5-year mean annual harvest for the general hunt has been 25 moose, with a range of 21 to 29 (Table 8).

Permit Hunts. Longer seasons and more liberal bag limits have enticed many resident hunters to participate in the registration hunts (RM573, RM583, and RM585). By 1998, 682 hunters received permits, and 529 hunters reported hunting, harvesting 220 moose (Table 9).

During the first legal hunting season in Unit 17A (1997), 39 hunters reported taking 15 moose, 43 hunters reported taking 10 moose during the 1998 season (Table 10). Of 629 hunters receiving registration hunt permits for Units 17B and 17C in 1997, 485 reported hunting and 182 moose were harvested. Of 634 hunters receiving registration hunt permits for Units 17B and 17C in 1998, 477 reported hunting and harvesting 210 moose (Tables 11 and 12).

Hunter Residency and Success. The mean number of moose hunters participating in the general moose hunting season in Unit 17 during the past 5 years was 483, a slight decline from the previous reporting period (Van Daele 1998). Participation by resident hunters in the general hunt has declined because of increased interest in the registration hunt. Nonresident participation continued to increase, despite more restrictive regulations from previous years. Unitwide success during the general hunt ranged from 32% to 40% during the past 5 years. The mean annual hunter success rate for the previous 5 years was 35%. Nonresidents accounted for 61% of reporting hunters, residents of Unit 17 10%, and other residents of Alaska made up 27% of the total number of hunters in the general hunt from RY1994–95 to 1998–99 (Table 5). The number of unit residents participating in the hunt was probably underreported because of individuals failing to obtain or submit harvest tickets.

The mean number of moose hunters participating in the registration moose hunts in Units 17B and 17C during the past 5 years was 419, a marked increase from the previous reporting period (Van Daele 1998). Success during the registration hunts in Units 17B and 17C ranged from 37% to 44% during the past 5 years. The mean annual hunter success rate for the previous 5 years was 42%. Residents of Unit 17 composed 74%, and other residents of Alaska made up 26% of the total number of hunters in the registration hunts from RY1994–95 to 1998–99 (Table 9).

Harvest Chronology. Because of changes in seasons and weather, chronology data did not indicate consistent patterns (Table 13 and 14). Unit residents were the main participants in the August and December seasons. These seasons were originally established to provide local residents an opportunity to harvest moose that were 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 = 67%, Table 15). Most participants in the registration hunt used boats for access (5-yr mean = 69%, Table 16). In 1990–91 off-road vehicles, including 3- and 4-wheelers, became prohibited modes of transportation for big game hunters in Unit 17B.

Other Mortality

Predation by wolves and bears occurred regularly throughout this reporting period. Reports from local resident and nonlocal hunters suggest wolf numbers appeared to be increasing unitwide. Snow depths throughout the unit were extremely deep during the winter of 1997–98 and snow remained late in spring 1999, although there were no reports of excessive winter mortality. Moose were able to find abundant forage on winter ranges in riparian areas.

There was one report of a moose being killed by a motor vehicle on the Aleknagik Lake Road near Dillingham during this reporting period. The meat was salvaged for human consumption.

Illegal harvest continued to be a problem in Unit 17A. Unit residents actively pursued moose with aircraft and snowmachines during the winter and spring. Both male and female moose were taken. However, illegal harvests in Units 17B and 17C have decreased dramatically in the past 10 years. There has also been a significant decline in the number of female moose taken. It is now common to see moose near Nushagak River villages throughout the winters. During the March 1999 population estimation survey, we located 34 moose within the 7-mi^2 sample unit that included the village of New Stuyahok.

HABITAT

Assessment

Aderman (1999) established 7 intensive mapping areas in Unit 17A, based on computer-aided analysis of Landsat photos. We visited 104 sites for ground-truthing in July 1998. Information collected included dominant vegetation species, slope, aspect, and drainage. We preliminarily estimated 560 mi^2 of optimal moose winter habitat and another 520 mi^2 of secondary moose winter habitat in Unit 17A.

No formal habitat monitoring programs were conducted in the remainder of Unit 17. Moose winter ranges along the Nushagak and Mulchatna Rivers, and along the lower reaches of the major tributaries to those rivers, are probably in good condition. Although there is evidence of heavy browsing, willow stands on gravel bars are abundant and include a good mix of brush heights. Winter range conditions in the middle and upper reaches of the tributaries have not been assessed but are probably not as productive.

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, man-caused habitat enhancement activity is not practical or necessary.

Lightning-caused wildfires are not uncommon in the unit each summer, particularly in Unit 17B. During the summer of 1997, the unit experienced the most active fire season on record. Extremely dry conditions and a plethora of lightning strikes resulted in fires consuming significant acreage. Spruce/birch forest habitat was the most affected, but fire also impacted moist tundra habitats. Smoke was thick during most of July, at times restricting air travel. Most fires were monitored and fire crews attempted to contain those that threatened villages and structures. The fires burned a complex mosaic of habitats and should enhance moose browse in the future.

In most years 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 the major tributaries to those rivers.

NONREGULATORY MANAGEMENT PROBLEMS

Dramatic increases in the number of caribou in the Mulchatna herd continued to impact the moose population in the unit, even though there was little direct competition between these ungulates. Short-term impacts 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 impact on moose may be the response of predator populations to abundant prey resources. Wolf numbers increased in the unit during this reporting period. There were few instances of wolves following the caribou herd, so when the herd moved out of a pack's territory, moose became the primary source of meat for wolves. 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 and a continuing series of less than severe winters resulted in stable to increasing moose populations in Unit 17 during this reporting period. The moose population has exceeded the minimum goal in Unit 17A and is approaching the management objective. No reliable population estimate is available for Unit 17B. A reliable population estimation survey for Unit 17C indicated the population 17C has reached or exceeded the management objective. Survey data indicate that the unit population continues to be healthy and productive. Although objective habitat evaluations were lacking for most of the unit, it appeared that 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 onto winter range, rarely occur before antler drop. Late winter surveys of the major drainages were initiated in 1992 to supplement fall composition counts. Periodic population estimation surveys of portions of the unit would provide the best moose population information.

Moose hunting activity and harvest have increased in Unit 17 during the past decade. The increased number of caribou in the area has contributed to more nonlocal hunters along the Nushagak/Mulchatna River drainages. Hunting methods and harvest chronology have remained consistent in recent years, so the increased harvest may indicate a greater density of moose in the unit.

The moose population in Unit 17A has increased dramatically in recent years. Unit residents anxious to take advantage of this increase were given that opportunity during the 1997–98 season. We worked with local residents and with staff from TNWR and developed a draft moose management guideline that establishes an objective of 600–1000 moose in the unit. We also entered into a cooperative moose research project with TNWR in March 1998 to 1) document population trends, 2) evaluate the moose habitat in the unit 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 had considered impacts of liberalized caribou seasons on the Unit 17 moose population and adjusted the moose season for 1993–94, and the board adjusted it again in 1997. The board and the department will need to continue managing these 2 ungulate populations and monitoring predator populations.

Recommended management actions for the next few years include the following:

1 Establish moose survey areas within Unit 17 and attempt to conduct a population estimation survey area each winter on a rotating basis;

2 Develop a final moose management plan for Unit 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 Continue to seek cost-effective and accurate methods to obtain bull:cow ratios within the unit.

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Table 1 Unit 17B, Upper Mulchatna river drainages moose trend count areas, late winter aerial moose counts, 1992/93–1998/99

Regulatory year	Survey area: Mulchatna River[a]	Survey area: Mosquito River	Survey area: Stuyahok River	Survey area: Old Man River	Survey Total	Moose/ hour	Relative Snow Level[b]
1992–93[c]	304	64	13	126	507	194.3	moderate
1993–94[d]	201	47	6	102	356	114.5	low
1994–95[fe]	354	96	9	83	542	140.1	moderate
1995–96[f]	62[f]	14	4	---	90	52.9	very low
1996–97[g]	---	--	--	---	0	---	bare ground
1997–98[h]	354	96	9	83	484	258.1	deep
1998–99[i]	---	--	--	---	---	---	low

[a] Survey area encompasses the Mulchatna River from its mouth to Red Veils, including all riparian habitat within 1 mile of the river.
[b] Subjective evaluation of snow depths within the vicinity of the survey area (actual depths are recorded in field notes)
[c] Mulchatna River drainages surveyed on 25 Jan. 1993, other drainages surveyed on 9 Feb. 1993.
[d] Mulchatna River drainages surveyed on 15 Mar. 1994, other drainages not surveyed.
[e] Mulchatna River drainages surveyed on 23 Feb. 1995, other drainages surveyed 24 Jan. 1995.
[f] All drainages surveyed on 11 March 1996. Mulchatna and Old Man surveys were aborted due to bare ground.
[g] No survey conducted due to extremely low snow levels and a preponderance of bare ground.
[h] All drainages surveyed on 23 January 1998.
[i] No surveys conducted in 1999

Table 2 Units 17B and 17C, Upper Nushagak, Nuyakuk, and Wood river drainages moose trend count areas, late winter aerial moose counts, 1992/93–1998/99

Regulatory year	Survey area				Survey Total	Moose/ hour[d]	Relative Snow Level[e]
	Nushagak River[a]	Nuyakuk River[b]	King Salmon River[b]	Wood River[c]			
1992–93[f]	319	12	--	19	350	203.2	moderate
1993–94[g]	---	--	--	--	0	---	low
1994–95[h]	484	4	--	42	530	281.4	moderate
1995–96[i]	401	7	26	--	434	253.8	very low
1996–97[j]	---	--	--	--	0	---	bare ground
1997–98[k]	882	--	--	--	882	363.0	deep
1998–99[l]	---	--	--	--	---	---	low

[a] Survey area encompasses the Nushagak River from its Koliganek to Big Bend, including all riparian habitat within 1 mile of the river. Entire survey area is within unit 17B.

[b] Survey area within unit 17B.

[c] Survey area within unit 17C.

[d] Moose per hour analysis only includes the Nushagak River portion of the survey.

[e] Subjective evaluation of snow depths within the vicinity of the survey area (actual depths are recorded in field notes)

[f] All areas surveyed on 3 February 1993.

[g] No survey conducted.

[h] All areas surveyed on 24 January 1995.

[i] All areas surveyed on 6 March 1996.

[j] No survey conducted due to extremely low snow levels and a preponderance of bare ground.

[k] All drainages surveyed on 5 February 1998.

[l] No surveys conducted in 1999

Table 3 Reported moose harvest data for all hunts in Unit 17, 1964/65–1998/99

Regulatory year	Reported harvest	Hunters afield	Success rate	Unit[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	705	47%	0	160	90	13
1993–94	249	705	35%	1	150	78	20
1994–95	296	800	37%	0	167	94	69
1995–96	336	881	38%	0	192	109	35
1996–97	373	913	41%	0	207	113	53
1997–98	347	956[b]	36%	15	168	126	38
1998–99	389	1,053[b]	37%	10	168	171	40

[a] Harvest data not broken down by unit before 1983–84.

[b] Included hunters who registered for both fall and winter registration hunts.

Table 4 Unit 17 moose antler sizes (percent) in the reported harvest, 1992/93–1998/99

Regulatory year	Antler size <30"	Antler size 30–50"	Antler size >50"	Largest antlers
1992–93	6	36	57	80"
1993–94	3	30	68	73"
1994–95	9	29	62	73"
1995–96	7	35	57	78"
1996–97	9	26	65	75"
1997–98	6	36	57	73"
1998–99	9	35	56	74"

Table 5 Unit 17 moose hunter[a] residency and success, 1992/93–1998/99

Regulatory year	Successful				Unsuccessful				Total hunters
	Local resident	Nonlocal resident	Nonresident	Total (%)	Local resident	Nonlocal resident	Nonresident	Total(%)	
1992–93	61	79	64	212 (41)[b]	65	114	124[b]	310 (59)[b]	522
1993–94	21	28	93	144 (33)[c]	27	117	142[c]	292 (67)[c]	436
1994–95	22	41	91	161 (33)[d]	24	117	180[d]	329 (67)[d]	490
1995–96	23	31	114	171 (35)[e]	28	104	170[e]	314 (65)[e]	485
1996–97	16	35	144	196 (40)[f]	33	82	174[f]	291 (60)[f]	487
1997–98	13	34	101	150 (35)[g]	29	82	162	277 (65)[g]	427
1998–99	16	33	120	169 (32)	27	111	220	359 (68)[h]	528

[a] Excludes hunters in permit hunts.
[b] Includes 8 successful and 7 unsuccessful hunters of unknown residency.
[c] Includes 2 successful and 6 unsuccessful hunters of unknown residency.
[d] Includes 7 successful and 8 unsuccessful hunters of unknown residency.
[e] Includes 3 successful and 12 unsuccessful hunters of unknown residency.
[f] Includes 1 successful and 2 unsuccessful hunters of unknown residency.
[g] Includes 2 successful and 4 unsuccessful hunters of unknown residency.
[h] Includes 1 unsuccessful hunter of unknown residency.

Table 6 Unit 17A moose harvest[a] and accidental death, 1992/93–1998/99

Regulatory	Hunter Harvest								Grand
	Reported				Estimated				
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Accidental death	total
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
1995–96	0	0	0	0	0	15	15	0	15
1996–97	0	0	0	0	0	10	10	0	10
1997–98	0	0	0	0	0	10	10	0	10
1998–99	0	0	0	0	0	10	10	0	10

[a] Excludes permit hunt harvest.

Table 7 Unit 17B reported moose harvest[a] and accidental death, 1992/93–1998/99

Regulatory	Hunter Harvest								Grand
	Reported				Estimated[b]				
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Accidental death	total
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
1995–96	148 (100)	0	0	148	0	0	0	0	148
1996–97	171 (100)	0	0	171	0	0	0	0	171
1997–98	127 (100)	0	0	127	0	0	0	0	127
1998–99	139 (100)	0	0	139	0	0	0	0	139

[a] Excludes permit hunt harvest.

[b] No estimates of unreported/illegal harvests have been made for this unit.

Table 8 Unit 17C reported moose harvest[a] and accidental death, 1992/93–1998/99

Regulatory	Hunter Harvest								Grand
	Reported				Estimated[b]				
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Accidental death	total
1992–93	56 (100)	0	0	56[c]	0	0	0	0	56
1993–94	18 (100)	0	0	18	0	0	0	0	18
1994–95	28 (100)	0	0	28[d]	0	0	0	1[e]	29
1995–96	32 (100)	0	0	22[f]	0	0	0	0	22
1996–97	23 (100)	0	0	23[g]	0	0	0	2[h]	25
1997–98	21 (100)	0	0	21[i]	0	0	0	0	21
1998–99	27 (100)	0	0	27[j]	0	0	0	1	28

[a] Excludes permit hunt harvest.
[b] No estimates of unreported/illegal harvests have been made for this unit.
[c] Does not include 3 bulls from an unspecified portion of Unit 17.
[d] Does not include 1 bulls from an unspecified portion of Unit 17.
[e] Includes 1 bull killed in defense of life or property.
[f] Does not include 3 bulls from an unspecified portion of Unit 17.
[g] Does not include 11 bulls from an unspecified portion of Unit 17.
[h] Does not include 1 cow and 1 bull killed in motor vehicle accidents near Dillingham.
[i] Does not include 2 bulls from an unspecified portion of Unit 17.
[j] Does not include 3 bulls from an unspecified portion of Unit 17.

Table 9 Unit 17 moose hunter residency and success[a] by permit hunt, 1992/93–1998/99

Regulatory year	Successful				Unsuccessful				Total hunters
	Local resident	Nonlocal resident	Nonresident	Total (%)	Local resident	Nonlocal resident	Nonresident	Total(%)	
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[c]
1994–95	106	29	0	135 (44)	128	45	0	175 (56)	310[d]
1995–96	117	48	0	165 (42)	131	100	0	231 (58)	396
1996–97	117	60	0	177 (42)	157	92	0	249 (58)	426
1997–98	164	33	0	197 (37)	272	60	0	332 (63)	529
1998–99	183	37	0	220 (42)	251	54	0	305 (58)	525

[a] Includes only permittees who reported hunting.

[b] Unit 17 residents.

[c] Includes 0 successful and 1 unsuccessful hunters of unknown residency.

[d] Includes 0 successful and 2 unsuccessful hunters of unknown residency.

Table 10 Unit 17A reported moose harvest data by permit hunt, 1997/98–1998/99

Hunt No /Area	Regulatory year	Permits issued[a]	Percent did not hunt	Percent unsuccessful hunters[b]	Percent successful hunters[b]	Bulls (%)	Cows (%)	Unk.	Total harvest
573	1997–98	44	11	62	38	15 (100)	0	0	15
	1998–99	48	10	77	23	10 (100)	0	0	10

[a] Registration permits were valid for only Unit 17A.
[b] Includes only those permittees reporting that they hunted.

Table 11 Unit 17B reported moose harvest data by permit hunt, 1992/93–1998/99

Hunt No /Area	Regulatory year	Permits issued[a]	Percent did not hunt	Percent unsuccessful hunters[b]	Percent successful hunters[b]	Bulls (%)	Cows (%)	Unk.	Total harvest
983	1992–93	277	30	63	27	8(100)	0	0	8
583	1993–94	433	19	61	39	23 (100)	0	1	24
	1994–95	438	18	56	44	35 (100)	0	0	35
	1995–96	521	21	56	44	44 (100)	0	0	44
	1996–97	546	20	63	37	36 (100)	0	0	36
583/585	1997–98[c]	629	25	63	37	41 (100)	0	0	41
	1998–99[c]	634	25	69	31	29 (100)	0	0	29

[a] Registration permits were valid for both Units 17B and 17C. Permit data are for both areas combined, harvest data are specific to Unit 17B.
[b] Of those permittees that reported hunting in Unit 17B.
[c] Includes permits issued and harvest for both fall (Aug.20-Sept15) and winter (Dec. 1-31) permit hunts.

Table 12 Unit 17C reported moose harvest data by permit hunt, 1992/93–1998/99

Hunt No /Area	Regulatory year	Permits issued[a]	Percent did not hunt	Percent unsuccessful hunters[b]	Percent successful hunters[b]	Bulls (%)	Cows (%)	Unk.	Total harvest
983	1992–93	277[b]	30	63	27	31[d] (100)	0	3	34
583	1993–94	433	19	61	39	59[e] (100)	1	0	60
	1994–95	438	18	56	44	65[f] (100)	0	1	66
	1995–96	521	21	59	41	87[g] (100)	0	0	87
	1996–97	546	20	54	46	89[h] (99)	0	1	90
583/585	1997–98[c]	629	25	60	40	105[i] (100)	0	0	105
	1998–99[c]	634	25	48	52	144[j] (100)	0	0	144

[a] Registration permits were valid for both Units 17B and 17C. Permit data are for both areas combined, harvest data are specific to Unit 17C.

[b] Of those permittees who reported hunting in Unit 17C.

[c] Includes permits issued and harvest for both fall (Aug.20-Sept15) and winter (Dec. 1-31) permit hunts.

[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 Unit 17A.

[f] Not included are 34 bulls from an unspecified portion of Unit 17.

[g] Not included are 33 bulls from an unspecified portion of Unit 17 and 1unknown sex.

[h] Not included are 51 bulls from an unspecified portion of Unit 17.

Table 13 Unit 17 reported moose harvest[a] chronology percent by month, 1992/93–1998/99

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]
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
1995–96[d]	1	2	55	32	0	0	1	1	9	171
1996–97[d]	1	2	63	27	0	1	0	2	6	196
1997–98[d]	0	1	55	36	0	1	1	1	5	150
1998–99[d]	0	2	60	35	0	0	0	0	2	169

[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 14 Unit 17 reported moose harvest by permit, chronology percent by month, 1992/93–1998/99

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]
1992–93[b]	20	72	2	0	0	0	0	0	6	50
1993–94[c]	9	40	19	10	2	3	6	5	8	105
1994–95[c]	7	30	29	10	1	2	7	8	6	135
1995–96[c]	15	33	26	14	1	2	1	4	6	165
1996–97[c]	7	33	23	20	1	2	5	3	5	177
1997–98[d]	6	35	16	21	0	2	4	11	5	197
1998–99[d]	10	44	22	14	0	1	1	6	2	220

[a] Reported harvest

[b] Registration permits valid for Aug 20–31.

[c] Registration permits valid for any bull, Aug 20–Sep 15 and Dec 1–31.

d Registration permits valid for any bull; Unit 17A Aug. 20-Sep 15, Unit 17B and 17C Aug 20–Sep15 and Dec. 1–31.

Table 15 Unit 17 reported moose harvest[a] percent by transport method, 1992/93–1998/99

Regulatory year	Percent of harvest								Total moose
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1992–93	64	0	29	0	2	0	1	3	212
1993–94	71	0	26	0	9	0	0	1	144
1994–95	71	0	22	0	2	0	1	3	161
1995–96	64	0	33	1	1	0	1	1	171
1996–97	68	0	29	0	2	0	1	1	196
1997–98	65	0	30	1	3	0	1	0	150
1998–99	67	0	32	0	1	1	0	1	169

[a] Excludes permit hunt harvest.

Table 16 Unit 17 reported moose harvest by permit hunt, percent by transport method, 1992/93–1998/99

Regulatory year	Percent of harvest								Total moose
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1992–93	9	0	83	1	0	1	1	5	50
1993–94	15	0	73	0	6	0	4	3	105
1994–95	18	0	59	0	12	0	3	8	135
1995–96	25	0	68	0	4	0	1	2	165
1996–97	26	0	63	0	6	0	2	3	177
1997–98	8	1	73	0	16	0	1	2	197
1998–99	5	0	81	3	6	0	0	5	220

LOCATION

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

GEOGRAPHIC DESCRIPTION: Yukon-Kuskokwim Delta

BACKGROUND

Moose were thought to have begun immigrating to the Yukon-Kuskokwim Delta during the mid-to-late 1940s. Local elders from the Yukon River have confirmed this timing. The Yukon population occupies most of the available riparian habitat and the population is growing. The Kuskokwim population is small and is still in the process of colonizing the available riparian habitat. Most of the Yukon-Kuskokwim Delta is lowland treeless tundra, which is not suitable as winter habitat for moose. During the winter, moose are generally confined to riparian zones (forest and willow habitats) along the major rivers.

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

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

MANAGEMENT DIRECTION

MANAGEMENT GOALS AND OBJECTIVES

- Allow the lower Yukon River moose population to increase above its estimated size of 2500–3000 moose. Allow the lower Kuskokwim River moose population to increase above its estimated size of 150–250 moose to at least 2000 moose.

- Maintain the current age and sex structure for both populations, with a minimum of 30 bulls: 100 cows.

- Conduct fall sex and age composition surveys as weather allows.

- Conduct winter censuses and recruitment surveys in the established survey areas on a rotating basis.

- Allow a harvest of bulls without hindering a high rate of population increase.

- Improve harvest reporting and compliance with hunting regulations.

- Minimize conflicts among user groups interested in moose within and adjacent to Unit 18.

METHODS

Moose harvests in Unit 18 are monitored using hunter checkstations and harvest tickets/reports. From late August through September 1997 and 1998, we operated a hunter checkstation at Paimiut Slough along the Yukon River near the border of Units 18 and 21E. In 1997, as in the previous year, we operated a hunter checkstation on the Kuskokwim River below the village of Lower Kalskag. In 1998, we monitored hunter activity from a checkstation based in Aniak. Hunting activity and harvest is monitored at checkstations through the voluntary cooperation of hunters from communities along these rivers.

In 1998, we initiated an incentive program to encourage hunters to turn in their harvest reports. Local license vendors donated several prizes ranging from small items such as baseball caps to a $400 gift certificate. These prizes were awarded randomly by drawing the returned harvest reports from a hat. We held the drawing in August just prior to the upcoming hunting season. While returns have not yet improved, this program holds promise and it will be continued until we are certain that Unit 18 residents have widespread knowledge of the program. At that point, it will be reevaluated.

Prior to 1999, we used 5 census areas to estimate the size of the moose population in Unit 18. Gasaway census methods (Gasaway 1986) were used in 4 areas and intensive surveys were used in 1 area. Each area was scheduled to be censused on a rotational basis. The census areas were delineated along the vegetated corridors of the Yukon and Kuskokwim rivers (Fig 1), as follows:

- Paimiut Area: The Yukon River from Pilot Station upriver to old Paimiut Village, previously censused with Gasaway methods in late February and early March 1992. This area was censused again in winter 1998.

- Lower Kuskokwim Area: The Kuskokwim River corridor between Kalskag and Kwethluk, previously censused with Gasaway methods in March 1993.

- Lowest Yukon Area: The Yukon River downstream of Mountain Village, where moose populations on 1700 square miles of forested habitat were estimated with intensive surveys in March 1994.

- Andreavsky Area: The Yukon River from Pilot Station downstream to Mountain Village, censused with Gasaway methods in March 1995. The area was again surveyed in 1999 using the method developed by VerHoef (1998, personal communication).

- NYAC Area: The tributaries of the lower Kuskokwim River. This census area was delineated but was never surveyed prior to adopting a different survey strategy.

With the advent of a new moose survey technique developed by Jay VerHoef (1998, personal communication), we revised our methods for estimating moose populations during this reporting period. In 1999, the Andreavsky Area was censused using VerHoef's method. We retained the census areas described above within the limits of these methods.

This new method developed by VerHoef utilizes GPS technology and provides some other statistical advantages. We are likely to reconsider our survey schedule and survey areas in the near future in order to utilize these advantages more fully.

We initiated discussions for a cooperative strategy to improve the moose population along the Lower Kuskokwim River with the Lower Kuskokwim Fish and Game Advisory Committee, the Association of Village Council Presidents, interested individuals, and the Fish and Wildlife Service.

Public information and education was provided through public service announcements made available to the media, a regularly scheduled radio essay of wildlife issues, newspaper articles, and informal hunter contacts.

Enforcement efforts have declined during this reporting period due to the transfer of the Bethel based Fish and Wildlife Protection Trooper to a different post in 1999. The Bethel position remains vacant.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Two population censuses were conducted during this reporting period. A Gasaway-type census was completed in late January 1998 of the Paimiut Area in eastern Unit 18 in the Yukon River drainage (Fig 1, Area 1). This area consists of 159 polygons of which 49 were sampled. A population estimate of 2024 (± 8.31% standard deviation at the 80% confidence interval) moose was calculated. Compared to the census conducted in March 1992, where the midpoint of that estimate was 994 (± 12.5% standard deviation at the 80% confidence interval), clearly there has been substantial population growth since 1992.

In March 1999 a census was completed of the Andreavsky Area using the method developed by VerHoef (1998). This area roughly coincides with the Andreavsky Area formerly surveyed using Gasaway-type methods (Fig 1, Area 4). It consists of 365 nearly rectangular polygons each being 2 minutes of latitude by 5 minutes of longitude. The area of each of these polygons ranged from 6.143 mi^2 to 6.321 mi^2 and 98 polygons were sampled resulting in an estimate of 524 (±19.5% standard deviation at the 80% confidence interval) moose. Compared to the Gasaway-type census conducted in 1995, where the midpoint of that estimate was 52 (± 48.3% standard deviation at the 80% confidence interval), it is clear that moose have sustained substantial population growth in this portion of the Yukon River drainage, despite the wide range in confidence intervals.

The moose population in the riparian zone of the Lowest Yukon Area downstream of Mountain Village (Fig 1, Area 3) was last surveyed using an intensive aerial technique in

March 1994. We believed the moose densities were too low for a Gasaway-type census, so we modified the technique and conducted a total count. Observers in four aircraft counted 65 moose during 38.7 hours of surveying, or about 1.7 moose/hour. While this population is still far below our goals, it is encouraging since moose were not present in this area when it was surveyed in 1988.

Lower Yukon Fish and Game Advisory Committee members reported observing more moose in the Lowest Yukon Area in January 1998. In response, we conducted a survey along the Yukon River from Mt. Village to Emmonak in March 1998. In just under 4 hours of surveying, we counted 54 moose, or approximately 13.8 moose/hour. While not strictly comparable to the total count conducted in 1994, this survey suggests that the moose population on the Yukon Delta continues to grow.

In contrast to the growing moose population along the Yukon River, moose densities remain very low in the Kuskokwim drainage. The last time a census was completed in the Lower Kuskokwim drainage (Fig 1, Area 2) was in March 1993. At that time, 217 (± 27.6% standard deviation at the 80% confidence level) moose were estimated using Gasaway-type census methods. Even though adjacent populations along the Yukon River have increased, we do not believe the size of the Kuskokwim moose population has substantially changed because there is more vigorous human exploitation of the moose population by villages on the Kuskokwim River.

Population Composition

Collection of population composition and recruitment information on moose in Unit 18 was limited to winter surveys due to weather. Thus, no information on bull:cow ratios are available. During the January 1998 census in the Paimiut Area we observed a calf:adult ratio of 33:100. During the March 1998 survey along the Yukon River from Mt. Village to Emmonak we observed a calf:adult ratio of 64:100 and during the March 1999 census of the Andreavsky Area we observed a calf:adult ratio of 33:100.

Age composition information is available from incisors of hunter-killed moose harvested in the Yukon drainage in adjacent Unit 21E and collected at the hunter checkstation near the boundary of Unit 18. Of the teeth collected, 60% were from male moose between 1 and 3 years of age (Table 5). This age composition is probably similar to that within Unit 18. If that's the case, and given the increasing trend of the Yukon River moose population, and given the ratio of calves to adults observed during population surveys, we can conclude that recruitment has been favorable for this reporting period along the Yukon River.

No population composition information is available for the Unit 18 portion of the Kuskokwim River drainage.

Distribution and Movements

Moose are distributed throughout the Yukon River riparian corridor. The highest concentrations occur during the winter. Within this riparian corridor, the densities are greatest toward the east and decline from there toward the west. Moose nearly always occur at low density near the villages. Some moose are also found along the tributaries and distributaries of the Yukon and in the highlands north of the Yukon River.

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

The area drained by the tributaries of the Kuskokwim River and those rivers draining into Kuskokwim Bay support small numbers of moose as colonizing animals from adjacent areas arrive. However, these moose have not survived to establish localized populations.

We have some radiotelemetry data, which show that moose are entering Unit 18 from adjacent Unit 17. Two cow moose radiocollared in the Togiak drainage by Togiak National Wildlife Refuge staff were found dead in Unit 18. One was found in the upper Goodnews drainage and the other in the upper Kwethluk drainage. Both moose were killed illegally.

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

MORTALITY

Harvest

Season and Bag Limits. Seasons and bag limits were similar to those from the previous reporting period (Table 2). Even the winter seasons in 1997–98 and 1998–99, which are opened by emergency order, remained the same as in the final year of the previous reporting period. The only difference was that the fall season in the hunt area downriver from Mt. Village was shifted 5 days earlier in 1998–1999, from 5 Sep–25 Sep to 1 Sep–21 Sep. This change will not remain in effect for subsequent seasons. Federal and State agencies have worked together to keep seasons aligned. The bag limit was 1 bull.

1997-1998 Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 18, that portion north and west of a line from Cape Romanzof to Kusilvak Mountain, and then to Mountain Village, and west of (but not including) the Andreafsky drainage	5 Sep–25 Sep	5 Sep–25 Sep
1 bull		
Remainder of Unit 18		
1 bull per regulatory year;	1 Sep–30 Sep	1 Sep–30 Sep

1997-1998 Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
during the period Dec 1–28 Feb, a 10-day season may be announced by emergency order	1 Dec–28 Feb (To be announced)	
1998-1999		
Unit 18, that portion north and west of a line from Cape Romanzof to Kusilvak Mountain, and then to Mountain Village, and west of (but not including) the Andreafsky drainage	1 Sep–21 Sep	1 Sep–21 Sep
1 bull		
Remainder of Unit 18		
1 bull per regulatory year; during the period Dec 1–28 Feb, a 10-day season may be announced by emergency order	1 Sep–30 Sep 1 Dec–28 Feb (To be announced)	1 Sep–30 Sep

<u>Board of Game Actions and Emergency Orders</u>. The winter seasons to be announced by Emergency Order were held in both 1997–1998 and 1998–1999 from 27 Dec–5 Jan. These are the same dates as the winter season in 1996–1997 and only a day earlier than in 1995–1996. These seasons were set after polling the village councils within the Unit and announcing the season based on their collective preference. Most villages prefer to have this season just after Christmas to allow time for travel conditions to improve and to avoid interference with the holiday. They also prefer to hunt prior to Slavic since feasting is an important part of the Russian Orthodox celebration. This explains the rather static nature of these emergency order openings.

In 1998–1999, the chair of the Lower Yukon Fish and Game Advisory Committee initiated a measure to open the moose season 5 days earlier in the area downriver from Mt. Village. In response, the Board of Game held an emergency meeting by teleconference and adopted an emergency regulation to accommodate this request. The Federal Subsistence Board also adopted the same adjusted season.

<u>Hunter Harvest</u>. Hunting (both legal and illegal) remains the most significant source of moose mortality in Unit 18. During the 1997–1998 open season, 363 hunters reported a harvest of 95 moose. For the 1998–1999 season, 383 hunters reported a harvest of 125 moose (Table 3). Nearly all of this reported harvest comes from the fall seasons. Harvest reporting for moose taken during the winter season has typically been very poor.

The moose population in Unit 18 is used heavily by local residents, and the annual combined reported and unreported harvest is estimated at 8–12% of the population on the Yukon River. Harvest probably exceeds annual recruitment on the Kuskokwim River and moose only survive there due to continual immigration from adjacent areas. Estimated unreported harvest probably equals or exceeds the reported harvest in the Kuskokwim drainage. We estimate the unit-wide unreported harvest is approximately 100–200 moose annually.

It is clear that the reported harvest of moose in Unit 18 does not reflect the actual harvest, but only shows the harvest 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 the fall. On the Yukon River, we believe that harvest reporting has improved in the last 11 years largely because of the presence of the Paimiut hunter check-station, the acceptance of harvest tickets/reports, and the willingness of most hunters to harvest only bulls. Although reporting has improved along the Yukon River, in Unit 18 there are hunters who do not report. Because of the unreported harvest, moose harvest data from Unit 18 must be regarded as incomplete and should be viewed as minimum estimates.

These poor harvest reporting rates are being addressed through a unique attempt to provide an incentive to use harvest tickets and send in the attached harvest reports. We are conducting a raffle of prizes donated by local license vendors and the department by using the hunt reports as entry forms for the raffle. This raffle was initiated for the 1998–1999 hunting season and how it affects harvest reporting rates remains to be seen. However, it has been well received by area hunters.

During the 1997–1998 season, approximately 75% (71 moose) of the reported harvest occurred in the Yukon River drainage with the remainder in the Kuskokwim River drainage. During the 1998–1999 season, 78% of the harvest (98 moose) was reported taken in the Yukon River drainage with the remainder in the Kuskokwim River drainage or elsewhere within the Unit (Table 4).

In 1995–1996, 1996–1997, and 1997–1998 there were 19 moose reported harvested each year from the Lowest Yukon Area downstream of Mountain Village. In 1998–1999, this number increased to 28. This is particularly interesting since as late as 1988, no moose were observed during a March survey of the lower Yukon Delta. It is also interesting to note that more moose were reported harvested in 1998–1999 from the area below Mt. Village than were reported harvested from the Andreavsky Area just upriver. Whether or not this is an artifact of better harvest reporting from the villages below Mt. Village is unknown.

During September 1997 and 1998, we operated the Paimiut checkstation for the twelfth and thirteenth consecutive years, respectively, at the junction of Twelve-Mile Slough and Paimiut Slough on the Yukon River. The checkstation is located near the border of Units 18 and 21E. In the summer of 1998 the Fish and Wildlife Service and the department built a cabin on the checkstation site. This cabin has greatly improved the comfort and safety of workers at Paimiut. It also provided an opportunity to honor the previous area biologist who died in 1996 while doing moose composition counts on the Yukon River. This cabin was dedicated to the memory of Randy Kaycon.

Determining the exact number of hunters using the area is difficult since some boats make multiple trips, some pass during the evening, and some hunters chose to stop only on their way out of the hunt area. We estimate that 75–100 boats carrying 175–225 hunters passed the checkstation with the large majority electing to stop at least once during their hunt.

We estimate between 50–100 moose were harvested each year from an area extending from the upper Innoko River and Iditarod River in Unit 21E to Russian Mission in Unit 18. Many of these moose were brought through or processed near the Paimiut checkstation. The moose examined at the checkstation each season were primarily young bulls in good condition.

In 1997, 67 moose were examined at the Paimiut checkstation. A tooth was collected from 42 of these moose. Average antler width was 36.1 inches. In 1998, 39 moose were examined at the checkstation and 36 teeth were collected. Average antler width was 36.5 inches. Tooth sectioning data indicated that the moose examined at the Paimiut checkstation typically are young animals (Table 5). These data suggest that hunters are not selective but rather harvest the first legal animal available to them.

In 1997, a hunter checkstation was operated on the Kuskokwim River eight miles below the village of Kalskag. 39 moose were examined from which 27 teeth were collected to be aged. 18 of these were 2 ½years of age or younger and had an average age of 3.1 years. All of the moose examined at this checkstation were harvested in Unit 19.

In 1998, a hunter checkstation was operated on the Kuskokwim River in the village of Aniak at the very location where we believed hunters were likely to purchase boat fuel. 39 moose, all from Unit 19, were examined at the checkstation. 18 teeth were collected from these moose and sent in to be aged. The average age of this collection was 3.9 years with 9 of these being 2 ½years of age or younger. The average antler size was 42.7 inches and ranged from a low of 21.5 inches to a high of 61.5 inches. While these averages are high, it's likely an artifact more of hunters who catch large moose being more willing to keep a large set of antlers and to stop at a checkstation than any biological criteria. Of the 39 successful hunters interviewed at the checkstation, 7 did not salvagc the antlers. We also observed 39 additional boats with antlers continue their travel downriver without stopping at the checkstation. With the large amount of local traffic around Aniak, no attempt was made to enumerate the number of hunters traveling on the river without visible evidence of moose in their boats.

Moose during winter are concentrated on islands with large cottonwood stands and bushy willow fringes along the Yukon and 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 revealed that several moose, including females and calves, were illegally harvested during these two winters.

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

Hunter Residency and Success. As reported in past years, Alaska residents accounted for most of the hunting activity in Unit 18. Nearly all of the Unit 18 moose hunters reside in Unit 18.

Of 385 hunters who reported hunting during the 1997–1998 season, only 3 nonresidents hunted in Unit 18. Of 370 hunters who reported hunting during the 1998–1999 season, only 6 nonresidents reported hunting in Unit 18. From informal conversations it is clear that when nonresidents choose to hunt moose in Unit 18, it is generally because they have friends or relatives who live in the Unit or are former Unit 18 residents themselves. The low moose densities and high cost generally make Unit 18 an unattractive destination for nonresident moose hunters.

Hunter success rate based on harvest reports was 33% for the 1997–1998 season and 32% for the 1998–1999 season. Successful hunters spent an average of 8.4 days hunting moose in Unit 18 in 1997–1998 and 9.9 days in 1998–1999.

Many Unit 18 residents are aware that hunting opportunities are better in adjacent Units 19 and 21E. Hunters from Unit 18 regularly use boats during the fall season to access hunting areas upriver in adjoining units. On the Kuskokwim River, many of the residents hunting moose between Kalskag and McGrath (in Unit 19) are from Unit 18. Similarly, on the Yukon River, a large number of hunters use boats to travel from Unit 18 into Unit 21E. All of the hunters at the Paimiut hunter checkstation who reported hunting in Unit 21E were residents of Unit 18. As a consequence, harvest allocation has been controversial among residents of Unit 18 and residents of Units 19 and 21E.

Harvest Chronology. The majority of reported moose harvest occurs during September when the general season is opened. Only small numbers of moose have been harvested in the winter season during December and January (Table 3).

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

Other Mortality

Black and grizzly bears occur along the major river corridors and large tributaries in Unit 18. Little information is available indicating that predation by bears is a significant source of moose mortality in Unit 18. The effect they have on moose numbers, particularly through predation on calves, is unknown.

Reports indicate that wolf numbers have increased considerably during this and the previous reporting period. This is expected since caribou have become more available, trapping pressure has declined, and moose numbers have increased. We estimate 100–150 wolves in 15–20 packs reside in Unit 18. Throughout most of Unit 18 the distribution of wolves reflects the distribution of moose, especially in the Yukon River drainage. In the lower Kuskokwim River drainage, caribou are the main prey item for wolves and the distribution of wolves is not as closely linked to moose. Several wolf packs in the Kilbuck Mountains are thought to follow caribou into and out of Unit 18.

HABITAT

Assessment

We estimate a minimum of 8000 mi^2 of moose habitat exists in Unit 18. Approximately 4500 mi^2 of this habitat occurs along the riparian zone of the Yukon River and the remaining 3500 mi^2 is found along the Kuskokwim River and its tributaries. The islands and adjacent sloughs along the Yukon River corridor from Paimiut to Mountain Village represent the most productive moose habitat in Unit 18. No overbrowsing is evident in this area. The willows downriver from Mountain Village in the Yukon Delta proper are overgrown and senescent, except for the expanse of willows toward Kusilvak Mountain and the Kashunak River, and those islands in the Yukon flooded each spring. Because the Yukon Delta has many distributaries fringed by willows and cottonwoods and yet supports very few moose, the availability of forage is not a limiting factor there.

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

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

Enhancement

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

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

The major nonregulatory issue is the allocation of hunting effort and harvest by local residents of Units 18, 19 and 21E. This is an 'upriver resident' versus 'downriver resident' issue along the Yukon River. Additional meetings, objectives and planning are needed to minimize conflicts.

CONCLUSIONS AND RECOMMENDATIONS

Within living memory, moose have colonized the Yukon-Kuskokwim Delta in moderate densities along the Yukon River from Paimiut to the mouths of the Yukon, but remain at low to very low densities throughout the remainder of the unit. Although much of Unit 18 is lowland tundra unsuitable as moose winter habitat, moose should be present in higher numbers because areas of riparian 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 slowed moose population growth.

The illegal harvest, particularly of cows, remains the most serious moose management problem in Unit 18. Although compliance is improving, a poorly developed cash economy, and high density of people and villages along the major rivers complicate moose management considerably. Nearly 25,000 rural residents live in 42 communities throughout Unit 18 and we need continued effort to curb illegal harvest of moose.

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

Recent actions by user groups to shoulder some responsibility for the growth of local moose populations are welcome signs of increasing participation with existing management systems. Continued efforts to work with local user groups are vital for effective management. However, individuals 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 Mulchatna caribou herd and recent movements of the Western Arctic caribou herd into Unit 18 may eventually reduce hunting pressure on the local moose population. However, we anticipate the demand for moose will continue to exceed the supply.

We recommend monitoring and inventory of the moose population remain a priority in Unit 18, especially the continuation of the population censuses along the Yukon and Kuskokwim rivers. We should continue to attempt fall composition counts in the Yukon and Kuskokwim drainages, despite the fact that poor winter weather and snow conditions will regularly prevent completion of composition counts before bulls drop their antlers. The census results, in conjunction with annual composition surveys, will provide the department with baseline demographic information and recruitment rates to properly manage the moose population.

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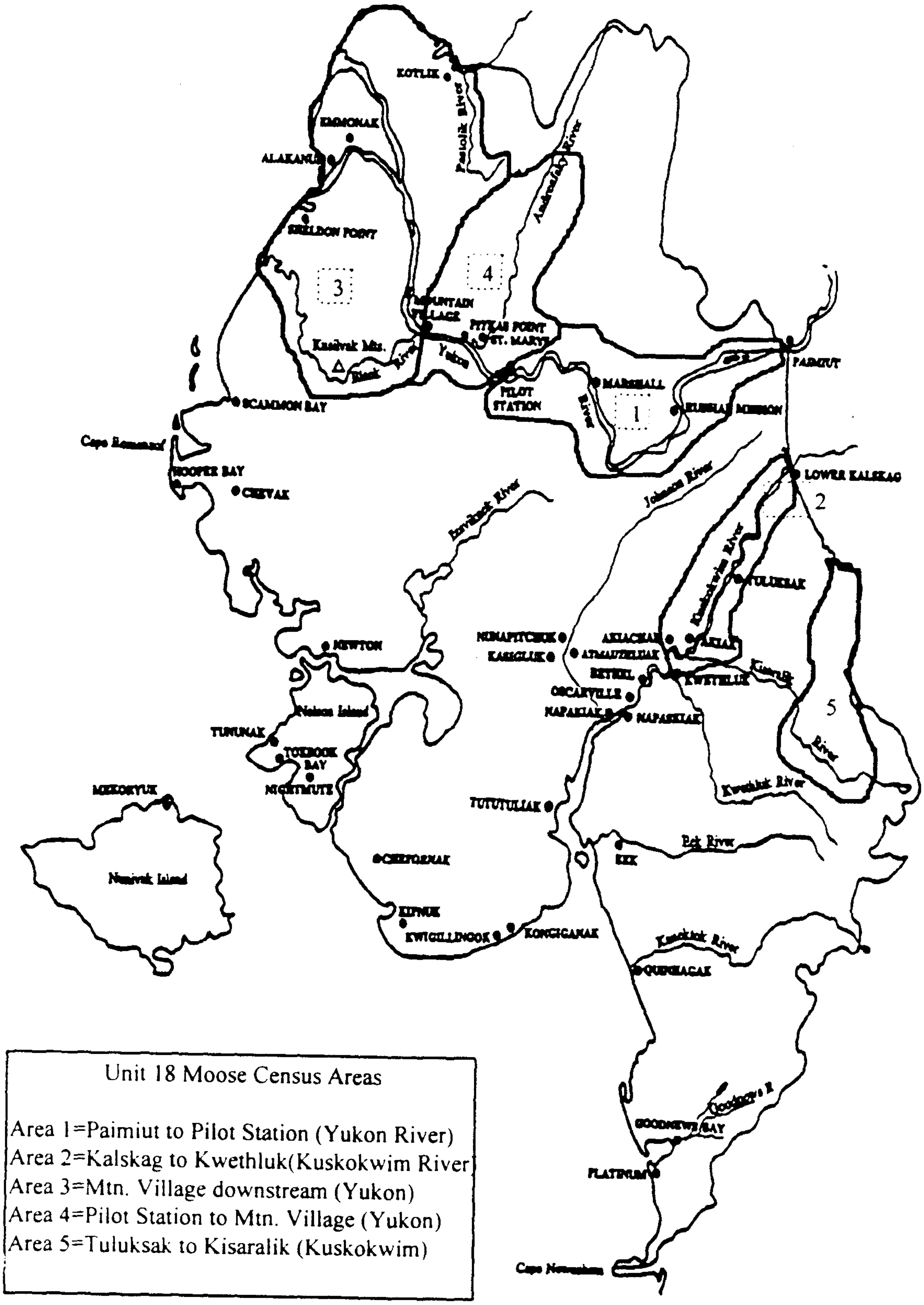

Figure 1. Game Management Unit 18, showing major drainages, communities, and census areas

Table 1 Unit 18 moose census area results, 1992–1998

Census Area	Date	Total Area (mi^2)	Total polygons (N)	Area sampled (mi^2)	Polygons Sampled (n)	Population estimate	80% confidence interval (%)
1. Paimiut Area: Paimiut to Pilot Station	March 1992	1558	159	628	39	994	± 12.5
	January 1998	1592	158	505	45	2,024	± 8.31
2. Lower Kuskokwim River Area: Kalskag to Kwethluk	March 1993	648	41	249	18	217	± 27.6
3. Lowest Yukon River Area: downriver from Mountain Village	March 1994	1700	19	1700	19	65	not applicable
4. Andreavsky Area: Pilot Station to Mountain Village	March 1995	1984	97	513	29	52	± 46.3
	March 1999*	2279	365	612	98	524	±19.5%
5. NYAC Area: Upper Tuluksak River to Upper Kisaralik River – proposed	March 1998	892	65	(proposed)	(proposed)	(proposed)	(proposed)

*VerHoef's census method

Table 2 Summary of moose hunting regulations and harvest in Unit 18, 1961–1999

Regulatory year	Season dates	Reported Harvest	Bag limit and area affected
1961–1962	20 Aug–30 Sep	73	1 bull
	20 Nov–10 Dec		
1962–1975	20 Aug–31 Dec	134	1 bull
1975–1982[a]	1 Sep–20 Sep	20	1 bull; Yukon River Delta[b]
	1 Sep–31 Dec	122	1 bull; remainder of Unit 18
1982–1985	1 Sep–20 Sep	20	1 bull; Yukon River Delta[c]
	1 Sep–30 Sep	77	1 bull; remainder Unit 18
	15 Nov–31 Dec		
1985–1988[de]	1 Sep–20 Sep	20	1 bull; Yukon River Delta
	1 Sep–30 Sep	40	1 bull; remainder of Unit 18
	1 Feb–10 Feb		
1988–1992[f]	CLOSED		Yukon River Delta
	1 Sep–30 Sep	41	1 bull; remainder Unit 18
	20 Dec–30 Dec[g]		
1993–1994	CLOSED		Yukon River Delta
	1 Sep–30 Sep	40+	1 bull; remainder Unit 18
	Winter Season TBA[h]		
1994–1995	5 Sep–25 Sep	10	Yukon River Delta
	1 Sep–30 Sep	40+	1 bull; remainder of Unit 18
	Winter Season TBA[i]		
1995–1996	5 Sep–25 Sep	19	Yukon River Delta
	1 Sep–30 Sep	71	1 bull; remainder of Unit 18
	Winter Season TBA[j]	3	
1996–1997	5 Sep–25 Sep	19	Yukon River Delta
	1 Sep–30 Sep	97	1 bull; remainder of Unit 18
	Winter Season TBA[k]		
1997–1998	5 Sep–25 Sep	19	Yukon River Delta
	1 Sep–30 Sep	76	1 bull; remainder of Unit 18
	Winter Season TBA[k]		
1998–1999	1 Sep–21 Sep	28	Yukon River Delta
	1 Sep–30 Sep	96	1 bull; remainder of Unit 18
	Winter Season TBA[k]	1	

[a] The Alaska Board of Game established the Kalskag Controlled Use Area in 1977.
[b] That area north & west of a line from Cape Romanzof to Mountain Village, & west of & excluding the Andreafsky River drainage.
[c] That portion of Unit 18 north & west of a line from Cape Romanzof to Kusilvak Mountain, to Mountain Village, & west of & excluding the Andreafsky River drainage.

Table 2 Continued.

[d] In 1985–1989, hunting regulations were divided into general and subsistence 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 began. 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 15–24 Dec. which overlapped the state season.

[g] The federal winter season was 31 Dec–9 Jan 1992–1993.

[h] The 10-day state winter season was To Be Announced by Emergency Order between 20 Dec–20 Jan; the federal winter season was also a To Be Announced season by the Refuge Manager between 1 Dec–28 Feb State season dates were 20–29 Dec 1993 while the federal season was 21–30 Dec 1993. The federal season was also extended from 4–10 Feb 1994.

[i]The federal fall season in the Kuskokwim drainage was from 25 Aug–25 Sep, while the state fall season was 1–30 Sep 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 25 Sep 1994. State season: 20–29 Dec 1994; federal season 21–30 Dec 1994.The USFWS extended the winter hunt from 4–10 Feb 1994.

[j]In 1995 both the state and the federal winter seasons coincided, 28 Dec1995–6 Jan 1996.

[k]In 1996–1997, 1997–1998, and 1998–1999 both the state and the federal winter seasons coincided, 27 Dec–5 Jan.

Table 3 Fall and winter moose harvests for Unit 18, 1978–1999

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

Table 4 Moose harvest in the Yukon River, Kuskokwim River and Johnson River drainages, Unit 18, 1981–1999

	Moose harvest (%)		
Regulatory year	Yukon River	Kuskokwim River	Johnson River
1981–1982	57	32	11
1982–1983	58	36	6
1983–1984	63	33	4
1984–1985	62	32	6
1985–1986	67	17	16
1986–1987	66	34	0
1987–1988	52	42	6
1988–1989	81	19	0
1989–1990	55	39	6
1990–1991	80	15	5
1991–1992	75	24	1
1992–1993	64	33	3
1993–1994	77	24	2
1994–1995	86	14	0
1995–1996	85	15	0
1996–1997	72	28	0
1997–1998	75	24	1
1998–1999	78	12	6
Average	70	26	4

Table 5 Summary of moose ages from teeth collected at the Paimiut moose hunter checkstation 1986–1999

	Year harvested														
	99	98	97	96	95	94	93	92	91	90	89	88	87	86	
DOB															TOTAL
99	0														0
98	8	0													8
97	12	13	0												25
96	7	7	21												35
95	2	8	9		1										20
94	1	1	7		14	0									23
93		4	2		11	14	0								31
92		1	0		8	13	21	1							44
91		0	2		1	9	6	12	1						31
90		0	1		7	4	15	16	17	0					60
89	1	2			0	3	5	8	12	17	1				49
88					5	3	3	3	14	13	7	0			48
87					1	3	3	4	5	10	21	22	1		70
86						4	2	2	2	4	6	12	12	0	44
85						0	1	0	0	4	3	4	5	0	17
84						1	0	1	2	1	2	2	3	6	18
83						0	0	0	0	0	0	0	0	8	8
82						1	1	1	1	4	3	1	1	2	15
81						0			0	1	0	1	5	3	10
80						1			2	1	1	0	1	2	8
79									1	1		0	0	0	2
78												0	2	1	3
77												0	0	1	1
76												1	0		1
75													1		1
Total	31	36	42		48	56	57	48	57	56	44	43	31	23	572

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. According to oral history, their initial discovery was apparently sometime after the turn of the century. As recent 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. The 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 those harvests 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 distinct 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 hunting for food and living in Unit 19, Unit 21, or adjacent Unit 18. 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 an important consideration as well.

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 and because of annual variations in snow and weather conditions that affect moose movements and timing and the quality of surveys.

Historical moose survey information is limited. A combination of changes in moose survey techniques and logistical challenges of moose surveys in remote areas has resulted in a very discontinuous and often incomparable moose count database. Since the general standardization of survey techniques in the 1980s, we have attempted to establish trend count areas and survey areas to balance the information needs of management with fiscal limitations.

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 in an attempt 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 should continue to be based on these premises.

MANAGEMENT OBJECTIVES

- Annually assess population status, bull:cow ratios, and trend in portions of the area where harvest levels make significant impacts on moose populations.
- 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

We conducted population composition and trend surveys in selected portions of the area using standard aerial survey techniques. These surveys were flown in 50–100 mi^2 sampling areas using fixed-wing aircraft. Sampling areas had fixed boundaries and were flown in the fall after sufficient snowfall has occurred, but prior to antler shedding by bulls. Surveys were usually flown at a search intensity of 3–5 minutes/mi^2, depending on the habitat type and the associated visibility.

We estimated population size in a portion of the Holitna/Hoholitna drainage during March 1998 using Gasaway et al. methods (1986). We also estimated populations in a portion of Unit 19D East in February 1999 and in a portion of Unit 21E in February 2000 using the Geo-Statistical Population Estimator (GSPE) (J Ver Hoef, ADF&G, personal communication). Unit 19D East includes that portion of Unit 19 within the Kuskokwim River drainage upstream from the Salatna River, not including the Takotna River drainage upstream from its confluence with the Nixon Fork River.

Calf twinning surveys were conducted during May and June in Unit 19D along the Kuskokwim River, in Unit 19A along the Holitna River and in Unit 21E. They were conducted much like the fall surveys described above, except they were done during mid-May (moose calving starts) through early June (leaf out limits sightability). These surveys were completed in fixed geographical areas, however search effort was greatest in meadows and low shrub areas with high sightability.

Harvest was monitored by requiring hunters to acquire moose harvest tickets and to report: residency, effort, location of hunt, transportation method, commercial services used, success, sex of kill, and antler width.

Population and harvest data were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY99 = 1 Jul 1999–30 Jun 2000).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size and Trend

We conducted trend area counts in every subunit except Unit 19B during this reporting period. However, only 1 trend survey was conducted during fall 1999, because of poor survey conditions. We also completed spring population estimates in Units 19A during March 1998, in 19D in February 1999, and 21E during February 2000.

Unit 19A. The 19A moose population was stable to declining, based on trend data from the Holitna/Hoholitna trend count area. Trend area information indicates that observable moose numbers increased from the late 1980s until RY94, when peak numbers of total moose and moose per hour were observed (Table 1). Trend counts during RY96 and RY97 indicated a steady decrease in total numbers of moose observed. The March 1998 density estimate was 1.25 moose/mi^2 (± 14.4%, 80% CI) indicating a moderate to late winter moose density for western Interior Alaska. During a survey flight on 19 February 2000 along the Hoholitna River from the Unit 19A/19B border to the confluence of the Holitna River and on to Sleetmute, I observed 152 moose, including 7 calves and 27 wolves. These data indicated poor overwinter calf survival in that area. Predation by wolves appeared to be increasing, based on local hunter and trapper information.

Unit 19B. No trend count data or population estimates are available from Unit 19B. Moose trend count areas have been sporadically established, but were abandoned because early winter snowfall conditions varied greatly, influencing moose distribution and causing extreme variations in the data. However, the moose population in Unit 19B appeared to be stable to declining based on harvest data and information from local hunters and guides.

Unit 19C. The moose population in Unit 19C was stable based on trend counts (Table 2). Trend data through the fall of 1997 showed a population increase. No trend survey was conducted during RY98, and the RY99 survey was incomplete because of insufficient snow depths and limited light conditions. Composition ratios were very similar during RY97 and RY99, however the total number of observed moose declined. The decline in numbers is assumed to be an artifact of the incomplete survey and not due to an actual drop in population.

Unit 19D. The moose population in Unit 19D declined during this reporting period to the lower densities of the "low-density equilibrium" described by Gasaway et al (1992) for wolf-bear-moose systems in Alaska and the Yukon. The GSPE completed in February 1999 in a portion (2645 mi^2) of Unit 19D East (5200 mi^2) indicated overall moose density was

0.27 moose/mi^2 (± 14.6 %, 90% CI). The 1996 Gasaway estimate, completed in a portion (1819 mi^2) of the GSPE area, was 0.37 moose/mi^2 (± 24.6%, 90% CI).

Unit 19D also contains 2 established composition/trend count areas. In the Candle/Wilson trend area in Unit 19D East, survey information indicated a low bull:cow ratio of 13:100 during RY98 that has been declining since the early 1990s (Table 3). In the White Mountains, 6 surveys during RY88–RY96 indicated fairly good calf:cow ratios, but relatively unstable bull:cow ratios (Table 4). The instability in the bull:cow ratios resulted in the cessation of surveys in that area.

Unit 21A. The moose population in Unit 21A was stable to declining. Trend data is not collected on a regular basis in the unit. However, anecdotal winter observations by trappers indicated a decline in the overwintering population. Also, staff from the Innoko National Wildlife Refuge estimated a density of 0.643 moose/mi^2 (± 29.6%, 90% CI) in the refuge portion of Unit 21A and into Unit 21E. However, this estimate is questionable because statistical assumptions were violated.

Unit 21E. The moose population in Unit 21E was stable, as indicated from composition information collected in the Holy Cross trend area (Table 5). Sex and age ratios were stable during RY96–RY98. However, the overall number of observed moose declined during this period. The decline raised some concern and will be closely monitored during the next reporting period. Our February 2000 GSPE in a 5070-mi^2 portion of Unit 21E indicated a density of 1.2 moose/mi^2 and provided a baseline for further population monitoring.

Population Composition

In Unit 19A, bull:cow ratios from 10 fall surveys between RY76 and RY97 in the Holitna River drainage showed some deterioration of the bull:cow ratio, indicating a stable or possibly declining population (Table 1). Hunting pressure was intense, and was probably responsible for the declining ratios. Fall calf:cow ratios in this area were relatively high, with the exception of RY97, indicating favorable range conditions, low neonatal mortality rates, and sufficient bull:cow ratios. This indication was contradicted by data gathered during a February 2000 survey, along the Hoholitna River. The survey indicated calf (9 months old) survival was <5% (7/152), which was very low.

Unit 19B bull:cow ratios are largely unknown. However, data from adjacent Unit 19A indicated a decline in the ratio. Also, anecdotal information collected after the 1999 hunting season from several guides indicated a reduction in the number of bulls available.

Unit 19C is represented by the Farewell and the Windy-Pingston trend count areas. In 16 surveys conducted in the Farewell area from RY73 to RY99, notable increases in the moose herd were seen. This was due to the Bear Creek Burn that occurred in 1977. By 1983, moose numbers had increased dramatically, and bull:cow ratios averaged over 50:100. Despite recent increases in the hunting pressure in the area, bull:cow ratios remained at moderate levels (Table 2).

In Unit 19D, the situation is bleak. Moose per hour figures, as indicated above, were quite low. Bull:cow ratios in the Candle-Wilson Count Area were highly variable (6–16:100), but the overall trend was down. Fluctuations could have been a combination of the decreasing sample sizes and declining number of bulls (Table 4). Calf:cow ratios likewise were highly variable (14–60:100). In our spring 1999 SUPE, calves made up 22% of the sample.

Units 21A and 21E sex and age composition data were gathered from the Holy Cross trend count area. It had extremely high fall moose densities, and, despite high hunter interest, bull:cow ratios remained at moderate levels. They averaged 28:100 between RY87 and RY99 (Table 5). Calf:cow ratios in the area during the same time period were 22–63:100, with no discernible trends.

MORTALITY

Harvest

Seasons and Bag Limits.

In Unit 19A within the Lime Village Management Area, residents could take 2 moose of either sex by Tier II permit during 10 August–25 September or during 20 November–31 March. The Lime Village Management Area was closed to nonresidents.

Unit 19A outside of the Lime Village Management Area and upstream of the Kolmakof and Holokuk Rivers had a bag limit for residents of 1 bull during 1–20 September or 20–30 November, and either sex could be harvested during 1–10 February. Nonresidents could take 1 bull having antlers at least 50 inches (or at least 4 brow tines on 1 or both sides) during 1–20 September.

Unit 19A outside of the Lime Village Management Area and downstream of the Kolmakof and Holokuk drainages had resident open seasons of 1–20 September, 20–30 November, and 1–10 February for any bull. Nonresidents were allowed to harvest bulls 50 inches or greater, or with at least 4 brow tines on 1 or both sides during 1–20 September.

Units 19B and 19C had resident seasons of 1–25 September for any bull. Nonresidents were allowed to harvest bulls with 50-inch plus antlers or antlers with 4 or more brow tines on 1 side during the same time period. In addition, a registration hunt was established by the Board of Game in Unit 19C for a resident antlered bull moose hunt during 15 January–15 February.

In Unit 19D along the Kuskokwim River upstream from and including the Selatna River drainage, resident hunters could take 1 bull moose during 1–25 September or during 1–31 December. Nonresidents were not allowed to participate in the hunt. An additional 20–31 August season was available within the area upstream of Big River, south and east of the north fork of the Kuskokwim River.

In the remainder of Unit 19D, residents were allowed 1 bull during 1–25 September or 1–31 December. Nonresidents had to comply with the 50-inch antler regulation and could hunt only during 1–25 September.

Unit 21A resident hunters could harvest 1 bull during 5–25 September or in November. Nonresident hunters could harvest 1 bull during the 5–25 September season with a 50-inch minimum antler or antlers with 4 or more brow tines on 1 side.

Unit 21E resident hunters could hunt any bull from 5–25 September, or any moose from 1–10 February with no moose taken within ½ mi of either the Yukon or Innoko Rivers during this latter period. Nonresidents had the same September seasons, but had to select a bull with at least 50-inch antlers, or antlers with 4 or more brow tines on 1 side.

Board of Game Actions and Emergency Orders. Unit 19D season dates were changed during the spring 2000 Board of Game meeting. We proposed reducing the season to 15 days in September and eliminating the December season, except in the remainder of the unit downstream of the Selatna River. The goal was to slow the decline in bull:cow ratios. The board passed a 5-day season reduction during the fall season, throughout the unit, and shortened the December season upstream of the Selatna River to 1–15 December. Included with these changes was a complete elimination of the nonresident season that had existed below the Selatna River drainage. It is unknown whether these changes will be significant enough to stabilize and eventually increase the bull:cow ratio, along with retarding the overall population decline in Unit 19D.

Hunter Harvest. Reported annual moose harvest in Unit 19A was relatively stable, with actual harvest probably >200 moose annually. The average reported annual harvest during RY94–RY98 was 156 (Table 6a). The majority of those moose were bulls (94%), with light cow harvesting occurring during the February seasons. This reported harvest was lower than the actual kill because reporting rate by hunters in this area is low. Based on data collected in 1998 at the Holitna River checkstation, only 45% of the actual harvest is reported.

Reported annual harvests in Units 19B and 19C were probably much closer to reality than reported harvest for Unit 19A. They averaged 155 and 144 moose, respectively, during RY94–RY98 (Tables 6b and 6c). In Unit 19D, compliance with reporting requirements was poor. Reported kill averaged 102 (Table 6d) during RY94–RY98. This was a decline from the previous 5-year average of 122 moose.

In Unit 21A, reported moose harvests were stable during RY94–RY98, with 119 animals taken on average (Table 6e). In Unit 21E, reported harvests were stable, but have generally increased during RY94–RY98. The reported harvest of 205 moose in RY97 was the highest on record, probably reflecting better compliance with reporting requirements rather than a significant increase in the actual harvest (Table 6f).

Permit Hunts. Beginning with the RY90 season, a Tier II drawing permit hunt was established for moose hunting in the Lime Village Management Area in Unit 19A. During RY90, 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 RY93. Reported harvests were light, for example the RY98 hunt included 7 moose killed, 1 unsuccessful hunter, and 7 permittees that did not attempt to hunt (Table 7). There was also a federal permit hunt in the same area, with a harvest quota of 40 moose.

Antler Size. The average antler size for RY94–RY98 in Units 19B, 19C, and 21A was 53 inches, 51 inches, and 50 inches, respectively (Table 8). These subunits had a high proportion of guided and unguided nonresident hunters who were required to take bulls with a minimum antler size. The average antler size for RY94–RY98 in the Units 19A, 19D, and 21E was 43 inches, 46 inches, and 43 inches, respectively. These subunits had a high proportion of local resident hunters who were not required to take bulls with a minimum antler size. Average antler size within individual subunits was relatively stable during RY94–RY98.

Hunter Residency and Success. Nonlocal residents accounted for the major portion of the reported harvests in Units 19A, 21A, and 21E, while the majority of hunters in Unit 19B were nonresidents (Tables 9a–f). In Unit 19C, hunters were presented in equal proportions of nonlocal residents and residents. In Unit 19D, the majority of the hunters were local unit residents. This segregation by residence location is due to different means of access and access restrictions.

In Unit 19A hunter residency did not change dramatically during RY94–RY98. Hunters from Unit 19 accounted for 27% of reporting hunters. Alaska residents from outside the unit accounted for 55% of reporting hunters. Nonresident hunters accounted for very few, averaging less than 15% (Table 9a). During RY94–RY98, Unit 19B hunters consisted largely of nonlocal Alaskan (51%) and nonresident (49%) hunters (Table 9b). Very few people live in the subunit. Likewise, hunters in Unit 19C were primarily nonlocal Alaskans (59%) and nonresidents (40%). Unit residents accounted for <2% of the reporting hunters in Unit 19C (Table 9c). Unit 19D hunters were largely local residents (50%). Alaska residents from other areas made up an additional 33% of the reporting hunters. Nonresidents only accounted for about 15% of the hunters who have reported during the previous 5-year period (Table 9d). Unit 21A hunters consisted largely of nonlocals (59%) and nonresidents (35%) (Table 9e). Hunters reporting from Unit 21E were generally from 1 of 4 villages in the subunit (17%), and were nonlocal residents including residents of Unit 18 (71%). The proportion of nonresidents was generally less than 5% but has increased in recent years up to a 5-year average of 11% of all hunters in the subunit (Table 9f).

In Unit 19A the reported hunter success rate averaged 49% (46–54%) during RY94–RY98 and averaged 50% during RY97–RY98. In Unit 19B the reported hunter success averaged 41% (37–47%) during RY94–RY98 and averaged 39% during RY97–RY98. In Unit 19C the reported success rate averaged 54% (49–60%) during RY94–RY98 and was stable at 55% during RY97–RY98. In Unit 19D the reported success averaged 48% (43–54%) from RY94–RY98 and averaged 51.5% during RY97–RY98. In Unit 21A the reported average success was 61% (52–65%) from RY94–RY98 and was stable at an average 62% during RY97–RY98. In Unit 21E the average reported success was 81% (76–86%) during RY94–RY98 and was stable at 82% during RY97–RY98.

Transport Methods. As in previous years, the Unit 19A, 19D, and 21E method of transport most commonly used was boat (RY98 data, 67%, 79%, and 79%, respectively) (Tables 10a, 10d and 10f). In Units 19B and 21A, the use of aircraft for transportation was predominant during RY98, with 90%and 69%, respectively, of all access (Tables 10b and 10e). In Unit 19C transportation to the field for 98% of the hunters was usually by aircraft, however, hunters reported using aircraft 67% and ATVs and horses 31% during RY98 (Table 10c). This happens because most hunters transport their own ATVs to the Farewell Station Airstrip, and some guided hunters use horses provided by the guides. Differences in transportation methods were used to define the original unit boundaries to spatially separate user groups and hunting patterns, and "local" hunters are still largely separated from "nonlocal" hunters.

Other Mortality

Illegal harvests, defense of life or property kills, wounding loss, and funeral potlatch harvests probably account for an additional 150–200 moose deaths annually in Unit 19, and probably 100–150 additional kills in Units 21A and 21E. Of much greater importance to the dynamics of the moose population, however, is predation mortality. Based on trapper questionnaires, pilot reports and data collected during moose surveys, predation on calves, yearlings, and adults by wolves has been substantial in recent years, as has calf predation by black bears.

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 exists 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.

A February 2000 browse survey in Unit 19D near McGrath indicated many of the riparian willows are beginning to outgrow the browsing pressure. The 1999–2000 snowfall in the same area was greater than normal, forcing more of the moose on to the riparian willow bars. Substantial browsing was documented in these areas.

Enhancement

We continued efforts to document browse utilization on heavily used winter ranges along the Kuskokwim River. We have also continued habitat enhancement efforts. Close cooperation with Alaska Department of Natural Resources fire management personnel resulted in relatively high-acreage burns in recent years. In cooperation with them, a prescribed fire plan was finished for portions of Unit 19C in the Farewell area. During spring 2000, ignition of a prescribed fire was attempted, but burning conditions were marginal.

CONCLUSIONS AND RECOMMENDATIONS

Populations over the reporting area were generally stable to declining, with considerable variation both within and between years. RY97 data indicated stable populations in all subunits surveyed except Unit 19D, where the population declined. RY98 surveys showed overall declines in observed moose in some trend areas, but composition data was stable. Declines in total number observed could be due to a change in observers between RY97 and RY98. Unit 19D was the only area indicating a decrease from the previous reporting period in observed numbers and in bull:cow ratios. However, calf:cow ratios were stable.

Because of lack of snow, the only trend area surveyed in RY99 was in Unit 19C near Farewell and results of that survey were marginal. During the next reporting period, we will emphasize collecting data in the trend areas that showed a decrease in RY98. This will help us further assess the likelihood of declining populations. Annual data collection efforts in as many units as possible are the best and most cost-effective way to assess yearly changes in population composition and to monitor population trends.

We accomplished much of our objective to assess population status, bull:cow ratios, and trend in portions of the unit where harvest levels make significant impacts on moose populations. However, efforts will be made during the next reporting period to improve data collection in the western portion of Unit 19A and Units 19B, 19C and 21A to complete gathering baseline information. This is the first step in developing sound long-term management plans for moose in this area.

We met our objective to maintain an annual average antler spread measurement of at least 48 inches in Units 19B, 19C and 21A during this reporting period. This objective was designed as an index to the population status of large bulls and overall hunter success.

We made some progress on our objective to assess the accuracy of harvest reporting in portions of the area. We reviewed subsistence harvest surveys and compared them to reported harvests. During the next reporting period efforts will be made to implement a system to better assess reporting rates in selected areas, primarily Units 19A, 21E, and 19D. These units have historically poor reporting and have sparked an ever increasing debate over the population levels, trends and the impact of all sources of mortality, including hunting.

We partially accomplished our objective to encourage wildfires by implementing a prescribed burn plan for the Farewell area. During spring 2000, the Farewell prescribed burn was attempted but burning conditions were not favorable for the desired effect. The prescription will be monitored, and hopefully this burn will occur sometime during the next reporting period.

The only quantifiable objective during this reporting period was to maintain an annual average antler spread measurement of at least 48 inches in Units 19B, 19C, and 21A. Other objectives were not quantifiable and, therefore, could not be readily evaluated. During the next reporting period new objectives will be formulated.

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Table 1 Unit 19A Holitna/Hoholitna trend count area fall aerial moose composition counts, regulatory years 1987–1988 through 1999–2000

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves: 100 Cows	Calves	Percent calves	Adults	Moose	Moose/ hr
1987–1988	22	4	72	50	36	84	140	85
1988–1989	31	16	56	103	30	240	343	95
1989–1990	24	13	55	160	30	361	528	163
1990–1991	26	10	52	139	29	336	475	162
1991–1992[a]								
1992–1993	31	15	63	172	32	360	542	169
1993–1994[a]								
1994–1995	14	2	42	209	27	568	778	251
1995–1996[a]								
1996–1997	22	10	50	146	29	355	502	152
1997–1998	14	11	34	85	23	286	371	169
1998–1999[a]								
1999–2000[a]								

[a] No survey.

Table 2 Unit 19C Farewell Burn trend count area fall aerial moose composition counts, regulatory years 1987–1988 through 1999–2000

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves: 100 Cows	Calves	Percent calves	Adults	Moose	Moose/ hr
1987–1988	53	10	19	32	13	207	242	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[a]								
1994–1995	52	10	19	45	11	353	404	170
1995–1996[a]								
1996–1997	46	11	15	43	10	411	454	158
1997–1998	30	10	27	75	17	368	443	174
1998–1999[a]								
1999–2000[b]	33	11	27	42	17	206	248	86

[a] No survey.

[b] Only 77.5% of the survey area flown.

Table 3 Unit 19D Candle/Wilson A, B, C, and D trend count areas fall aerial moose composition counts, regulatory years 1988–1989 through 1999–2000

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves: 100 Cows	Calves	Percent calves	Adults	Moose	Moose/hr
A and B								
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
1995–1996[a]								
1996–1997	16	5	38	14	25	43	57	26
1997–1998	16	6	53	17	31	37	54	25
1998–1999	14	10	14	3	11	24	27	11
1999–2000[a]								
C and D								
1988–1989[a]								
1989–1990	25	5	70	14	35	25	39	41
1990–1991	11	0	27	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
1995–1996[a]								
1996–1997	21	11	26	5	18	23	28	15
1997–1998	6	6	50	8	32	17	25	11
1998–1999	12	6	60	10	34	19	29	8
1999–2000[a]								

[a] No survey.

Table 4 Unit 19D White Mountains trend count area fall aerial moose composition counts, regulatory years 1987–1988 through 1999–2000

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves: 100 Cows	Calves	Percent calves	Adults	Moose	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]								
1996–1997	157	36	43	6	14	36	42	19
1997–1998[a]								
1998–1999[a]								
1999–2000[a]								

[a] No survey.

Table 5 Unit 21E Holy Cross trend count area fall aerial moose composition counts, regulatory years 1987–1988 through 1999–2000

Regulatory year	Bulls: Cows	Yearling bulls:100 Cows	Calves: 100 Cows	Calves	Percent calves	Adults	Moose	Moose/ hr
1987–1988	19	9	43	150	26	420	570	83
1988–1989[a]								
1989–1990	31	12	45	148	25	432	584	161
1990–1991	29	7	51	211	28	536	758	253
1991–1992[a]								
1992–1993	26	5	22	67	14	412	483	163
1993–1994[a]								
1994–1995	29	9	63	216	32	444	674	234
1995–1996[a]								
1996–1997	30	11	34	158	21	604	762	186
1997–1998[a]								
1998–1999	26	11	35	77	22	276	353	103
1999–2000[a]								

[a] No survey.

Table 6a Unit 19A reported moose harvest[a], regulatory years 1994–1995 through 1998–1999

Regulatory	Reported					
year	M	%	F	%	Unk	Total
1994–1995	160	95	8	5	0	168
1995–1996	137	99	2	1	2	141
1996–1997	174	96	8	4	2	184
1997–1998	136	96	6	4	0	142
1998–1999	124	88	17	12	3	144

[a] Permit data from TM684 not included.

Table 6b Unit 19B reported moose harvest, regulatory years 1994–1995 through 1998–1999

Regulatory	Reported					
year	M	%	F	%	Unk	Total
1994–1995	163	100	0	0	0	163
1995–1996	136	100	0	0	0	136
1996–1997	166	100	0	0	0	166
1997–1998	158	100	0	0	1	159
1998–1999	148	99	1	1	4	153

Table 6c Unit 19C reported moose harvest, regulatory years 1994–1995 through 1998–1999

Regulatory	Reported					
year	M	%	F	%	Unk	Total
1994–1995	152	100	0	0	0	152
1995–1996	127	100	0	0	0	127
1996–1997	153	100	0	0	0	153
1997–1998	140	100	0	0	0	140
1998–1999	145	100	0	0	4	149

Table 6d Unit 19D reported moose harvest, regulatory years 1994–1995 through 1998–1999

Regulatory	Reported					
year	M	%	F	%	Unk	Total
1994–1995	106	100	0	0	0	106
1995–1996	109	100	0	0	3	112
1996–1997	102	100	0	0	1	103
1997–1998	100	99	1	1	1	102
1998–1999	81	100	0	0	5	86

Table 6e Unit 21A reported moose harvest, regulatory years 1994–1995 through 1998–1999

Regulatory	Reported					
year	M	%	F	%	Unk	Total
1994–1995	124	99	1	1	0	125
1995–1996	116	100	0	0	0	116
1996–1997	130	100	0	0	0	130
1997–1998	112	100	0	0	0	112
1998–1999	109	100	0	0	3	112

Table 6f Unit 21E reported moose harvest, regulatory years 1994–1995 through 1998–1999

Regulatory	Reported					
year	M	%	F	%	Unk	Total
1994–1995	152	94	9	6	0	161
1995–1996	157	96	6	4	0	163
1996–1997	176	92	15	8	0	191
1997–1998	198	97	6	3	1	205
1998–1999	178	96	8	4	5	191

Table 7 Unit 19A Lime Village Management Area moose Tier II permit hunt history, regulatory years 1992–1993 through 1998–1999

Regulatory Year	Successful permits	Unsuccessful permits	Hunters that did not hunt	Did not report	Total permits issued
1992–1993[a]	9	4	3	0	16
1993–1994[b]	6	1	3	0	10
1994–1995	7	1	6	0	14
1995–1996[c]	5	3	6	1	15
1996–1997	4	1	4	5	14
1997–1998	5	2	7	0	14
1998–1999	7	5	6	2	14

[a] Community bag limit for 25 moose.
[b] Since 1993, 14 Tier II permits have been available with a total allowable harvest of 28 moose.
[c] Extra permit was issued, for reasons unknown.

Table 8 Units 19, 21A, and 21E moose harvest average antler size, regulatory years 1994–1995 through 1998–1999

Regulatory year	Unit					
	19A	19B	19C	19D	21A	21E
1994–1995	43	51	51	43	50	42
1995–1996	43	51	50	46	50	44
1996–1997	43	53	51	45	51	44
1997–1998	46	56	52	46	49	42
1998–1999	43	55	51	49	51	43

Table 9a Unit 19A moose hunter residency and success[a], regulatory years 1994–1995 through 1998–1999

Regulatory year	Successful						Unsuccessful						Total hunters
	Local resident[b]	Nonlocal resident	Nonresident	Unk	Total	%	Local resident	Nonlocal resident	Nonresident	Unk	Total	%	
1994–1995	56	82	23	7	168	46	61	107	26	2	196	54	364
1995–1996	28	86	23	4	141	46	58	90	15	0	163	54	304
1996–1997	42	120	20	2	184	54	51	86	18	0	155	46	339
1997–1998	44	76	19	3	142	51	33	67	35	2	137	49	279
1998–1999	55	62	25	2	144	50	22	89	32	1	144	50	288

[a] Permit data from TM684 not included.

[b] Residents of Aniak, Chuathbaluk, Crooked Creek, Kalskag, Lime Village, Red Devil, Sleetmute, and Stony River.

Table 9b Unit 19B moose hunter residency and success, regulatory years 1994–1995 through 1998–1999

Regulatory year	Successful						Unsuccessful						Total hunters
	Local resident[a]	Nonlocal resident	Nonresident	Unk	Total	%	Local resident	Nonlocal resident	Nonresident	Unk	Total	%	
1994–1995	0	71	88	4	163	40	0	128	108	9	245	60	408
1995–1996	0	67	69	0	136	41	0	85	107	2	194	59	330
1996–1997	0	58	107	1	166	47	0	79	103	2	184	53	350
1997–1998	0	41	114	4	159	40	0	83	147	4	234	60	393
1998–1999	0	48	105	0	153	37	0	78	180	1	259	63	412

[a] Residents of Sparrevohn Air Force Station.

Table 9c Unit 19C moose hunter residency and success, regulatory years 1994–1995 through 1998–1999

Regulatory year	Successful						Unsuccessful						Total hunters
	Local resident[a]	Nonlocal resident	Nonresident	Unk	Total	%	Local resident	Nonlocal resident	Nonresident	Unk	Total	%	
1994–1995	0	98	53	1	152	52	0	85	53	1	139	48	291
1995–1996	0	78	49	0	127	49	0	88	42	0	130	51	257
1996–1997	0	91	62	0	153	60	0	61	41	0	102	40	255
1997–1998	1	69	69	1	140	58	0	64	37	0	101	42	241
1998–1999	1	74	74	0	149	52	0	83	54	0	137	48	286

[a] Residents of Farewell Station.

Table 9d Unit 19D moose hunter residency and success, regulatory years 1994–1995 through 1998–1999

Regulatory year	Successful						Unsuccessful						Total hunters
	Local resident[a]	Nonlocal resident	Nonresident	Unk	Total	%	Local resident	Nonlocal resident	Nonresident	Unk	Total	%	
1994–1995	57	38	6	5	106	45	56	49	21	5	131	55	237
1995–1996	53	39	19	1	112	43	84	45	16	1	146	57	258
1996–1997	56	33	14	0	103	49	67	22	18	0	107	51	210
1997–1998	52	33	17	0	102	54	51	23	12	1	87	46	189
1998–1999	28	27	31	0	86	49	34	43	11	2	90	51	176

[a] Residents of McGrath, Medfra, Nikolai, Takotna, Tatalina, and Telida.

Table 9e Unit 21A moose hunter residency and success, regulatory years 1994–1995 through 1998–1999

	Successful						Unsuccessful						
Regulatory year	Local resident[a]	Nonlocal resident	Nonresident	Unk	Total	%	Local resident	Nonlocal resident	Nonresident	Unk	Total	%	Total hunters
1994–1995	0	83	39	3	125	52	0	76	37	1	114	48	239
1995–1996	3	77	36	0	116	64	1	37	26	1	65	36	181
1996–1997	1	78	51	0	130	65	0	45	25	0	70	35	200
1997–1998	1	57	50	4	112	63	0	36	29	1	66	37	178
1998–1999	0	64	47	1	112	61	0	26	46	0	72	39	184

[a] Residents of Flat, Iditarod, Ophir, and Poorman.

Table 9f Unit 21E moose hunter residency and success, regulatory years 1994–1995 through 1998–1999

	Successful						Unsuccessful						
Regulatory year	Local resident[a]	Nonlocal resident	Nonresident	Unk	Total	%	Local resident	Nonlocal resident	Nonresident	Unk	Total	%	Total hunters
1994–1995	40	106	8	7	161	86	8	17	1	0	26	14	187
1995–1996	34	114	10	5	163	76	6	40	5	1	52	24	215
1996–1997	31	138	20	2	191	80	4	35	6	2	47	20	238
1997–1998	26	157	17	5	205	83	2	27	12	2	43	17	248
1998–1999	36	130	25	0	191	80	2	32	15	0	49	20	240

[a] Residents of Anvik, Grayling, Holy Cross, and Shageluk.

Table 10a Unit 19A moose harvest percent by transport method[a], regulatory years 1994–1995 through 1998–1999

Regulatory year	Harvest percent by transport method: Airplane	Dog Team /Horse	Boat	3- or 4-Wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1994–1995	14	0	65	<1	17	0	<1	3	168
1995–1996	17	0	74	<1	2	<1	0	6	141
1996–1997	13	0	80	<1	5	<1	0	0	184
1997–1998	17	0	64	2	16	0	0	<1	142
1998–1999[b]	13	<1	67	1	15	0	1	1	144

[a] Permit data from TM684 not included.

[b] First reported use of airboats in Unit 19A, <1% of successful hunters.

Table 10b Unit 19B moose harvest percent by transport method, regulatory years 1994–1995 through 1998–1999

Regulatory year	Harvest percent by transport method: Airplane	Dog Team /Horse	Boat	3- or 4-Wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1994–1995	79	0	18	0	<1	0	0	2	163
1995–1996	85	<1	11	2	0	0	<1	0	136
1996–1997	90	0	8	<1	0	0	0	<1	166
1997–1998	92	0	5	0	<1	0	2	0	159
1998–1999[a]	90	0	7	<1	0	0	<1	1	153

[a] First reported use of airboats in Unit 19B, <1% of successful hunters.

Table 10c Unit 19C moose harvest percent by transport method, regulatory years 1994–1995 through 1998–1999

Regulatory year	Harvest percent by transport method								Total
	Airplane	Dog Team /Horse	Boat	3- or 4-Wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1994–1995	74	3	5	15	0	2	0	1	152
1995–1996	75	4	3	15	0	<1	2	<1	127
1996–1997	76	7	0	16	0	<1	0	<1	153
1997–1998	73	8	2	15	<1	1	0	0	140
1998–1999	64	6	1	25	2	<1	0	<1	149

Table 10d Unit 19D moose harvest percent by transport method, regulatory years 1994–1995 through 1998–1999

Regulatory year	Harvest percent by transport method								Total
	Airplane	Dog Team /Horse	Boat	3- or 4-Wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1994–1995	9	0	74	4	6	0	3	4	106
1995–1996	19	2	67	6	<1	0	2	4	112
1996–1997	17	0	71	3	4	<1	4	0	103
1997–1998	20	0	75	2	<1	0	2	0	102
1998–1999	20	0	79	0	1	0	0	0	86

Table 10e Unit 21A moose harvest percent by transport method, regulatory years 1994–1995 through 1998–1999

Regulatory year	Harvest percent by transport method								
	Airplane	Dog Team /Horse	Boat	3- or 4-Wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1994–1995	57	<1	33	2	<1	5	0	2	125
1995–1996	66	0	29	2	0	0	<1	2	116
1996–1997	68	0	30	2	0	0	0	<1	130
1997–1998	70	0	28	<1	<1	0	0	<1	112
1998–1999	69	0	30	0	<1	0	0	0	112

Table 10f Unit 21E moose harvest percent by transport method, regulatory years 1994–1995 through 1998–1999

Regulatory year	Harvest percent by transport method								
	Airplane	Dog Team /Horse	Boat	3- or 4-Wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1994–1995	4	0	83	<1	10	0	0	2	161
1995–1996	8	<1	86	0	4	0	0	1	163
1996–1997	10	0	79	<1	9	<1	0	<1	191
1997–1998	8	0	87	0	4	0	0	<1	205
1998–1999	14	0	79	<1	5	0	0	2	191

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 at exceptionally high densities relative to similarly sized areas throughout North America. Unit 20A moose are a world-class wildlife resource. Gasaway et al. (1983) presented a detailed history of the Unit 20A moose population through 1978, while Boertje et al. (1996) presented a history through 1995.

Preferred moose habitat is composed of riparian willow, poorly drained meadows, shallow lakes, early successional 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, perhaps 4–5 moose/mi^2. Annual moose harvests averaged 311 moose between 1963 and 1969 (McNay 1993). During 1969–1974, harvest increased to an average of 617 moose per year. Cow moose comprised 34% of the annual harvest during 1963–1974.

Similar to numerous other ungulate populations in Alaska, the moose population declined beginning in the late 1960s and reached its lowest point in the mid-1970s. Beginning in 1975, seasons and harvests were dramatically reduced and taking of cows was prohibited. In late winter 1976, the division implemented a program to reduce wolf numbers. During 1975–1978, mean annual moose harvest was limited to 64 bulls.

During wolf reduction efforts in Unit 20A (1976–1982), the moose population increased rapidly and has increased or remained stable most years since 1982. During 1979–1982, harvests averaged 226 bulls per year (McNay 1993). During 1983–1993, the mean annual harvest increased to 358 bulls. A wolf control program to reduce the effects of predation on the declining Delta Caribou Herd began in October 1993, but was discontinued in December 1994. Division staff reduced wolf numbers by trapping and snaring and may have influenced moose population dynamics.

Regulations provide a variety of hunting opportunities in Unit 20A, but a large majority of the harvest occurs during the general September bulls-only season. The southwestern portion of the subunit currently includes the Wood River Controlled Use Area (WRCUA; no motorized access except aircraft), the Ferry Trail Management Area (FTMA; harvest limited to bulls with spike-fork or 50-inch antlers), the Healy Lignite Management Area (HLMA; bowhunting only), the Yanert Controlled Use Area (YCUA; no motorized access except aircraft, with harvest limited to bulls with spike-fork or 50-inch antlers), and the Nenana Controlled Use Area (NCUA; restricts the use of airboats for hunting moose).

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. A variety of access restrictions, both spatial and temporal, apply to portions of these military lands.

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.
- Manage for a posthunting sex ratio of ≥30 bulls:100 cows unitwide and ≥20 bulls:100 cows in the Tanana Flats, Western Foothills, and Eastern Foothills areas.

METHODS

POPULATION STATUS AND TREND

Population Estimation Surveys

We completed a low-effort population estimation survey in 1997 and moderate-effort surveys in 1998 and 1999 in all suitable moose habitat throughout Unit 20A. Surveys were conducted primarily at the unitwide scale, but also at the management area scale.

<u>November 1997</u>. We conducted a moose survey during November using methods described by Gasaway et al. (1986). Due to a long spell of windy and warm weather, the survey dates ranged widely (2–25 Nov).

We used existing data for stratification of sample units (SU) into 2 population density strata, high and low. In addition, we considered 2 geographic strata, foothills and flats. This resulted in 4 strata: foothills high, foothills low, flats high and flats low. This design increased precision by accounting for differences in moose distribution and density among the geographic areas. Furthermore, it simplified comparison of the subpopulations with previous estimates.

We sampled 27 of 402 SUs at 4–6 minutes/mi^2. Sample units were selected randomly and were allocated among the 4 strata based on simulations conducted from earlier data sets. Sampling effort was weighted as heavily as possible to high-density strata while maintaining a minimum sample size of 6 units in the low-density strata. We grouped SUs into clusters that could easily be completed in a single day and generally assigned the clusters so that the more distant and difficult SUs were completed as early in the survey as possible. We employed highly experienced pilots, however, observer experience varied markedly. Airsickness did not appear to be a factor. Although observers generally reported good survey conditions, we considered conditions below average overall. We aborted operations on many units due to wind.

We analyzed the data using the software program MOOSEPOP (Moose Population Estimation Survey Software, Version 2.0, RA DeLong and DJ Reed, ADF&G, Fairbanks, Alaska). We also calculated separate estimates for the flats, foothills, western foothills, and central flats for comparisons with previous surveys. We did not estimate sightability, but rather used the long-term average sightability correction factor (SCF) of 1.15.

December 1998. We completed a moose survey during 6–8 December employing the methods described for the 1997 survey. We surveyed 43 SUs, 40 from our random sample and 3 additional SUs in the FTMA to increase sample size in that management unit. Observers generally reported snow age as "fresh" or "<1 week" and snow cover as "some low vegetation showing." Light conditions were generally "flat" and of low to moderate intensity. Turbulent and windy conditions were common.

November 1999. We conducted a moose survey during 6–15 November using the Geo-Statistical Population Estimator (GSPE; Jay Ver Hoef, ADF&G, Fairbanks) method, a modification of the standard Gasaway et al. (1986) technique. Unit 20A was subdivided into SUs with north/south boundaries every 2 degrees of latitude and east/west boundaries every 5 degrees of longitude. This resulted in nearly square SUs that were approximately 5.7 mi^2 in size. Sample units included all areas of suitable moose habitat at or below 4500 feet of elevation. Sample units entirely above 4500 feet in elevation were excluded from the survey because habitat above that elevation is not considered suitable moose habitat (Gasaway et al. 1986). However, if any portion of a SU was at or below 4500 feet, the entire SU was included in the analysis.

We dry-lab stratified Unit 20A into low- and high-density strata based on an earlier 4 strata classification of the area. Medium-, high- and super-high density strata from the 4 strata classification were combined into a single "high-density" stratum. In instances where a SU contained both high- and low-density strata, the stratum assigned to that SU was that of the stratum found in the highest percentage (e.g., if a sample unit contained 75% high-density and 25% low-density strata, the stratum assignment for that block was "high-density"). Sixty percent of the SUs surveyed were high-density, and 40% surveyed were low-density. A simple random sample of SUs was selected from each stratum using Microsoft®Excel software (1998 Microsoft Corporation). "Tanana Flats" and "Foothills" portions of Unit 20A, which were treated as separate geographic strata in 1996, 1997, and 1998 surveys, were combined in the 1999 analysis.

The GSPE method does not employ a SCF at this time and, thus, does not correct for moose not seen during the survey. Rather, the GSPE method employs greater search intensity, 8–

10 min/mi^2 vs. 4–6 min/mi^2 (Gasaway et al. 1986), resulting in a higher level of sightability. Survey conditions with regard to snow age and coverage were considered "good" (Gasaway et al. 1986).

Data were analyzed using geo-statistical techniques (Jay Ver Hoef, ADF&G, Fairbanks).

Twinning Surveys

Twinning rates were estimated from surveys conducted in traditional twinning survey trend count areas on the central Tanana Flats. Surveys consisted of roughly parallel transects flown at approximately ½-mile intervals in PA18 or Scout aircraft by experienced contract pilots. All moose observed were classified as bull, yearling cow, adult cow without a calf, or adult cow with single, twin or triplet calves. Twinning rate surveys were flown for 3.4 hr on 26 and 30 May 1998 and 3.1 hr on 25 and 26 May 1999. We terminated and excluded data from surveys when less than about 15% of the cows had calves. For statistical reasons, we established, a priori, a minimum sample size of 50 cows with calves. Twinning rate was calculated as the proportion of cows with twins or triplets from the sample of all cows with calves.

HARVEST

We estimated annual harvest from harvest report cards. Harvest parameters summarized included hunter residency, hunter success, permit hunt results, harvest chronology and transport methods. We considered bulls with antler spreads <30 inches to be yearlings. Harvest data were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY99 = 1 Jul 1999–30 Jun 2000).

WEATHER

We evaluated weather (snowfall and temperature) using National Weather Service records and personal observations.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

We estimated 11,248 (± 27%, 90% CI) moose in 1997 and 9690 (± 19%, 90% CI) in 1998 without a sightability correction. Assuming a SCF of 1.15, our corrected estimates are 12,935 for 1997 and 11,144 for 1998 (Table 1). We estimated 11,205 (± 14%, 90% CI) moose in 1999. The poor precision in 1997 is probably the result of small sample size as only 27 SUs were surveyed; whereas, the high precision of the 1999 survey is likely the result of larger sample size and the use of the GSPE technique. Reasonably precise population estimates in 1996 (11,500 moose; ± 13%, 90% CI), 1998, and 1999 indicate that the Unit 20A moose population has stabilized at 11,000–11,500 animals.

Population Composition

In November 1997 we classified 1037 moose and estimated 34 calves:100 cows and 33 bulls:100 cows (Table 1). In December 1998 we classified 1268 moose and estimated 31 calves:100 cows and 31 bulls:100 cows. In November 1999 we classified 965 moose and estimated 33 calves:100 cows and 23 bulls:100 cows. Survey data indicate a declining trend in bull:cow ratios unitwide. Bull:cow ratios declined from 39 bulls:100 cows in 1996 to 23 bulls:100 cows in 1999 (Table 1). Bull:cow ratios were significantly ($Z = 2.51$, 1 df, $P < 0.05$) lower in 1999 than 1998, and the decline resulted in bull:cow ratios falling below the Unit 20A management objective of 30 bulls:100 cows.

We did not have sufficient data in 1997 (n = 27 SUs unitwide) to evaluate bull:cow ratios in the Tanana Flats, Eastern Foothills, or Western Foothills separately. However, in 1998, we obtained a larger sample for the Tanana Flats (n = 20 SUs) portion of Unit 20A and observed a bull:cow ratio of 20:100, the minimum allowable bull:cow ratio under our current set of management objectives.

In the southwestern portion of Unit 20A, where numerous trails provide motorized access, the bag limit has been 1 bull with spike-fork or 50-inch antlers (subsequently referred to as SF50) since RY88. This antler restriction was adopted in response to declining bull:cow ratios between RY84 (23–42 bulls:100 cows; Jennings 1986) and RY87 (13–27 bulls:100 cows; McNay 1989). Bull:cow ratios had improved during the early 1990s, presumably because of the antler restriction. For example, bull:cow ratios exceeded the management objective for the Western Foothills of 20 bulls:100 cows in 1993 (31 bulls:100 cows in the Walker Dome trend area). However, bull:cow ratios have recently declined in the FTMA: 26:100 in 1994, 23:100 in 1996, 19:100 in 1998, and 16:100 in 1999. The 1997 survey data were inadequate to assess ratios in the FTMA.

Twinning Rates

Twinning rates have declined to their lowest level since 1994 (Table 2). The decline is consistent with declines observed in the Minto Flats Management Area, where twinning rates have fallen from 35% in 1997 to 6% in 1999.

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 that the seasonal migrants probably increase the density of moose on the Tanana Flats 2- to 4-fold over the density of resident Unit 20A moose.

MORTALITY

Harvest

Seasons and Bag Limits. Seasons and bag limits in Unit 20A during RY97 and RY98 were as follows:

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Ferry Trail Management Area and the Yanert Controlled Use Area:		
1 bull with spike-fork or 50-inch antlers or antlers with 3 or more brow tines	1 Sep–25 Sep	1 Sep–25 Sep
Eastern portion of the Wood River Controlled Use Area:		
1 bull or	1 Sep–25 Sep	1 Sep–25 Sep
1 antlerless moose by drawing permit	1 Sep–25 Sep	1 Sep–25 Sep
or 1 bull by muzzleloader by drawing permit.	1 Nov–30 Nov	1 Nov–30 Nov
Remainder of 20A:		
1 bull	1 Sep–25 Sep	1 Sep–25 Sep
or in northcentral Tanana Flats, 1 antlerless moose by drawing permit.	1 Sep–25 Sep	1 Sep–25 Sep

Seasons and bag limits in Unit 20A during RY99 were as follows:

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Ferry Trail Management Area and the Yanert Controlled Use Area:		
1 bull with spike-fork or 50-inch antlers or antlers with 3 or more brow tines	1 Sep–25 Sep	1 Sep–25 Sep
Eastern portion of the Wood River Controlled Use Area:		
1 bull	1 Sep–25 Sep	1 Sep–25 Sep

Units and Bag Limits	Resident Open Season	Nonresident Open Season
or 1 bull by muzzleloader by drawing permit.	1 Nov–30 Nov	1 Nov–30 Nov
Remainder of 20A:		
1 bull	1 Sep–25 Sep	1 Sep–25 Sep

Board of Game Actions and Emergency Orders. In RY91 and RY92, the bag limit for the FTMA and YCUA was 1 bull moose with spike-fork or 50-inch antlers or antlers with 3 or more brow tines on 1 side. During RY93–RY95 the bag limit for the FTMA and YCUA was 1 bull moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side. In RY96 the board reduced the brow tine requirement to 3 brow tines in these areas and this bag limit remained in effect through RY99.

The board reauthorized 3 antlerless hunts by drawing permit in RY97 and RY98. Two (DM760 and DM762) occurred on the northcentral Tanana Flats near Fairbanks where moose densities were high. DM760 ran from 1–10 September while DM762 ran from 11–25 September. The third antlerless hunt (DM764) occurred during 1–25 September in the eastern portion of the WRCUA. The antlerless hunts were not held in RY99 due to an agreement with local advisory committees that these hunts be held only when the department can show that the moose population is increasing. Population estimates in 1998 indicated that the Unit 20A moose population was stable.

The Board of Game made no changes during this reporting period to muzzleloader permit hunt DM766 created in RY96. This bulls-only hunt allows the department to issue up to 75 permits for hunters using muzzleloaders in a portion of the WRCUA during November.

The board created the Nenana Controlled Use Area (NCUA) in portions of Units 20A and 20C in RY96, which prohibited the use of airboats for hunting or transporting moose hunters or their gear during 1–25 September. The NCUA was modified in RY98 to allow the use of airboats for hunting moose within the main channels of the Teklanika, Toklat, and Nenana Rivers, and at the public boat launch in Nenana.

Board of Game Actions, March 2000 — The board restricted seasons and bag limits for moose beginning RY00. The general moose season was reduced from 25 days to 20 days (1–20 Sep). Antler restrictions were increased in the FTMA and YCUA for residents from SF50 and 3 brow tines to SF50 and 4 brow tines. In addition, unitwide antler restrictions were imposed on nonresidents in which only bull moose with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side are legal. The board also reauthorized up to 300 antlerless drawing permits (hunts DM760, DM762 and DM764). The department will issue 300 antlerless permits for the northcentral Tanana Flats and eastern portion of the WRCUA in RY00. The board also reauthorized drawing permit hunt DM766 for bull moose in November by muzzleloader only, with the understanding that no permits will be issued in RY00 and in future years until support from affected advisory committees is obtained (i.e., by demonstrating that bull:cow ratios have recovered to levels that meet our management objectives).

Hunter Harvest. Reported harvest of bull moose in Unit 20A increased 66% between RY90–RY91 ($\bar{x}$ = 376 bulls) and RY96–1997 ($\bar{x}$ = 625 bulls), although harvest appears to have stabilized recently (Table 3). Liberalizing the general season from 20 to 25 days in RY95 likely contributed to the increased harvest. Current reported harvests are similar to the highest reported for the last 25 years.

Permit Hunts. Hunter participation and harvest was lower than expected for drawing permit hunts through RY98 (Table 4). For the antlerless hunts, this may partly be explained by some permittees choosing to take bull moose rather than filling their antlerless permit. For the November muzzleloader hunt (DM766), we suspect that several factors may have contributed to the low participation and harvest. First, some hunters may have harvested bulls during the general moose season. Second, poor snow conditions for snowmachine travel (the primary transportation method accessing the hunt area) existed during the hunt period in both 1997 and 1998, but conditions were particularly poor in 1998. Finally, late freeze-up of the Totatlanika River and Tatlanika Creek in 1997 restricted access (via the Rex Trail, the primary access route into the hunt area) until mid- to late November, which, in effect, shortened the November season significantly. We intend to explore ways to increase participation and harvest in these drawing hunts in the future.

Hunter Success and Residency. Overall success rates during general hunts have increased slightly since the early 1990s, but appear to have stabilized (Table 5). Recently, success rates have been relatively high averaging 37.5% over the past 4 regulatory years. Nonresidents had higher success rates than residents.

Number of hunters has increased since the early 1990s, but has remained relatively constant since RY96. A 40% increase between RY94 (n = 1166) and RY96 (n = 1636) was likely due, at least in part, to the liberalization of the general moose season in RY95 from 20 to 25 days.

Harvest Chronology. Moose harvest in Unit 20A has traditionally been well distributed throughout the season (Table 6). During this reporting period, more bull moose were taken during the 1–5 September and 16–20 September periods than during any other 5 days of the season.

Transport Methods. During the last 9 regulatory years, 28–37% of the successful moose hunters used airplanes, 26–37% used boats, 18–30% used ORVs or 3- or 4-wheelers, and 2–6% used horses (Table 7). Hunting by horseback is popular in the YCUA and the southern portion of the WRCUA. Three- and 4-wheeler use is increasing. The FTMA continues to be a popular place for hunters using 3- and 4-wheelers. In addition, hunters are increasingly using boats to transport these vehicles to the Tanana Flats.

Airboat use remains controversial. Since RY97, airboats have been distinguished as a transportation category on harvest report cards. The percentage of successful moose hunters in

Unit 20A that used airboats was 5% (n = 28) and 6% (n = 35) in RY97 and RY98, respectively.

Other Mortality

A study of moose mortality began in 1996, and a progress report is available (Boertje et al. 1999).

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 (Table 3). This may be the result of below average snowfall the area received during winters 1997–1998 and 1998–1999.

WEATHER

Unusual weather may have influenced moose population dynamics during the last 10 years. Winter 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 the long-term average (68 inches). Winters 1993–1994 (64.2 inches), 1994–1995 (81.4 inches), 1995–1996 (56.2 inches), and 1996–1997 (67.5 inches) were relatively normal in terms of snowfall. Winters 1997–1998 (46.0 inches) and 1998–1999 (31.0 inches) received less than normal accumulations of snow.

Summer 1992 was probably the shortest on record. It was bracketed with snowfall in mid-May and in September (24 inches of snowfall, 3 times the previous record, and cold temperatures, 13 degrees colder than previous record). In contrast, 1993 was likely the longest summer on record, with an early spring leaf-out, warm summer temperatures, and a late fall.

HABITAT

There has been considerable discussion in recent years about the potential for Unit 20A to support many more moose. We remain concerned about the population exceeding the habitat capability and becoming vulnerable to severe weather patterns. Already, we have documented that this population has the lowest productivity of studied moose populations in North America (Boertje et al., in prep). Therefore, a higher moose density is not desirable until habitat improves. Mortality research implemented in 1996 is evaluating many factors influencing the status of the moose population relative to habitat, predators, and sustainable harvest.

NONREGULATORY PROBLEMS/ISSUES

An electric intertie that will bisect important moose habitat in western Unit 20A is scheduled for construction between Healy and Fairbanks. Construction on the selected Rex-South route will probably affect moose in 2 ways. First, the intertie corridor may improve access, and changes in regulations to prevent local overharvest of bulls may be necessary. More importantly, increased fire suppression near the corridor may adversely affect habitat capability for moose over time. We forwarded these concerns to appropriate land use agencies, and the line has been routed so that minimal effects on fire suppression will occur. Currently, construction of the intertie has been halted due to a court-ordered injunction.

CONCLUSIONS AND RECOMMENDATIONS

Population estimates in 1996, 1998, and 1999 indicated the Unit 20A moose population has stabilized within the range of our population objective. However, estimates also showed that the proportion of cows in the population increased slightly, while the proportion of bulls declined. Also, low twinning rates and 0% yearling pregnancy rates indicated a relatively unproductive moose population. Current research indicates that moose production in Unit 20A is reduced because of high moose densities and declining habitat quality. Therefore, I recommend antlerless moose hunts (i.e., DM760, DM762, and DM764) in the high moose density areas of the northcentral Tanana Flats and eastern WRCUA when the moose population is at or above the population objective and when the overall or adult cow segment of the moose population is increasing. Antlerless moose harvest should be evaluated as a tool to prevent an overabundance of moose that are vulnerable to the synergistic effects of adverse weather and increased predation. In addition, it is important to improve habitat quality and determine the status of the Unit 20A moose population relative to nutrient/climate limitations, and increasing predator numbers (Boertje et al. 1996).

Bull:cow ratios have declined unitwide and are below the Unit 20A management objective of 30 bulls:100 cows. Likewise, in a portion of the Western Foothills (i.e., the FTMA), bull:cow ratios have dropped below the management objective of 20 bulls:100 cows. Consequently, I recommend reducing the harvest of bulls from the current harvest of over 600 to 430 by shortening the season and increasing antler restrictions for residents in the FTMA and YCUA and nonresidents unitwide. In addition, I recommend adding a management objective stating that bull harvest not exceed 430 animals until bull:cow ratios reach the management objective of 30 bulls:100 cows overall in Unit 20A (Management Objective 2). Furthermore, I recommend that we closely monitor bull:cow ratios unitwide and at smaller spatial scales (e.g., management area and controlled use area scale), where appropriate, to monitor the effects of current regulatory changes on bull:cow ratios. As a result, I recommend changing Management Objective 2 from "Manage for a posthunting sex ratio of ≥30 bulls:100 cows unitwide and ≥20 bulls:100 cows in the Tanana Flats, Western Foothills, and Eastern Foothills areas" to "Manage for a posthunting sex ratio of ≥30 bulls:100 cows unitwide and ≥20 bulls:100 cows in the Tanana Flats, Eastern Foothills/Mountains, and the FTMA, WRCUA and YCUA (Western Foothills/Mountains)."

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Table 1 Unit 20A early winter (Oct–Dec) aerial moose composition counts and estimated population size, 1990–1999

Year	Bulls:100 Cows	Yearlings: 100 Cows	Calves:100 Cows	Percent calves	Adults	Moose observed	Moose/mi^2	Estimated population size
1990[a]	23, 24, 26	15	48	27	584	292, 180, 158	2.0	10,100
1991[b]	22, 32	15	34	21	1954	949, 1531	2.2	11,100
1992[a]	28, 31, 36	14	36	21	274	107, 105, 137	2.2	11,300
1993[b]	29, 30	19	38	23	1340	852, 883	2.4	11,900
1994[c]	35	23	46	25	1038	1391	2.6	13,300
1995[d]				28		575		
1996	39	24	42	23	2578	3343	2.3	11,500
1997	33	28	34	21	816	1037	2.6	12,935
1998	31	18	31	18	1035	1268	2.2	11,144
1999	23	13	33	21	760	965	2.2	11,205

[a] Windy, Walker Dome, and Japan Hills trend areas, respectively.
[b] Central Tanana Flats and Western Foothills, respectively.
[c] Central Tanana Flats and Western Foothills combined.
[d] Lack of snow prevented early winter surveys.

Table 2 Unit 20A Tanana Flats moose twinning rates, 1987–1999

Year	Date	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
1996	26 May	33	7	40	18
1997	21 May	26	3	29	10
1998	26–30 May	51	4	55	7
1999	25–26 May	62	2	64	3

[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 3 Estimate of Unit 20A moose harvest[a] and accidental death, regulatory years 1990–1991 through 1999–2000

Regulatory	Harvest by hunters										
	Reported				Estimated			Accidental death			
year	M	F	Unk	Total	Unreported[b]	Illegal/Other[c]	Total	Road[d]	Train[e]	Total	Total
1990–1991	370	0	0	370	65		65				435
1991–1992	382	0	0	382	68		68				450
1992–1993	246	0	0	246	44		44				290
1993–1994	386	0	0	386	68		68				454
1994–1995	399	0	0	399	71		71				470
1995–1996	526	0	0	526	93		93				619
1996–1997	617	61	0	678	120		120				798
1997–1998	633	63	0	696	123	11	134	2	7	9	839
1998–1999	617	69	0	686	121	2	123	3	8	11	820
1999–2000[f]	571	0	0	571	101	2[g]	103	2[g]	13[h]	15	689

[a] Includes general and permit hunt harvest.
[b] Based on 17.7% unreported harvest (including wounding loss) estimated by Gasaway et al. (1992).
[c] Includes illegal, DLP, dispatched, potlatch, stickdance, and other reported deaths.
[d] Documented kills; actual number killed by vehicles is certainly greater.
[e] Confirmed dead between Alaska Railroad mileposts 371.0 and 411.7; "Missing" (moose hit but not recovered) are not included. Data provided by the Alaska Railroad.
[f] Preliminary data.
[g] Number of moose killed through December 1999.
[h] Number of moose killed through April 2000.

Table 4 Unit 20A moose harvest data by permit hunt, regulatory years 1996–1997 through 1999–2000

Hunt	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Bulls (%)	Cows (%)	Unk (%)	Harvest
760	1996–1997	75	19 (25)	31 (55)	25 (45)	0 (0)	25 (100)	0 (0)	25
	1997–1998	75	17 (23)	32 (55)	26 (45)	0 (0)	26 (100)	0 (0)	26
	1998–1999	75	13 (17)	32 (52)	30 (48)	0 (0)	30 (100)	0 (0)	30
	1999–2000	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (100)	0 (0)	0
762	1996–1997	75	24 (32)	24 (47)	27 (53)	0 (0)	27 (100)	0 (0)	27
	1997–1998	75	23 (31)	24 (46)	28 (54)	0 (0)	28 (100)	0 (0)	28
	1998–1999	75	22 (29)	23 (43)	30 (57)	0 (0)	30 (100)	0 (0)	30
	1999–2000	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (100)	0 (0)	0
764	1996–1997	150	107 (71)	34 (79)	9 (21)	0 (0)	9 (100)	0 (0)	9
	1997–1998	150	107 (71)	34 (79)	9 (21)	0 (0)	9 (100)	0 (0)	9
	1998–1999	150	87 (58)	54 (86)	9 (14)	0 (0)	9 (100)	0 (0)	9
	1999–2000	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (100)	0 (0)	0
766	1996–1997	75	43 (57)	22 (69)	10 (31)	10 (100)	0 (0)	0 (0)	10
	1997–1998	75	43 (57)	18 (56)	14 (44)	14 (100)	0 (0)	0 (0)	14
	1998–1999	75	39 (52)	25 (69)	11 (31)	11 (100)	0 (0)	0 (0)	11
	1999–2000	75	32 (43)	23 (54)	20 (46)	20 (100)	0 (0)	0 (0)	20
Totals for all permit hunts	1996–1997	375	193 (51)	111 (61)	71 (39)	10 (14)	61 (86)	0 (0)	71
	1997–1998	375	190 (51)	108 (58)	77 (42)	14 (18)	63 (82)	0 (0)	77
	1998–1999	375	161 (43)	134 (63)	80 (37)	11 (14)	69 (86)	0 (0)	80
	1999–2000	75	32 (43)	23 (53)	20 (47)	20 (100)	0 (0)	0 (0)	20

Table 5 Unit 20A moose hunter[a] residency and success, regulatory years 1990–1991 through 1998–1999

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	
1990–1991	257	43	61	9	370 (31)	651	122	52	15	840 (69)	1210
1991–1992	264	62	48	8	382 (33)	566	148	48	10	772 (67)	1154
1992–1993	150	51	32	13	246 (25)	549	113	59	15	736 (75)	982
1993–1994	281	54	39	12	386 (34)	571	108	32	24	735 (66)	1121
1994–1995	270	67	45	17	399 (34)	605	103	43	16	767 (66)	1166
1995–1996	390	68	64	4	526 (37)	709	107	37	8	861 (62)	1387
1996–1997	427	102	73	5	607 (37)	830	134	61	4	1029 (63)	1636
1997–1998	363	153	98	5	619 (39)	620	281	65	10	976 (61)	1595
1998–1999	366	129	108	3	606 (37)	817	161	64	6	1048 (63)	1654

[a] Excludes hunters in permit hunts.
[b] Residents of Unit 20.

Table 6 Unit 20A moose harvest[a] chronology percent by month/day, regulatory years 1990–1991 through 1998–1999

Regulatory	Harvest chronology percent by month/day						
year	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	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
1995–1996	19	17	21	22	15	4	526
1996–1997	26	15	19	22	14	4	607
1997–1998	24	15	17	22	18	4	619
1998–1999	22	15	17	24	19	3	606

[a] Excludes permit hunt harvest.

Table 7 Unit 20A moose harvest[a] percent by transport method, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest percent by transport method								
	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
1995–1996	30	4	35	17	0	7	4	2	526
1996–1997	28	3	32	20	0	10	4	3	607
1997–1998	32	6	27	23	0	5	6	3	619
1998–1999	37	3	26	22	0	7	4	1	606

[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, 1971, 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 nearly 400 bulls in 1987 and 1988 to approximately 700 bulls in 1998, 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 were 2 permit moose hunts in Unit 20B during this reporting period, 1 in the Minto Flats Management Area (MFMA) and 1 in the Fairbanks Management Area (FMA). The MFMA (898 mi^2) was established in 1979 to restrict harvest in a low-density moose population. In 1988 the Alaska Legislature established the Minto Flats State Game Refuge to ensure the protection and enhancement of habitat; the conservation of fish and wildlife; and to guarantee the continuation of hunting, fishing, trapping, and other compatible public uses within approximately 800 mi^2 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 in the past, no changes were made during this reporting period. The FMA currently encompasses 217 mi^2, of which about 50 mi^2 is heavily inhabited by people. Even though harvest is generally low, this hunt is very popular.

For management purposes, Unit 20B has been divided into 3 geographic zones: Unit 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 OBJECTIVE

- Manage for a posthunting sex ratio of ≥30 bulls:100 cows unitwide and ≥20 bulls:100 cows in each count area (i.e., Unit 20B East, Unit 20B Central, Unit 20B West, and MFMA).

METHODS

POPULATION STATUS AND TREND

We did not conduct unitwide population estimation surveys in Unit 20B during this reporting period, but rather did population estimation surveys in the MFMA in November 1997 and 1999 and in Unit 20B West in November 1999. We also conducted composition (adults vs. calves) surveys in the MFMA in February 1999.

November 1997 Population Estimation Survey

We estimated the population in the MFMA on 4–5 November using the standard Gasaway et al. (1986) technique. We stratified sample units (SUs) into 2 strata (low- and high-density) using preexisting data of relative moose density. Sampling effort was weighted to the high-density strata in order to optimize survey effort and precision. A simple random selection of SUs was taken from each stratum using Microsoft®Excel for Windows®98 software. We employed highly experienced pilots, however, observer experience varied markedly. We analyzed the data using the Moosepop software program (Moose Population Estimation Survey Software, Version 2.0, RA DeLong and DJ Reed, ADF&G, Fairbanks, Alaska). We did not estimate sightability, but rather used a Sightability Correction Factor (SCF) of 1.18 that was estimated during a moose population estimation survey conducted in the MFMA in 1996.

We surveyed 16 (6 low- and 10 high-density; 196.5 mi^2) of 80 SUs (967 mi^2). Observers generally reported good survey conditions with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence).

February 1999 Composition Survey

We surveyed the MFMA on 23–24 February to determine the proportion of calves in the population. Methods used were the same as those described above, except that 12 (4 low- and 8 high-density; ca. 144 mi^2) of 80 SUs were surveyed. Moose were classified as calves or adults. Observers generally reported good survey conditions with regard to snow (age and cover), light (intensity and type), and wind (strength and turbulence).

November 1999 Population Estimation Survey

We surveyed Unit 20B West, including the MFMA, on 14–23 November 1999 using the Geo-Statistical Population Estimator (GSPE; Jay Ver Hoef, ADF&G, Fairbanks) method, a modification of the standard Gasaway et al. (1986) technique. Unit 20B West was subdivided into SUs with north/south boundaries every 2 degrees of latitude and east/west boundaries every 5 degrees of longitude. This resulted in nearly square SUs that were approximately 5.7 mi^2. They included all areas of suitable moose habitat ≤4500 feet elevation. Sample units entirely above 4500 feet elevation were excluded from the survey because land above that elevation is not considered suitable moose habitat (Gasaway et al. 1986). However, if any portion of an SU was ≤4500 feet, the entire SU was included in the survey. Sample units were classified as low- or high-density stratum during a presurvey reconnaissance flight (stratification survey) flown in a Cessna 206 traveling at approximately 90 nautical miles/hr and, generally, 400–500 feet above ground level. Stratification surveys were conducted with 2 observers (aft port and starboard) and 1 recorder (fore starboard). Criteria used to place sample units in strata included number of moose observed, number of tracks observed, and overall quality (low, medium, high) of the habitat. Previous analyses suggest that survey effort and the precision of population estimates are optimized when the survey effort includes approximately 40% low-density and 60% high-density sample units. However, during this survey, sampling effort between low- and high-density strata was comparable due to statistical constraints requiring a minimum sample size of approximately 25 SUs per stratum. A simple random sample of SUs was selected from each stratum using Microsoft®Excel for Windows®98 software. Data were analyzed using geo-statistical techniques (Jay Ver Hoef, ADF&G, Fairbanks).

The GSPE method does not employ a SCF at this time and, thus, does not correct for moose not seen during the survey. Rather, the GSPE method employs greater search intensity, 8–10 min/mi^2 vs. 4–6 min/mi^2 (Gasaway et al. 1986), resulting in a higher level of sightability.

We stratified 649 SUs (3644 mi^2) in Unit 20B West, including the MFMA, on 9–11 November 1999. We then surveyed 54 (26 low- and 28 high-density; 304 mi^2) of 649 SUs (3644 mi^2), including 42 (20 low- and 22 high-density; 236 mi^2) of 169 SUs (951 mi^2) in the MFMA. Search intensity averaged 4.8 min/mi^2. Although search intensity for this survey was less than the recommended 8–10 min/mi^2, we contend that sightability of moose was high and, thus, our results were reliable because a large portion of the MFMA is open habitat comprised of lakes and grass/sedge flats or areas with few shrubs and trees and because we had excellent survey conditions. Interior Alaska received over 12" of snow in late October and early November. Observers generally reported snow cover as either "complete" or "some low vegetation showing"; snow age as either "<1 week" or ">1 week"; and light type and intensity as "flat", but of "moderate" intensity. Turbulence was not a factor during surveys, although surveys were suspended several days due to high or turbulent winds.

Twinning Rate Surveys

Twinning rates were estimated from surveys conducted in traditional twinning survey trend count areas on the Minto Flats. Surveys consisted of roughly parallel transects flown at approximately ½-mile intervals at ≤500 feet above ground level in PA18 or Scout aircraft by experienced contract pilots. All moose observed were classified as bull, yearling cow, adult cow without a calf, or adult cow with single, twin or triplet calves. Twinning rate surveys were flown for 3.1 hr on 31 May 1998 and 3.9 hr on 27 and 29 May 1999. We terminated and excluded data from surveys when <15% of the cows had calves. For statistical reasons, we established, a priori, a minimum sample size of 50 cows with calves. Twinning rate was calculated as the proportion of cows with twins or triplets from the sample of all cows with calves.

MORTALITY

We estimated harvest based on harvest report cards. This included data from report cards from the general season, the FMA drawing hunt, and the MFMA Tier II permit hunt. One mail-out of reminder letters was sent to nonreporting general season hunters, and up to 2 mail-outs were sent to permit holders who failed to report. When antler size of bulls was reported, we considered bulls with antler spreads of <30 inches to be yearlings. Harvest data were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY99 = 1 Jul 1999–30 Jun 2000).

We estimated other mortality from Department of Public Safety records of collisions with motor-vehicles and Alaska Railroad records of collisions with trains.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The 1990 Unit 20B moose population estimate was 9800 moose (about 1.1 moose/mi^2) including: 3400 in Unit 20B West, 4200 in Unit 20B Central, and 2200 in Unit 20B East (McNay 1993). The subunit-wide adult moose population in 1990 was 7600 moose: 2500 in Unit 20B West, 3300 in Unit 20B Central, and 1800 in Unit 20B East. At that time, the population was increasing and was expected to reach 10,000 adult moose (excluding calves) by 1993. Because of changes in priorities, we have been unable to complete unitwide surveys planned to verify population status. However, in 1999, we did conduct a low-effort population estimation survey in 3644 mi^2 of Unit 20B West (Table 1) and obtained an estimate of 4881 moose (3908–5855, 90% CI), or approximately 1.1–1.6 moose/mi^2. Applying this density estimate subunitwide, we arrived at an estimate of 10,000–14,500 moose (8000–11,600 adults). This indicates that moose numbers have increased since 1990; however, a unitwide survey is required to draw definitive conclusions concerning population trend in Unit 20B.

Population estimation surveys indicate that moose densities may have declined in the MFMA between 1996 and 1999 (Table 1). Although density estimates in 1996 (2.9 moose/ mi^2) and 1997 (2.7 moose/mi^2) were similar, the 1999 estimate was substantially lower (1.9 moose/mi^2).

Surveys in the MFMA may be influenced by changes in moose distribution, due to the migratory nature of moose in the area (P Valkenburg and R Boertje, ADF&G, personal observation), therefore, inconsistent results occasionally may occur regardless of sampling effort. This problem is exacerbated due to the relatively small size of the survey area. In addition, surveys are not directly comparable across years. For instance, the 1996 survey included 898 mi^2, whereas, the 1997 survey included 967 mi^2, of which, most of the additional area (7.7%) included habitat with low moose densities. The 1999 survey (951 mi^2), although similar in size to that conducted in 1997, used different methodology (GSPE method). Also, the precision of the 1997 estimate was extremely poor with the 90% CI equal to ± 45%.

Measures of productivity and recruitment support the hypothesis that moose numbers in the MFMA declined between 1996 and 1999 (Table 1). Calf:100 cow ratios declined from 47:100 in 1994 and 1996 to 34:100 and 36:100 in 1997 and 1999, respectively. Likewise, yearlings:100 cows declined from 27:100 in 1996 to 15:100 and 16:100 in 1997 and 1999, respectively.

Despite the apparent decline, moose densities remained relatively high at approximately 2.0 moose/mi^2 (Table 1). Gasaway et al. (1992), reported that most areas of Interior Alaska and the Yukon have densities of 0.1–1.0 moose/mi^2. Higher densities occurred where wolves and/or bears were below food-limited levels.

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 9–14:100 (1989–1994).

Low bull:cow ratios in the FMA (9:100 in 1993, 14:100 in 1994) are desired, in part, to reduce vehicle collisions. Hunting pressure during fall, prior to our surveys, is intense and most bulls killed are yearlings. Low yearling bull:cow ratios observed during our November surveys (4:100 in 1993, 3:100 in 1994) result largely from the high proportion of yearling bulls killed in September, and do not reflect poor calf recruitment.

Bull:cow ratios in the MFMA appeared relatively stable between 1996 and 1999 (Table 1), although the highly imprecise estimate obtained in 1999 (31:100, ± 56%, 90% CI) made drawing definitive conclusions regarding population trends tenuous. This poor precision also made it difficult to evaluate our management objective regarding bull:cow ratios. Although the 1999 point estimate of 27 bulls:100 cows (± 21%, 90% CI) for Unit 20B West was below our management objective of 30 bulls:100 cows, the difference was not significant and the results were inconclusive.

Calf:Cow Ratios. Calf production and summer calf survival was good in all areas surveyed (Table 1). However, calf:cow ratios did decline from the high forties in 1994 and in 1996 to the mid-thirties during 1997–1999.

Twinning Rates

Twinning rates in the MFMA declined dramatically between 1997 and 1999 (Table 2). The decline in the MFMA was consistent with declines recently observed on the Tanana Flats in Unit 20A, where twinning rates fell from 18% in 1996 to just 3% in 1999. Typically, twinning rates are higher in the MFMA than on the Tanana Flats.

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 migrates, 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 in Unit 20B during RY97 and RY98 were:

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Fairbanks Mgmt Area:		
1 antlerless moose by bow and arrow by drawing permit.	1 Sep–30 Sep	1 Sep–30 Sep
or 1 bull with antlers by bow and arrow.	1 Sep–30 Sep 21 Nov–27 Nov	1 Sep–30 Sep 21 Nov–27 Nov
Minto Flats Mgmt Area:		
1 moose by Tier II permit only	1 Sep–20 Sep 10 Jan–28 Feb	No open season
or 1 bull with spike-fork or	11 Sep–20 Sep	No open season

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
50-inch antlers, or with at least 4 brow tines on 1 side.		
Middle Fork drainage of Chena River, and Salcha River drainage upstream from and including Goose Creek. 1 bull.	1 Sep–20 Sep	1 Sep–20 Sep
Remainder of Unit 20B. 1 bull.	1 Sep–15 Sep	5 Sep–15 Sep

In RY95, 60 MFMA Tier II permits could be issued. The number of Tier II permits was increased to 100 in RY96 and has remained at 100 through RY98.

Board of Game Actions and Emergency Orders.

Historical Board of Game Actions — In the MFMA, the department issued 150 Tier II permits per year from RY90 through RY92 to provide for an annual harvest quota of 50 bulls. However, harvests were only 28–42 per year. In spring 1993 we calculated a new harvest quota of 100 bulls and recommended the board authorize up to 250 permits. The board passed our recommendation and the department issued 200 permits in RY93 and RY94. In spring 1995 the board 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 60. 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 MFMA general season was further reduced in RY96.

The board also approved a drawing hunt for antlerless moose in the FMA for RY95 and replaced the registration hunt with a general season.

Spring 2000 Board of Game Actions — During their spring 2000 meeting, the board took several actions concerning the FMA. It was increased in size from 217 mi^2 to 303 mi^2 to clarify boundaries in the Cripple Creek and Goldstream areas and to address safety issues in developed areas in the Goldstream Valley and Chena Hot Springs Road/Nordale areas. The number of FMA antlerless moose permits that may be issued was increased from 25 to 100. This was in response to high moose densities and the increasing number of moose/vehicle collisions and moose/human conflicts in the Fairbanks area. And finally, the FMA antlerless moose hunt was liberalized to include 21–27 November to align the bull and antlerless seasons, to increase the harvest of cows, and to provide additional hunting opportunity.

Hunter Harvest.

General Season — In the general season, reported harvests were 533–678 bulls per year during RY93–RY98, with an increasing trend (Table 3). Within the MFMA and FMA, the increasing trend was also apparent. Reported harvest in the MFMA increased from 47 to 59 bulls per year (RY93–RY98), while reported harvest in the FMA increased from 48 to over 60 bulls per year (RY93–RY98). The increases were due to expanded opportunity created by adding more general seasons, to increased effort, and to increasing moose numbers. Since RY93, large antlered (50"+) bulls comprised moderate portions of the harvest, except in the FMA; however, the proportion taken in the general season has declined since RY94 (Table 4).

Drawing Permit Hunts — In the antlerless hunt DM788, success rates increased 14% between RY96 and RY98 (Table 5). Similarly, success rates improved in hunt TM785, but not by as large a margin (9% between RY96 and RY98). Since RY93, large antlered (50"+) bulls comprised moderate portions of the harvest in TM785 (Table 4).

Hunter Residency and Success. Primarily local residents hunted moose in Unit 20B (Table 3). Participation by nonlocal residents and nonresidents was relatively low.

Hunter success was generally lower in Unit 20B than elsewhere in Unit 20. From RY93 through RY98 only 19–22% of the general season hunters per year were successful (Table 3). During this reporting period, success rates for general hunts were relatively high at 20% (RY97) and 22% (RY98). Likewise, in the FMA, success rates improved from a low of 11% in RY93 to 18% in RY97, nearly the highest level in 9 years. We suspect this increase is a function of increasing moose numbers in the FMA over the past 10 years. Population estimates indicate that moose densities increased in the FMA between RY93 and RY94 (Table 1) and anecdotal information suggests that moose numbers continued to increase through this reporting period.

Harvest Chronology. More bulls were killed during the first 5 days of the season than during any other 5-day period (Table 6).

Transport Methods. Highway vehicles were the primary method of transportation for successful hunters (Table 7). Since the last reporting period, the proportion of successful hunters using 3- or 4-wheelers increased, whereas, the proportion using boats declined. Airplane transportation was used by <6% of successful hunters since RY94.

Other Mortality

The number of moose killed in accidents with motor vehicles and trains has been substantial in some years (Table 8). The number of moose reported killed on highways in the FMA was 97 during RY97 and 121 during RY98. This translates into an average highway kill density of 0.5 moose/mi^2. By comparison, average harvest density was 0.29 moose/mi^2 in the FMA and 0.08 moose/mi^2 for Unit 20B overall, during the same period.

HABITAT

Assessment/Enhancement

The department is planning and/or conducting moose habitat enhancement for portions of the Fairbanks area. These efforts include regeneration of decadent willows by planting willows in recently logged areas and use of prescribed fire. In addition, existing habitat improvement projects for grouse in Unit 20B have positive benefits for moose.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

We have been collecting more systematic information on non-hunting 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 (Table 8). 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. For instance, in 1998, the department received 97 complaints involving moose within the FMA. Departmental policy for the treatment of nuisance moose should be formalized for public consideration. Mitigation measures, including public education, are continuing.

CONCLUSIONS AND RECOMMENDATIONS

It is uncertain whether or not we achieved our management objective of 30 bulls:100 cows overall in Unit 20B because unitwide population composition surveys have not been conducted since 1990. Surveys conducted in Unit 20B Central in 1994 and Unit 20B West in 1999 indicated that this objective was not met. We need to collect unitwide data to determine the status of the population, then reevaluate management objectives, and gain public approval of those management objectives. Also, in response to the apparent decline in the MFMA moose population, we need to closely monitor population numbers, productivity and recruitment of that population.

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Table 1 Unit 20B fall/winter aerial moose composition counts and estimated population size, regulatory years 1993–1994 through 1999–2000

Count area	Regulatory year	Bulls:100 Cows	Yearlings: 100 Cows	Calves:100 Cows	Percent calves	Adults	Moose observed	Moose/mi^2	Estimated population size
FMA[a]	1993–1994	9		30	27		65	1.3	
FMA	1994–1995	14		61	40		165	2.6[b]	
Unit 20B Central[c]	1994–1995	18	5	47	28		428	1.3[b]	
MFMA	1994–1995	47	11	47	24		489	2.9[e]	
MFMA[d]	1995–1996[f]				28		275		
MFMA[d]	1996–1997	27	27	47	27			2.9[g]	2627
MFMA[h]	1997–1998	33	15	34			647	2.7[g]	2604
MFMA	1998–1999[f]				19	237	237		
MFMA[i]	1999–2000	31	16	36	19	374	463	1.9[j]	1778
Unit 20B West[k]	1999–2000	27	14	34	20	438	546	1.4[j]	4881

[a] Fairbanks Management Area.
[b] Corrected for sightability (SCF = 1.23).
[c] A 642-mi^2 count area north and west of Fairbanks.
[d] Minto Flats Management Area (898 mi^2).
[e] Corrected for sightability (SCF = 1.13).
[f] February survey.
[g] Corrected for sightability (SCF = 1.18).
[h] A 967-mi^2 count area.
i A 951-mi^2 count area.
j The Geo-Statistical Population Estimator technique does not incorporate a SCF (see methods).
[k] A 3644-mi^2 survey area encompassing most of Unit 20B West (3955 mi^2), including the MFMA.

Table 2 Unit 20B (Minto Flats Management Area) moose twinning rate surveys, regulatory years 1997–1998 through 1999–2000

Regulatory year	Date	Cows w/Single calf	Cows w/Twins	Total	% Twins[a]
1997–1998	22 May	17	9	26	35
1998–1999	31 May	18	5	23	22
1999–2000	27–29 May	59	4	63	6

[a] Percentage of cows with calves that had twins.

Table 3 Unit 20B moose hunter[a] residency and success, regulatory years 1993–1994 through 1998–1999

Area/Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	
FMA general archery hunt:											
1993–1994	48				48	344	19	7		370	418
1994–1995	45				45	331	27	4		362	407
1995–1996	43	3	4	1	51	246	7	30	4	287	338
1996–1997	60	3	2	1	66	239	17	25	1	282	348
1997–1998	58	1	4		63	246	12	23	4	285	348
1998–1999	55		6		61	247	21	33	2	303	364
MFMA general hunt:											
1993–1994	44	3			47	74	3			77	124
1994–1995	49				49	81	5			86	135
1995–1996	33	2	2		37	105	10	1	1	117	154
1996–1997	36	3		1	40	59	8	3		70	110
1997–1998	37	7			44	65	4	1		70	114
1998–1999	45	12	1	1	59	112	6	1	1	120	179
Unit 20B remainder general hunt:											
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
1995–1996	375	39	30	4	448	1438	97	80	16	1631	2079
1996–1997	428	42	44	1	515	1688	88	96	7	1879	2394
1997–1998	388	30	30	2	450	1679	110	68	16	1873	2323
1998–1999	473	43	39	3	558	1699	111	89	15	1914	2472
All general hunts:											
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
1995–1996	451	44	36	5	536	1789	114	111	21	2035	2571
1996–1997	524	48	46	3	621	1986	113	124	8	2231	2852
1997–1998	483	38	34	2	557	1990	126	92	20	2228	2785
1998–1999	573	55	46	4	678	2058	138	123	18	2337	3015

[a] Excludes drawing permit hunt harvest.
[b] Residents of Unit 20.

Table 4 Unit 20B moose harvest antler spread, regulatory years 1993–1994 through 1998–1999

Hunt	Regulatory year	% Moose harvested by antler spread[a] <30"	30–39"	40–49"	50"+	Moose[b]
General season (includes FMA and MFMA general hunts after 1994)	1993–1994	26	36	20	18	414
	1994–1995	21	33	20	26	360
	1995–1996	36	25	17	22	505
	1996–1997	38	28	13	20	589
	1997–1998	42	29	14	15	527
	1998–1999	29	36	20	14	601
Fairbanks Mgmt Area	1993–1994	39	43	11	7	46
	1994–1995	62	28	10	0	40
Minto Mgmt Area (TM785)	1993–1994	16	34	19	31	32
	1994–1995	22	28	28	22	32
	1995–1996	10	60	10	20	10
	1996–1997	35	29	12	24	17
	1997–1998	22	33	22	22	18
	1998–1999	24	29	19	29	21

[a] Percent of moose with known antler spread.
[b] Only includes moose with antler spreads reported.

Table 5 Unit 20B moose harvest data by permit hunt, regulatory years 1996–1997 through 1999–2000

Hunt	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Bulls (%)	Cows (%)	Unk (%)	Harvest
DM788	1996–1997	15	1 (7)	7 (50)	7 (50)	0 (0)	7 (100)	0 (0)	7
	1997–1998	25	2 (8)	9 (39)	14 (61)	0 (0)	14 (100)	0 (0)	14
	1998–1999	25	0 (0)	9 (36)	16 (64)	0 (0)	16 (100)	0 (0)	16
	1999–2000	25	2 (8)	12 (52)	11 (48)	0 (0)	11 (100)	0 (0)	11
TM785	1996–1997	100	20 (20)	30 (38)	50 (62)	27 (54)	23 (46)	0 (0)	50
	1997–1998	100	17 (17)	30 (36)	53 (64)	30 (57)	23 (43)	0 (0)	53
	1998–1999	100	17 (17)	24 (29)	59 (71)	32 (54)	27 (46)	0 (0)	59
	1999–2000	100	22 (22)	21 (27)	57 (73)	34 (60)	23 (40)	0 (0)	57
Totals for all permit hunts	1996–1997	115	21 (18)	37 (39)	57 (61)	27 (47)	30 (53)	0 (0)	57
	1997–1998	125	19 (15)	39 (37)	67 (63)	30 (45)	37 (55)	0 (0)	67
	1998–1999	125	17 (14)	33 (31)	75 (69)	32 (43)	43 (57)	0 (0)	75
	1999–2000	125	24 (19)	33 (33)	68 (67)	34 (50)	34 (50)	0 (0)	68

Table 6 Unit 20B moose harvest[a] chronology percent by monrh/day, regulatory years 1993–1994 through 1998–1999

Regulatory	Harvest chronology percent by month/day						
year	9/1–9/5	9/6–9/10	9/11–9/15	9/16–9/20	9/21–9/25	Unk/Other	*n*
1993–1994	37	27	27	5	0	4	438
1994–1995	34	23	32	7	0	2	381
1995–1996	31	25	31	5	2	4	448
1996–1997	37	25	26	5	1	4	515
1997–1998	34	27	29	4	0	6	450
1998–1999	37	26	28	4	0	4	558

[a] Excludes drawing permit hunt harvests and Minto Flats Management Area and Fairbanks Management Area general hunt harvests.

Table 7 Unit 20B moose harvest[a] percent by transport method, regulatory years 1993–1994 through 1998–1999

Regulatory year	Harvest percent by transport method						
	Airplane	Boat	3- or 4-wheeler	Other ORV	Highway vehicle	Other/ Unknown	*n*
1993–1994	5	21	24	6	41	3	438
1994–1995	6	24	25	6	37	3	381
1995–1996	4	27	21	5	40	3	448
1996–1997	3	26	22	3	43	2	515
1997–1998	4	17[b]	29	6	41	2	450
1998–1999	3	20[c]	31	3	41	2	558

[a] Excludes drawing permit hunt harvests and Minto Flats Management Area and Fairbanks Management Area general hunt harvests.
[b] Airboats accounted for 1.6% ($n = 7$).
[c] Airboats accounted for 2.3% ($n = 13$).

Table 8 Unit 20B moose harvest[a] and accidental death, regulatory years 1993–1994 through 1999–2000

	Harvest by hunters							Accidental death					
	Reported				Estimated			Road[b]					
Regulatory year	M	F	Unk	Total	Unreported[c]	Illegal/ Other[d]	Total	FMA[e]	Unit 20B remainder	Total	Train[f]	Total	Total
1993–1994	572	0	0	572	101		101						673
1994–1995	524	0	0	524	93		93				28	28	645
1995–1996	555	15	0	570	101		101				2	2	673
1996–1997	648	30	0	678	120		120				19	19	817
1997–1998	587	37	0	624	110	79	189	97	70	167	15	182	995
1998–1999	710	43	0	753	133	38	171	121	74	195	15	210	1134
1999–2000[g]	537	34	0	571	101	21[h]	122	71[h]	49[h]	120	61[i]	181	874

[a] Includes general and permit hunt harvest.
[b] Documented kills; actual number killed by vehicles is certainly greater.
[c] Based on 17.7% unreported harvest (including wounding loss) estimated by Gasaway et al. (1992).
[d] Includes illegal, DLP, dispatched, potlatch, stickdance, and other reported deaths.
[e] Fairbanks Management Area.
[f] Confirmed dead between Alaska Railroad mileposts 411.8 and 470.0; "Missing" (moose hit but not recovered) are not included. Data provided by the Alaska Railroad.
[g] Preliminary data.
[h] Number of moose killed through December 1999.
[i] Number of moose killed through April 2000.

LOCATION

GAME MANAGEMENT UNIT: 20C (11,902 mi^2), 20F (6267 mi^2), and 25C (5149 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 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, presumably because of combined predation from wolves and bears (Gasaway et al. 1992). Wolf and bear populations are lightly harvested. Moose harvest is thought to be low relative to population size, and it probably is a minor factor affecting population dynamics relative to predation.

These subunits contain large tracts of mature black spruce that are poor quality moose habitat. However, many riparian areas, subalpine hills, and old burns appear to have suitable habitat capable of supporting many more moose than are currently present.

Trends in moose populations have been difficult to identify, but densities probably fluctuate between 0.1 and 1 moose/mi^2 based on Alaska-wide and Yukon studies (Gasaway et al. 1992). Approximately 26% (6034 mi^2) of the area has been stratified for relative moose abundance. After the entire area is stratified and funding is available, we will do an intensive aerial census to estimate actual moose densities.

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

MANAGEMENT OBJECTIVES

- Provide for a sustained harvest of these low-density populations.
- Estimate hunting mortality and document nonhunting mortality when possible.
- Estimate moose densities in Units 20C, 20F, and 25C by 1998.
- Cooperate with Bureau of Land Management (BLM) to superstratify approximately 1000 mi^2 in central Unit 25C in November 1997.
- Promote moose habitat enhancement by allowing natural fires to alter vegetation.

METHODS

A Geo-Statistical Population Estimator (GSPE) (J Ver Hoef, Alaska Department of Fish and Game [ADF&G], personal communication) was completed in Unit 25C (5000 mi^2) during November/December 1997. A census using Gasaway methods (Gasaway et al. 1986) was conducted during November 1994 by DNPP biologists in the Lake Minchumina Area (1007 mi^2) of Unit 20C.

We estimated annual moose mortality with data from harvest report cards including the benefit of reminder letters, calls to our office concerning nonhunting mortality of moose, records of moose/motor vehicle collisions (Fish and Wildlife Protection log sheets), and records of moose/train collisions (Alaska Railroad summary sheets). The Alaska Railroad travels through Unit 20C between railroad mileposts 327 (Windy) and 371 (Ferry). Data were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY98 = 1 Jul 1998–30 Jun 1999).

Information from a Subsistence Division study conducted in 1987 to assess wild resource use in the village of Tanana was used to estimate unreported harvest.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

We estimated that 3500–4500 moose were in Unit 20C, 2000 within Denali National Park (DNP) and 1500–2500 outside DNP (but including Denali National Preserve). These estimates assumed an average density of 0.58 moose/mi^2 inside DNP (October 1991 census; T Meier, personal communication) and 0.25 moose/mi^2 outside DNP. During a November 1994 survey of the Lake Minchumina area, DNP biologists estimated the density at 0.34 moose/mi^2 (K Stahlnecker, personal communication). In November 1999, approximately one-third of the area in Unit 20C outside DNPP was stratified for relative moose abundance. Once stratification is completed and funds are available, we will conduct a census in this area.

We estimated that 1000–2000 moose reside in Unit 20F. This assumed 0.25–0.50 moose/mi^2, with roughly 4250 mi^2 of moose habitat (McNay 1990).

The density estimate for Unit 25C was 0.46 moose/mi^2 based on the 1997 GSPE, with a total population estimate of 2279 moose (90% CI $\pm$ 16.5%). This low estimate was expected because nearly half the subunit contains mountainous non-moose habitat or open mountainous tundra interspersed by small drainages with localized, good moose habitat. The 1997 estimate was a cooperative effort between BLM and the ADF&G.

Population Composition

Population composition data in Units 20C and 20F were limited to the percent of large bulls in the harvest (Fig 1). The percentage of large bulls in the reported harvest for Unit 20C has been relatively stable since 1995 (30–36%) and has been variable in Unit 20F (24–55%). A possible reason for the variability in Unit 20F is a small annual sample size (29–41). Results from the 1997 GSPE in Unit 25C included estimates of 53 bulls:100 cows and 37 calves:100 cows (Table 1).

Distribution and Movements

No movement data were collected in any of the units and no distribution data were collected in Unit 20F during this reporting period. Distribution data for the other 2 units were limited to the 1997 census in Unit 25C and the stratification flights in Unit 20C. In both areas moose were most abundant in the limited riparian areas of good habitat.

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% white) moose may not be taken.	1 Sep–20 Sep	
NONRESIDENT HUNTERS: 1 bull; however, white-phased or partial albino (more than 50% 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.		

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
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 25C		
RESIDENT HUNTERS: 1 bull.	1 Sep–15 Sep	
NONRESIDENT HUNTERS: 1 bull.		5 Sep–15 Sep

Hunting seasons and bag limits have not changed since RY93 (Table 2).

Board of Game Actions and Emergency Orders. No Board of Game actions were taken during this reporting period.

Hunter Harvest. Overall there was a slight increase in moose hunting pressure and harvest during this reporting period (Table 3). During RY97, 143 moose were reported killed by 382 hunters in Unit 20C, 29 moose were reported killed by 118 hunters in Unit 20F, and 57 moose were reported killed by 212 hunters in Unit 25C. In RY98, 140 moose were reported killed by 396 hunters in Unit 20C, 45 moose were reported killed by 154 hunters in Unit 20F, and 85 moose were reported killed by 252 hunters in Unit 25C.

Nuchalawoyya Potlatch — In spring 1989 the Board of Game authorized the department to issue permits to take up to 3 moose/year for the Nuchalawoyya potlatch. No potlatch was held during this report period.

Federal Permit Hunt 790 — In RY92 the Federal Subsistence Board created a 1–25 September moose season on federal public land in Unit 20F for qualified local subsistence users by federal registration permit. The federal public land is located within the Dalton Highway corridor. In RY96, 2 permits were issued with 1 successful permittee. During RY97 3 permits were issued, and all 3 permittees did not hunt. During RY98 no permits were issued (C Miller, US Fish and Wildlife Service, personal communication, May 2000).

Harvest data for a federal hunt in Unit 20C were not available when this report was written. Efforts will be made to obtain these data for the next reporting period.

Unreported Harvest and Estimated Nonhunting Mortality — The number of unreported kills in Units 20C, 20F, and 25C is not easily estimated. Harvest report card returns are minimal from Tanana, Rampart, Manley, Livengood, Central, Circle, and Circle Hot Springs. For example, ADF&G, Division of Subsistence, research information from the village of Tanana illustrates the magnitude of the nonreporting problem. They found that only 10–20% of the actual harvest for Tanana residents is reported. The reporting rate for other rural communities in this area is unknown.

Illegal, other, and motor vehicle deaths were obtained from the Fairbanks Fish and Wildlife Protection wildlife mortality logs. While data concerning deaths caused by train collisions (only applicable for Unit 20C) were obtained from the Alaska Railroad. Documented causes of nonhunting mortality were minimal (0–3 annually) in Unit 20F and Unit 25C, but higher in Unit 20C (4–21 annually) due to deaths caused by train collisions (Table 4).

Hunter Residency and Success. The number of nonresident hunters was relatively constant in all units and success rates for all hunters remained fairly stable in Unit 20C, while increasing slightly in Units 20F and 25C during this report period (Table 3). During the last 5 years, 7% (223/3035) of the hunters reporting in Units 20C and 25C were nonresidents, and there was no nonresident season in Unit 20F. The 5-year average success rate for hunters was 35% (679/1934) in Unit 20C, 26% (174/661) in Unit 20F, and 28% (311/1101) in Unit 25C.

Most successful hunters in Units 20C and 20F continue to be Alaskan residents (Table 3). During RY97, 87% (125/143) of the reported successful hunters were Alaskan residents in Unit 20C, and 82% (47/57) were Alaskan residents in Unit 25C. During RY98 within Unit 20C, 89% (125/140) of the reported harvest was from Alaskan residents, 86% (73/85) of the reported harvest was by Alaskan residents in Unit 25C.

Harvest Chronology. Since RY93, most reported harvest in Units 20C and 20F was consistently during the second week of the 3-week season, with the first and third weeks being similar, but at a lower level. In Unit 25C the harvest increased during the last week of the 15-day season (Table 5).

Transport Methods. In Unit 20C most successful hunters used boats, airplanes, and 3- or 4-wheelers for transportation (Table 6). Extensive river systems, many lakes, gravel bars, and an expanding trail system make these transport methods most useful. In Unit 20F boats were the primary mode of transportation for successful hunters, and in Unit 25C successful moose hunters utilized highway vehicles, boats, and 3- or 4-wheelers. The transportation methods used throughout this area are reflective of access options.

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 improvements in these units have been associated with wildfire. For a history of wildfires in this area, refer to BLM's URL: ftp://borealis.ak.blm.gov/pub/gis/ and download file *firehist99.tar*.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

Harvest reporting in these subunits is poor. We need to contact more people in remote areas to emphasize the importance and benefits of reporting harvest. It would be especially helpful to contact young people in the village schools to establish harvest reporting as a responsibility of all hunters and to promote the positive aspects of reporting.

Fire is an integral part of Interior ecosystems and is essential to producing good moose habitat in areas of climax spruce forests. We should continue to coordinate wildlife needs with fire suppression activities and encourage more controlled burns to enhance habitat. Eastern Unit 25C should be evaluated for its potential for a controlled burn. This area presently contains wide expanses of black spruce with only small areas of moose habitat.

Collisions with trains are a significant mortality factor for moose in some areas. Efforts to reduce these mortalities should continue, and we need to establish better reporting and data management strategies when accidents do occur.

CONCLUSIONS AND RECOMMENDATIONS

Low density moose populations are found in Units 20C, 20F, and 25C. Hunting pressure was relatively low. Regulations in place during this reporting period addressed our current management objectives, and no regulatory changes are recommended at this time.

We met our objective to estimate hunting and nonhunting mortality, and we worked to gather information on reporting rate from rural communities so a more comprehensive total estimate of harvest could be produced.

We continued the effort to stratify portions of Unit 20C outside of DNPP and to initiate stratification of relative moose abundance in Unit 20F. We made progress on our objective to promote natural fires to enhance moose habitat through the department's efforts on the Interagency Fire Management Team.

New objectives will be formulated during the next reporting period.

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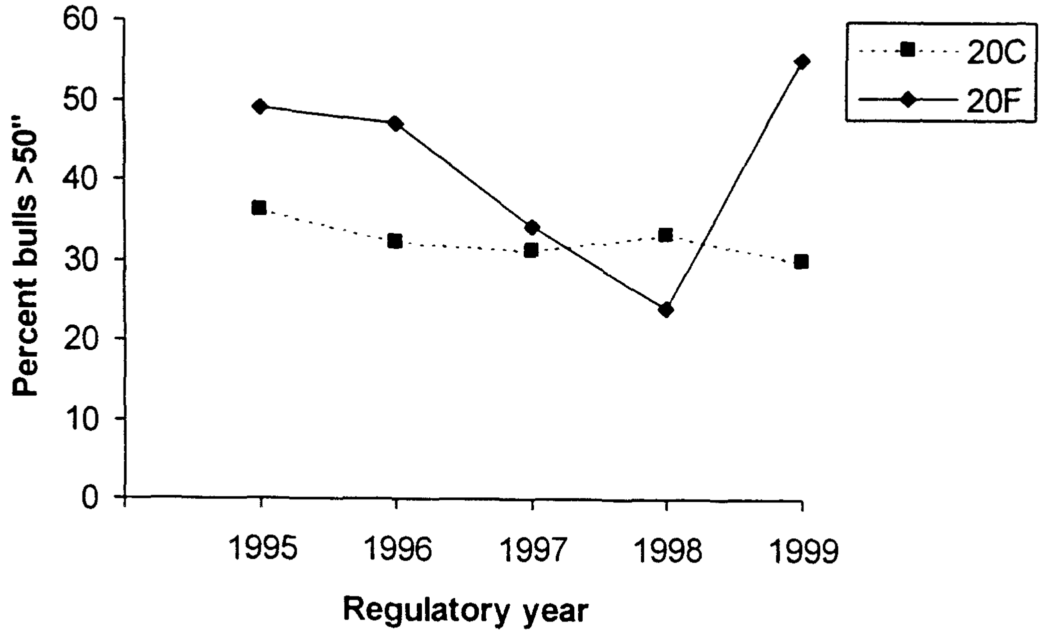

Figure 1 Percent of bull moose in the reported fall harvest with an antler spread >50 inches in Units 20C and 20F, regulatory years 1995–1996 through 1999–2000

Table 1 Unit 25C fall aerial moose composition counts, 1986–1997

Area/Year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves: 100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/mi^2	Survey area size (mi^2)
O'Brien Creek Trend Count Area									
1986	103	13	21	8	9	77	85	1.49	57.0
1987	77	11	28	13	14	83	96	1.68	57.0
1988	129	37	33	16	13	112	128	2.25	57.0
1996	119		11	3	5	57	60	1.05	57.0
Unit 25C Population Estimate (GSPE)[a]									
1997	53	13	37	80	20	319	399	0.46	5000

[a] A Geo-Statistical Population Estimator (J Ver Hoef, ADF&G, personal communication) moose population estimate conducted 2 November 1997 through 3 December 1997.

Table 2 Units 20C, 20F and 25C moose hunting seasons, regulatory years 1990–1991 through 1998–1999

	Unit 20C		Unit 20F		Unit 25C	
Regulatory year	Season[a]	Hunters allowed[b]	Season	Hunters allowed[b]	Season	Hunters allowed[b]
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
through	5–15 Sep	N	1–10 Dec[f]	R	5–15 Sep	N
1998–1999	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 Denali National Park and Preserve.

Table 3 Units 20C, 20F and 25C reported moose hunter residency and success, regulatory years 1990–1991 through 1998–1999

Regulatory year	Successful hunters				Unsuccessful hunters				Total hunters
	Resident	Nonresident	Unk	Total (%)	Resident	Nonresident	Unk	Total (%)	
Unit 20C									
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	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
1995–1996	108	9	4	121 (32)	254	7	0	261 (68)	382
1996–1997	114	9	0	123 (35)	221	11	0	232 (65)	355
1997–1998	125	17	1	143 (37)	224	12	3	239 (63)	382
1998–1999	125	14	1	140 (35)	242	13	1	256 (65)	396
Unit 20F									
1990–1991[a]	38	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
1995–1996	39	0	0	39 (32)	83	0	0	83 (68)	122
1996–1997	30	0	0	30 (23)	99	1	0	100 (77)	130
1997–1998	28	1	0	29 (25)	89	0	0	89 (75)	118
1998–1999	44	1	0	45 (29)	106	3	0	109 (71)	154
Unit 25C									
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	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
1995–1996	51	5	0	56 (28)	130	11	0	141 (72)	197
1996–1997	47	11	0	58 (27)	138	18	0	156 (73)	214
1997–1998	47	10	0	57 (27)	140	13	2	155 (73)	212
1998–1999	73	11	1	85 (34)	152	13	2	167 (66)	252

[a] Excludes hunters in permit hunts.

Table 4 Estimate of Units 20C, 20F, and 25C moose harvest and accidental death, regulatory years 1997–1998 through 1999–2000

Regulatory year	Harvest by hunters: Reported[a]				Harvest by hunters: Estimated			Accidental death			
	M	F	Unk	Total	Unreported[b]	Illegal/Other[c]	Total	Road[d]	Train[e]	Total	Total
Unit 20C											
1997–1998	143	0	0	143	25	0	25	1	8	9	177
1998–1999	140	0	0	140	25	1	26	0	3	3	169
1999–2000	125	0	0	125	22	0	22	0	21	21	168
Unit 20F											
1997–1998	29	0	0	29	5	1	6	1	0	1	36
1998–1999	45	0	0	45	8	1	9	0	0	0	54
1999–2000	33	0	0	33	6	2	8	1	0	1	42
Unit 25C											
1997–1998	57	0	0	57	10	0	10	0	0	0	67
1998–1999	85	0	0	85	15	0	15	3	0	3	103
1999–2000	66	0	0	66	11	0	11	0	0	0	77

[a] Data from ADF&G harvest reports.

[b] Based on 17.7% unreported harvest (including wounding loss) estimated by Gasaway et al. (1992).

[c] Data from Fairbanks Fish and Wildlife Protection wildlife mortality logs.

[d] Documented kills from Fairbanks Fish and Wildlife Protection wildlife mortality logs.

[e] Confirmed dead between Alaska Railroad mileposts 327.0–370.9; "missing" (moose hit but not recovered) are not included. Data provided by the Alaska Railroad and summarized by ADF&G office in Palmer. Data were not available for May and June 2000.

Table 5 Units 20C, 20F, and 25C reported moose harvest chronology by month/day, regulatory years 1992–1993 through 1998–1999

Regulatory year	Harvest chronology by month/day					
	9/1–9/7	9/8–9/15	9/16–9/20	9/21–9/30	12/1–12/10	Total
Unit 20C						
1992–1993	28	15	19			62
1993–1994	40	53	32	3		128
1994–1995	32	70	40	1		143
1995–1996	33	49	35	3		120
1996–1997	37	52	31	4		124
1997–1998	38	54	39	1		132
1998–1999	35	54	42	3		134
Unit 20F						
1992–1993	9	10	2	1	4	26
1993–1994	8	12	1		3	24
1994–1995	15	15			1	31
1995–1996	7	19	14		1	41
1996–1997	6	23	6		0	35
1997–1998	4	13	10	1	0	28
1998–1999	11	25	6		3	45
Unit 25C						
1992–1993	20	19				39
1993–1994	23	25	6	1		55
1994–1995	27	23	1	1		52
1995–1996	23	29	3			55
1996–1997	20	34	1	1		58
1997–1998	22	34	0	1		57
1998–1999	35	47	2			84

Table 6 Units 20C, 20F, and 25C reported moose harvest percent by transport method, regulatory years 1990–1991 through 1998–1999

	Harvest percent by transport method								
Regulatory year	Airplane	Horse/Dogsled	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unk/other	*n*
Unit 20C									
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
1995–1996	29	0	37	14	0	12	7	0	121
1996–1997	28	0	26	21	0	11	8	6	127
1997–1998	21	0	38	21	0	13	6	2	143
1998–1999	16	1	33	24	0	19	5	2	140
Unit 20F									
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
1995–1996	3	0	54	20	0	3	22	0	41
1996–1997	3	3	57	14	6	0	17	0	35
1997–1998	3	0	45	31	0	3	17	0	29
1998–1999	0	2	56	16	4	2	20	0	45
Unit 25C									
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
1995–1996	9	0	29	25	0	9	27	2	56
1996–1997	9	0	22	36	0	5	28	0	58
1997–1998	7	0	18	53	0	7	14	2	57
1998–1999	4	0	21	40	0	5	28	2	85

LOCATION

GAME MANAGEMENT UNIT: 20D (5637 mi^2)

GEOGRAPHIC DESCRIPTION: Central Tanana Valley near Delta Junction

BACKGROUND

Unit 20D was created in 1971 from a portion of Unit 20C. During 1962–1970, the moose hunting season in the area that is currently Unit 20D consisted of a 70- to 72-day bull season and a 1- to 8-day antlerless moose season. Most (51–74%) of the harvest during 1964–1970 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. Poor recruitment of yearlings to the population in combination with intense bulls-only hunting depressed the bull:cow ratio to only 4:100 in the more accessible portions of the subunit. The moose hunting season was closed during 1971–1973 because the depressed moose population could no longer support any significant harvest (McIlroy 1974).

Despite restrictions on hunting, the moose population in Unit 20D continued to decline because of chronically high moose mortality from other causes. In 1973 the moose population in the area south of the Tanana River and between the Johnson and Delta Rivers was estimated at only 600. When limited moose hunting was resumed in 1974, it was conducted under a registration permit system for the entire unit, however, a portion of the subunit around Delta Junction was closed to the taking of antlerless moose. The moose population decline in the western portion of the subunit was gradually reversed by a combination of continued hunting restrictions, mild winters and wolf control efforts in adjacent Unit 20A (1976–1982) and western Unit 20D (1980–1983).

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 closed area around Delta Junction, which had been established in 1974, 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 to more accurately reflect its status as an area closed to hunting. In 1991 the DJCA was reduced in size to provide more hunting opportunity in the area. In 1996 the DJCA was renamed the DJMA and a drawing permit hunt was established in the area.

Unit 20D has been subdivided into 4 areas for moose management purposes: southwestern Unit 20D, the area south of the Tanana River from the Johnson River to the Delta River; southeastern Unit 20D, the area south of the Tanana River from the Robertson River to the Johnson River; northwestern Unit 20D, the area north of the Tanana River from Banner Creek to and including the Volkmar River; and northeastern Unit 20D, 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 expanded in southwestern Unit 20D by first eliminating the registration permit requirement and then by lengthening the season. Antler restrictions were implemented in 1988 to stabilize the increasing harvest and to improve the age structure in the bull segment of the population. In southeastern and northern Unit 20D, the seasons were also increased. The DJCA was renamed the DJMA and a drawing permit hunt was established during the 1996 hunting season.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVE

- Increase the fall moose population to 8000–10,000 moose with an annual reported sustainable harvest of 240–500 moose per year by the year 2002 as per 5 AAC 92.125 Wolf Predation Control Implementation Plans.

METHODS

1997 POPULATION SURVEYS

In fall 1997 a population estimation survey was flown in northeastern Unit 20D (including drainages from the Volkmar River east to the Unit 20D boundary) to estimate population size and sex and age composition. The survey was based on techniques described by Gasaway et al. (1986) and is referred to as the "Gasaway Method." The survey area was subdivided into sample units (SUs) averaging approximately 12 mi^2 each. SUs were drawn to include all areas of moose habitat below approximately 4500 ft of elevation. Areas above 4500 ft in elevation were generally excluded from the survey area. SUs were stratified into low density and high density stratum. Stratification was based on preexisting information about the area and a presurvey reconnaissance flight. SUs were surveyed with a fixed-wing Piper PA-18 or a Robinson R-22 helicopter. Intensive searches were flown in most low and high strata SUs to estimate sightability of moose during the survey and to calculate a sightability correction factor (SCF). Optimal allocation of survey effort was monitored and adjusted using the Moosepop software program (Moose Population Estimation Survey Software, Version 2.0, RA DeLong and DJ Reed, ADF&G, Fairbanks, Alaska). Data were analyzed using Moosepop to calculate the population estimate and composition data.

1998 POPULATION SURVEYS

In fall 1998 a population estimation survey was flown in southern Unit 20D which included all of Unit 20D south of the Tanana River. A small survey effort was also conducted in Unit 20D north of the Tanana River to provide for monitoring long-term population trends as described below. SUs were searched from a fixed-wing Piper PA-18 and from a Robinson R-22 helicopter.

Both surveys were based on techniques described by Gasaway et al. (1986) but were modified to incorporate spatial statistics and autocorrelation as developed by Jay Ver Hoef (Biometrician, ADF&G, Fairbanks). Ver Hoef's modification is the "Spatial Statistics Method" (SSM).

One advantage of using autocorrelation for data analysis is that a prediction can be made about the number of moose in any unsampled SU or cluster of SUs, based on information derived from adjacent sampled SUs, i.e., SUs that are close together but unsampled tend to be similar to nearby SUs that are sampled. This should result in more accurate population estimates (Ver Hoef, ADF&G, personal communication)

Autocorrelation of data requires a larger sample size than the stratified random sample design of the Gasaway Method. Therefore, SUs were drawn with boundaries every 2 degrees of latitude on even increments and every 5 degrees of longitude on multiples of 5 degrees. This technique resulted in SUs that were approximately 5.7–5.9 mi^2. All of Unit 20D was subdivided into SSM SUs. All SUs were stratified into low or high density stratum based on previous stratifications of the area.

SSM SUs also differed from Gasaway's because every SU that contained any moose habitat was included in the survey area. Gasaway's SUs were drawn based on topographic features and no areas of nonmoose habitat such as high elevation (above approximately 4500 feet) glaciers, large lakes, etc. were included. Because SSM SUs were based on longitude/latitude rather than topographic features, some SUs contained areas of nonmoose habitat. Therefore, SSM resulted in more SUs and a larger survey area, but moose density could still be calculated based on the area of moose habitat.

The SSM does not employ a sightability correction factor (SCF) at this time, and thus it does not correct for moose not seen during the survey. The Gasaway Method attempted to maintain consistently high sightability of moose during surveys by flying SUs at a standard search intensity of 4–6 min/mi^2 (Gasaway et al. 1986). A SCF was then calculated independently of the sampling effort by resurveying a portion of each SU at an intensive search effort of 12 min/mi^2. The SCF was based on the number of moose not seen during the standard search but seen on the intensive search. During the SSM survey, the standard search effort was increased to 8–10 min/mi^2 to achieve an initial higher level of sightability during the survey than the Gasaway Method standard search of 4–6 min/mi^2. Ver Hoef and others plan to research the assumption that 8–10 min/mi^2 of search effort is adequate to negate the need for a SCF (Ver Hoef, ADF&G, personal communication).

Based on funding availability, the goal of the 1998 survey was to sample approximately 40 SUs in the primary survey area of southern Unit 20D. A random selection of SUs was drawn with 40% of planned effort in the low stratum and 60% of effort in the high stratum. Also, a small secondary survey was conducted in northern Unit 20D. Ver Hoef (ADF&G, personal communication) feels that by maintaining a small survey effort in each area every year (i.e., southern and northern Unit 20D), more accurate monitoring of long-term population trends will be possible. Therefore, 10 SUs were randomly selected and surveyed in northern Unit 20D, with 20% in the low stratum and 80% in the high stratum.

Ver Hoef believes that advantages of the SSM over the Gasaway Method are: 1) autocorrelation produces a more accurate population estimate; 2) stratification does not have to be as accurate or time sensitive; 3) SSM can be conducted for lower cost and manpower; 4) the survey can be conducted over a longer period of time, making interruptions due to poor weather less problematic; 5) complete random sampling is not necessary and old survey areas can be incorporated in the SSM; 6) better estimates of population trend and population composition are available because SSMs can be conducted more frequently due to lower cost; and 7) data from 1 survey area may be applied to adjacent survey areas.

SU data were entered into a Microsoft®Excel spreadsheet and analyzed with S-PLUS 2000 software (Mathsoft, Seattle, WA) using a spatial statistics model developed by Ver Hoef. A population estimate was also calculated from the data using Moosepop software to allow a comparison of results between SSM and Moosepop.

Harvest Monitoring. Harvest of moose by hunters during the general hunting season was monitored by requiring hunters to acquire moose harvest tickets and report hunting activities that included: the location hunted, how long they hunted, their mode of transportation, whether they killed a moose, where and when they killed a moose, the antler spread and number of brow tines on moose killed, and the type of weapon used to kill the moose. Hunters participating in permit hunts provided the same information via permit report forms. Harvest data were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY99 = 1 Jul 1999–30 Jun 2000). Reminder letters were sent to holders of harvest tickets and permits.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

1997

In fall 1997 we estimated 883 moose (604–1163) and an overall density of 0.6 moose/mi^2 in northeastern Unit 20D (Table 1).

Completion of the northeastern Unit 20D population estimate allowed the calculation of a total northern Unit 20D population estimate by combining the results of the 1996 northwestern estimate and the 1997 northeastern estimate. An assumption of this calculation is that no significant changes occurred in the 2 populations during this time. This calculation was made by determining the standard error of the sum of the variances for the 2 population estimates. The standard error was then multiplied by the Student t test statistic of 1.68 to obtain the 90% confidence interval ± 25% (Gasaway et al. 1986). The confidence interval was then added and subtracted to the sum of the 2 population estimates, indicating 1583–2469 moose (Table 2).

We also estimated a fall population of 3847–5249 moose in all of Unit 20D during 1995–1997 by combining results of surveys during these years (Table 2). Again, I assumed that no significant changes occurred in the populations during this 3-year period. This assumption is probably less valid for this calculation than for the northern Unit 20D calculation, because the southern Unit 20D population was likely increasing whereas the northern Unit 20D population was likely stable.

Unit 20D has been designated for intensive management by the Alaska Board of Game who established a population goal of 8000–10,000 moose. The 1995–1997 Unit 20D population estimate of 3847–5249 moose is below the population objective.

1998

In fall 1998 I estimated 3630 moose (2533–4727) in southern Unit 20D using SSM techniques (Table 3). Moosepop software calculations using the Gasaway Method resulted in a population estimate of 4050 moose (2826–5275) with no SCF. I believe the SSM estimate is most accurate.

To allow a comparison of moose density in southern Unit 20D between the 1995 and the 1998 estimates, the number of moose estimated for 1998 was divided by the estimated size of the 1995 survey, even though the 1998 survey area was larger due to SU drawing technique differences described above. Using this calculation, density of moose was 1.9 moose/mi^2 (1.4–2.3) in 1995 compared to 2.7 moose/mi^2 (1.9–3.5) in 1998 (Table 3).

The 1998 southern Unit 20D SSM population estimate will be combined with a planned 1999 SSM population estimate of northern Unit 20D to calculate a new Unit 20D total population estimate. This will allow a reevaluation of progress toward meeting the population objective.

Population Composition

1997. The bull:cow ratio in northeastern Unit 20D was 32:100 (22–42) and the calf:cow ratio was 18:100 (12–24) during fall 1997 (Table 1).

1998. The population composition during fall 1998 in southern Unit 20D was very similar to 1995 parameters, with 21 bulls:100 cows (16–25) and 37calves:100 cows (32–42) (Table 3).

Distribution and Movements

No data were collected on moose distribution or movements during this reporting period.

MORTALITY

Harvest

Season and Bag Limit. Most hunting regulations were the same in both RY97 and RY98 with one exception (Table 4). The exception was an August and January-February hunt that was established in the Healy River drainage in RY98. An explanation for this hunt is given below in Board of Game Actions.

Board of Game Actions and Emergency Orders. The Healy Lake Village Council submitted 2 regulation proposals for the March 1998 Board of Game meeting. One proposal was for a 15–28 August hunting season for 1 bull moose in eastern Unit 20D, both north and south of the Tanana River. The other proposal was to expand the hunt area of the Unit 20D 1 January–

15 February Tier II hunt to include several drainages north of the Tanana River. In subsequent discussions with Healy Lake Village Council, I learned the important issues were: 1) they did not feel the existing 1–15 September moose hunting season was adequate to meet their need of approximately 20 moose/year because waterfowl hunters made it difficult to hunt moose around Healy Lake during the concurrent 1–15 September moose and waterfowl hunting seasons, 2) they wanted the opportunity to hunt close to Healy Lake, and 3) they wanted a fall and winter season to allow village residents the opportunity to acquire meat over a longer period of time. We worked with the Delta and Upper Tanana-Fortymile Fish and Game Advisory Committees, plus Healy Lake Village Council, to amend the original proposals and get them adopted by the Board.

In other action pertaining to Unit 20D, the board rejected a proposal from the public to establish a cow moose hunt.

Human-Induced Mortality

RY97. Estimated moose mortality from all human causes in Unit 20D during RY97 was 310 moose (Table 5). This included 210 moose reported killed by hunters, an estimated 37 unreported hunter kills, illegal harvest of 15 moose, and 48 road kills (Alaska Department of Public Safety). Most illegal kills and road kills occurred in southwestern Unit 20D. Total reported hunting harvest of 210 moose did not meet the harvest objective of 240–500.

RY98. Estimated moose mortality from all human causes increased during RY98 to 317 moose (Table 5). This includes 234 moose reported killed by hunters during the hunting season, an estimated 41 moose harvested but unreported, 11 moose killed illegally, and 31 road kills (Alaska Department of Public Safety). Most illegal kills and road kills occurred in southwestern Unit 20D. Total reported hunting mortality of 234 was slightly below the harvest objective of 240–500 established by the board. Since RY96, moose mortality has been higher, due in large part to increased hunting kill and road kills.

Southwestern Unit 20D Hunter Harvest. Reported hunter harvest in RY97 was 96 moose. During the general season, 325 hunters harvested 88 moose (Table 6). With the exception of RY96, this was a higher harvest than during any other year since at least RY84. Eight additional moose were harvested during permit drawing hunt DM790 (Delta Junction Management Area) (Table 7). Hunters had a 27% success rate during the general season and a 100% success rate during hunt DM790.

Reported hunter harvest during RY98 was 132 moose. During the general season, 431 hunters killed 122 moose (Table 6). This was the highest reported harvest of bulls in southwestern Unit 20D since 1964. An additional 10 moose were killed during permit hunt DM790 (Table 7). Hunters had a 28% success rate during the general season and a 100% success rate during hunt DM790.

Southwestern Unit 20D has the most restrictive hunting regulations in the subunit, yet moose harvest and number of hunters has continued to increase (Fig 1), likely due to increased numbers of moose in this area.

Southeastern Unit 20D Hunter Harvest. The harvest of moose has remained low in southeastern Unit 20D. During the general seasons, only 13 moose were killed in RY97 and only 17 in RY98 (Table 6). Hunter success rates were 34% and 40% each year, respectively. No moose were killed in Tier II hunt TM787 (Table 8). Harvest during the general hunting season is low in this area partly because of motorized access restrictions in the Macomb Plateau Controlled Use Area, which make moose hunting difficult.

Northwestern Unit 20D Hunter Harvest. During the RY97 general season, 241 hunters killed 72 moose (Table 6). Hunters had a 30% success rate. During the RY98 general season, 231 hunters killed 64 moose for a 28% success rate. There were no permit hunts in northwestern Unit 20D.

Northeastern Unit 20D. Number of hunters and harvest remained low in northeastern Unit 20D during the RY97 general season, with 46 hunters harvesting 19 moose (Table 6) for a 41% success rate. This area is difficult to access during the hunting season except for along the Tanana River, along a few small creeks and rivers flowing into the Tanana River, and around a few ridges with airstrips. During the RY98 general season, 43 hunters harvested 16 moose for a 37% success rate.

The additional moose hunting seasons in the Healy River drainage during RY98 did not significantly increase the harvest in this drainage. The Healy River drainage is Uniform Coding Unit (UCU) 501. The 19 hunters reporting within UCU 501 during RY98 were similar to the number of hunters reporting in the area during the RY93–RY97 hunting seasons (Table 9). Harvest in the area increased from a mean of 2.2 (2–3) for the 5 years prior to the increased hunting seasons, to 5 moose harvested in RY98. No successful hunters reporting for UCU 501 listed Healy Lake village as their community of residence. All 5 moose were reported taken by nonlocal hunters. Of the 13 unsuccessful hunters reporting, 3 were from Delta Junction or Fort Greely, 1 did not report residency, and the remainder were nonlocal residents. Therefore, based on reported hunting effort, it does not appear that residents of Healy Lake Village took advantage of the additional hunting seasons in the Healy Lake drainage, or they did not report.

In discussions I had with Healy Lake residents, they estimated a community need of 20 moose/year. Part of the reason for establishing the additional August and January/February seasons in this drainage was to provide an opportunity for them to meet this need during legal hunting seasons. Next year, I will make a concerted effort to work cooperatively with Healy Lake residents to help them meet their licensing and reporting requirements.

Hunter Residency. Most moose hunters in Unit 20D continue to be local residents. During the RY97 general season, 83% of successful hunters and 84% of the unsuccessful hunters were residents of the subunit. During the RY98 general season, 76% of successful hunters and 82% of unsuccessful hunters were residents of the subunit (Table 10).

Hunter Effort. Mean days hunted by successful and unsuccessful hunters is increasing unitwide (Table 11).

Permit Hunts. Tier II permit hunt number TM787 was conducted during 1 January–15 February of RY97 and RY98. Fifteen permits were issued yearly, with a harvest quota of 5 bulls. Participation in the hunt was low with 73% and 67% of permittees not hunting in each year, respectively. No moose were killed in either year (Table 8).

The number of permits issued for hunt DM790 was increased from 5 to 10 for the RY97 and RY98 seasons. The number of applications increased from 355 in RY96 to 380 in RY97 to 458 in RY98. Hunters killed 8 bull moose in RY97 and 10 in RY98 (Table 7).

Harvest Chronology. During this reporting period, harvest chronology remained similar to previous years, with most harvest occurring during the first 5 days of the 15-day general season (Table 12).

Transport Methods. During this reporting period, highway vehicles, 3- or 4-wheelers, and boats continued to be the most common modes of transportation used by successful hunters (Table 13).

Natural Mortality

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 limit moose population growth in the northern half of Unit 20D and account for reduced calf survival in portions of southern Unit 20D.

HABITAT

Assessment

No habitat assessment was done during this reporting period.

Enhancement

During this reporting period we conducted no habitat enhancement projects.

CONCLUSIONS AND RECOMMENDATIONS

A population estimate was completed for all of Unit 20D over a 3-year period and results indicated that the moose population did not meet the objective established by the Board of Game. In addition, a population estimate was also completed in 1998 for southern Unit 20D, which resulted in a higher estimate for the area than in 1995. Unitwide harvest of moose increased, and was only slightly below the lower range of the harvest objective established by the board. Participation in the Tier II permit hunt in southeastern Unit 20D continued to be low, and additional hunting seasons established within the Healy River drainage did not increase reported hunting by local residents of Healy Lake Village.

No regulatory changes are recommended. However, the unitwide population objective needs to be subdivided, as a minimum, into northern and southern Unit 20D objectives. The unitwide population objective of 8000–10,000 moose does not account for differences in moose density, habitat quality, harvest rates, and other factors that are substantially different between these areas.

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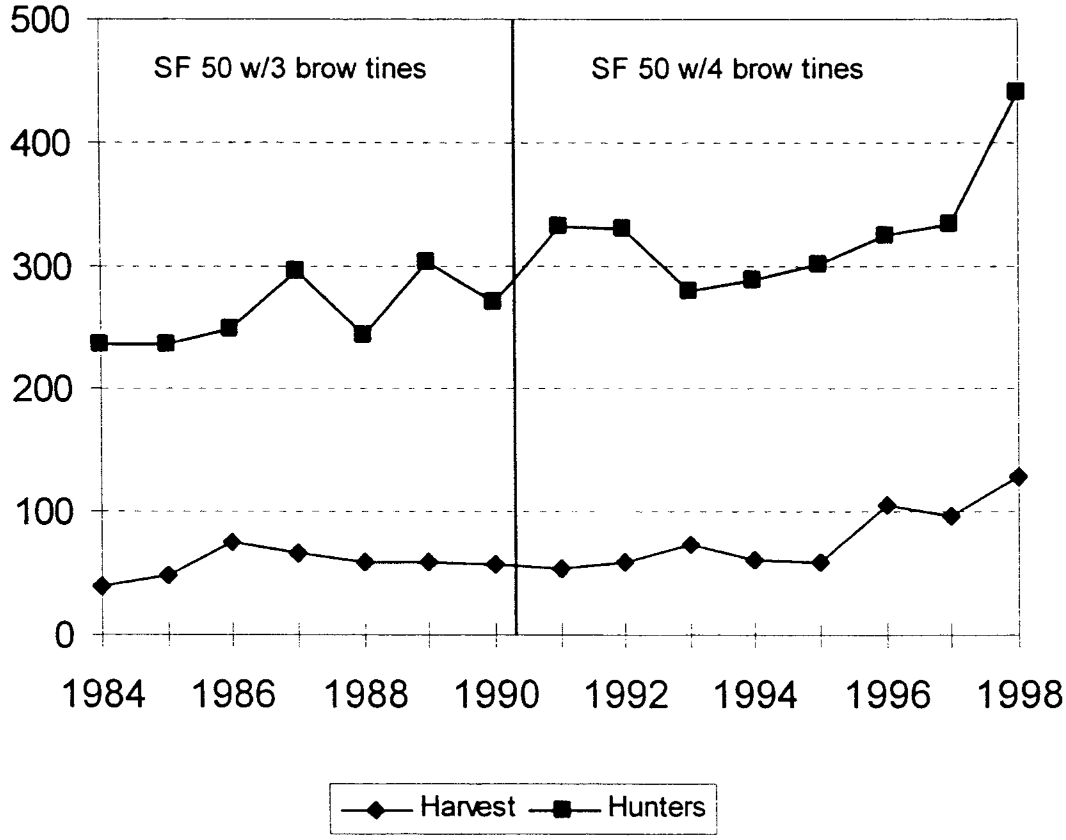

Figure 1 Southwestern Unit 20D moose harvest and number of hunters, regulatory years 1984–1985 through 1998–1999

Table 1 Northeastern Unit 20D moose population estimate survey results, fall 1997

Survey results	Value
Population estimate	883
LCI @ 0.90	604
UCI @ 0.90	1163
90% CI	± 31.6
SCF	1.31
Bull:100 Cow Ratio	32 (22–42)
Calf:100 Cow Ratio	18 (12–24)
Herd Composition	
Number Bulls	189 (136–242)
Number Cows	589 (381–796)
Number Calves	106 (57–154)
High stratum density	1.0 moose/mi^2
Low stratum density	0.3 moose/mi^2
Overall density	0.6 moose/mi^2
Total area High density stratum	498 mi^2
Total area Low density stratum	672 mi^2
Total area	1170 mi^2

Table 2 Unit 20D moose population and composition estimates, fall 1995–1997

Parameter	Northwest 20D 1996	Northeast 20D 1997	1996–1997 Total Northern 20D	Southern 20D 1995	1995–1997 Total Unit 20D
$T_{e\ pop\ est}$[a]	1143	883	2026	2522	4548
$V(T_e)$	45,829.16	23,777.49	69,606.65	104,381.17	173,987.82
LCI			1583	1979	3847
UCI			2469	3065	5249
$T_{e\ calf}$	162	106	268	552	820
$V\ (T_{e\ calf})$	2616.2	683.93	3300.13	7012.14	10,312.27
LCI			171	411	649
UCI			365	693	991
$T_{e\ cow}$	666	589	1255	1626	2881
$V\ (T_{e\ cow})$	16,116.61	13,347.12	29,463.73	44,544.69	74,008.42
LCI			967	1271	2424
UCI			1543	1981	3338
$T_{e\ ybull}$	25	34	59	148	207
$V\ (T_{e\ ybull})$	94.07	70.34	164.41	1104.11	1268.52
LCI			37	92	147
UCI			81	204	267
$T_{e\ bull}$	315	189	504	343	847
$V\ (T_{e\ bull})$	6027.13	950.38	6977.51	3125.39	10,102.90
LCI			364	249	678
UCI			644	437	1016

[a] T_e is the observed population estimate expanded by the sightability correction factor.

Table 3 Southern Unit 20D moose population estimation survey results and method comparison, fall 1998 and 1995

	1998		1995
	Spatial Statistics Method	Gasaway Method	Gasaway Method
Population Estimate	3630	4050	2522
LCI @ 0.90	2533	2826	1967
UCI @ 0.90	4727	5275	3076
90% CI	± 30.2%	± 30.2%	± 22.0%
SCF	0	0	1.06–1.17
Bull:100 Cow Ratio	21 (16–25)	21 (16–25)	21
Calf:100 Cow Ratio	37 (32–42)	36 (32–41)	34
Herd Composition			
Number Bulls	479 (305–653)	530 (350–710)	343
Number Cows	2321 (1570–3073)	2580 (1741–3418)	1624
Number Calves	863 (630–1097)	937 (682–1191)	552
High stratum density	n/a	4.3 moose/mi^2	3.3 moose/mi^2
Low stratum density	n/a	0.9 moose/mi^2	0.5 moose/mi^2
Overall density	2.7 moose/mi^2 (1.9–3.5)	3.0 moose/mi^2 (2.1–3.9)	1.9 moose/mi^2 (1.4–2.3)
Total area High density stratum	697 mi^2	697 mi^2	522 mi^2
Total area Low density stratum	1188 mi^2	1188 mi^2	839 mi^2
Total area	1885 mi^2	1885 mi^2	1361 mi^2

Table 4 Unit 20D moose hunting seasons and bag limits, regulatory years 1998–1999 through 1999–2000

Regulatory year	Area	Season		Bag limit
1998–1999	South of Tanana River and west of the Johnson River, except Delta Junction Management Area	Resident:	1–15 Sep	1 bull with spike-fork or 50-inch antlers or 4 or more brow tines on at least 1 side.
		Nonresident:	5–15 Sep	1 bull with 50-inch antlers[a].
	Within Delta Junction Management Area	Resident:	1–15 Sep	1 bull with spike-fork or 50-inch antlers or 4 or more brow tines by drawing permits.
		Nonresident:	5–15 Sep	1 bull with 50-inch antlers[a] by drawing permit.
	South of Tanana River and east of Johnson River	Resident:	1–15 Sep	1 bull.
			1 Jan–15 Feb	1 bull by Tier II permit.
		Nonresident:	No open season	
	Remainder of Unit 20D (north of Tanana River)	Resident:	1–15 Sep	1 bull.
		Nonresident:	1–15 Sep	1 bull.
1999–2000	South of Tanana River and west of Johnson River, except Delta Junction Management Area	Resident:	1–15 Sep	1 bull with spike-fork or 50-inch antlers or 4 or more brow tines on at least 1 side.
		Nonresident:	5–15 Sep	1 bull with 50-inch antlers[a].
	Within Delta Junction Management Area	Resident:	1–15 Sep	1 bull with spike-fork or 50-inch antlers or 4 or more brow tines by drawing permits.
		Nonresident:	5–15 Sep	1 bull with 50-inch antlers[a] by drawing permit.
	South of Tanana River and east of Johnson River	Resident:	1–15 Sep	1 bull.
			1 Jan–15 Feb	1 bull by Tier II permit.
		Nonresident:	No open season	
	Within the Healy River drainage	Resident:	15–28 Aug	1 bull with spike-fork antlers.
			1–15 Sep	1 bull.
			1 Jan–15 Feb	1 bull.
		Nonresident:	1–15 Sep	1 bull.
	Remainder of Unit 20D (north of Tanana River)	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 at least 1 side.

Table 5 Unit 20D moose harvest and accidental death, regulatory years 1986–1987 through 1998–1999

Regulatory year	Harvest by hunters							Accidental death			Total
	Reported				Estimated						
	M	F	Unk	Total	Unreported[a]	Illegal	Total	Road	Train[b]	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	128	0	0	128	23	9	31	16	0	16	176
1990–1991	118	1	0	119	21	4	25	11	0	11	155
1991–1992	143	1	0	144	25	11	36	13	0	13	193
1992–1993	143	0	1	144	25	5	30	32	0	32	206
1993–1994	154	0	1	155	27	14	41	30	0	30	226
1994–1995	128	0	0	128	23	7	30	31	0	31	189
1995–1996	138	0	0	138	24	20	44	25	0	25	207
1996–1997	214	0	0	214	38	22	60	39	0	39	313
1997–1998	210	0	0	210	37	15	52	48	0	48	310
1998–1999	234	0	0	234	41	11	52	31	0	31	317

[a] Based on 17.7% unreported harvest estimated by Gasaway et al. (1992).

[b] Not applicable in Unit 20D.

Table 6 Southwestern, southeastern, northwestern and northeastern Unit 20D reported moose harvest and number of hunters during general seasons, regulatory years 1984–1985 through 1998–1999

Regulatory	Moose harvest						Hunters					
year	SW	SE	NW	NE	Unk	Total	SW	SE	NW	NE	Unk	Total
1984–1985	39[a]	9[b]	40[c]	14[c]	0	102	236[a]	47[b]	294[c]	48[c]	10	635
1985–1986	48[d]	8[b]	60[d]	14[d]	0	130	236[d]	37[b]	272[d]	50[d]	9	604
1986–1987	76[d]	10[b]	40[d]	10[d]	1	137	250[d]	45[b]	232[d]	57[d]	12	596
1987–1988	66[d]	8[b]	43[d]	9[d]	0	126	296[d]	35[b]	208[d]	35[d]	17	591
1988–1989	60[e]	12[b]	39[d]	12[d]	3	126	244[e]	45[b]	201[d]	37[d]	28	555
1989–1990	60[e]	11[b]	41[d]	10[d]	5	127	303[e]	47[b]	191[d]	39[d]	40	620
1990–1991	58[f]	9[c]	40[g]	7[d]	4	118	270[f]	29[c]	195[g]	26[d]	28	548
1991–1992	54[f]	12[c]	66[g]	9[d]	3	144	331[f]	51[c]	231[g]	26[d]	19	658
1992–1993	59[f]	12[c]	58[g]	5[d]	9	143	329[f]	49[c]	257[g]	34[d]	48	717
1993–1994	74[h]	9[c]	58[c]	11[c]	2	154	323	33[c]	257[c]	29[c]	16	690
1994–1995	61[h]	7[c]	49[c]	9[c]	2	128	339	42[c]	267[c]	33[c]	28	709
1995–1996	60[h]	14[c]	50[c]	12[c]	2	138	301	32[c]	237[c]	42[c]	33	645
1996–1997	102[h]	13[c]	72[c]	15[c]	5	210	320	40[c]	267[c]	35[c]	31	693
1997–1998	88[h]	13[c]	72[c]	19[c]	10	202	325[h]	38[c]	241[c]	46[c]	33	683
1998–1999	122[h]	17[c]	64[c]	16[i]	8	227	431[h]	43[c]	231[c]	43[i]	47	795

[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.

[i] Resident season within 1–15 Sep; 1 bull. Within Healy River drainage: resident season 15–18 Aug, 1 bull with spike-fork antlers; 1–15 Sep, 1 bull; 1 Jan–15 Feb, 1 bull; nonresident season, 1–15 Sep; 1 bull. Remainder area is resident and nonresident 1–15 Sep, 1 bull.

Table 7 Unit 20D Delta Junction Management Area moose drawing permit harvest, regulatory years 1996–1997 through 1998–1999

Hunt /Area	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Percent bulls	Percent cows	Unk	Harvest
DM790	1996–1997	5	0	40	60	100	0	0	3
DM790	1997–1998	10	20	0	100	100	0	0	8
DM790	1998–1999	10	0	0	100	100	0	0	10

Table 8 Unit 20D moose Tier II permit harvest, regulatory years 1989–1990 through 1998–1999

Hunt number	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Percent bulls	Percent cows	Unk	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
TM787	1995–1996	15	47	100	0	0	0	0	0
TM787	1996–1997	15	53	86	14	100	0	0	1
TM787	1997–1998	15	73	100	0	0	0	0	0
TM787	1998–1999	15	67	100	0	0	0	0	0

Table 9 Unit 20D Healy River (Uniform Coding Unit 501) reported moose harvest, regulatory years 1993–1994 through 1998–1999

Regulatory	Unit 20D Healy River	
year	Hunters	Harvest
1993–1994[a]	9	2
1994–1995[a]	13	2
1995–1996[a]	24	2
1996–1997[a]	10	2
1997–1998[a]	14	3
1998–1999[b]	19	5

[a] Resident moose hunting season 1–15 Sep, 1 bull.

[b] Resident moose hunting season: 15–28 Aug, 1 spike-fork bull; 1–15 Sep, 1 bull; 1 Jan–15 Feb, 1 bull.

Table 10 Unit 20D moose hunter residency and success[a], regulatory years 1986–1987 through 1998–1999

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	
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
1995–1996	113	16	9	4	142 (21)	447	55	20	13	535 (79)	677
1996–1997	168	30	11	1	210 (29)	460	39	14	2	515 (71)	725
1997–1998	167	24	11	0	202 (29)	421	55	26	2	504 (71)	706
1998–1999	173	37	13	4	227 (29)	468	71	24	5	568 (71)	795

[a] Excludes hunters in permit hunts.

[b] Local means reside in Unit 20D.

Table 11 Southwestern, southeastern, northwestern, and northeastern Unit 20D moose hunter success and mean days hunted[a], regulatory years 1986–1987 through 1998–1999

Regulatory year	Successful hunters					Unsuccessful hunters				
	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
1995–1996	7.2	5.4	5.6	4.5	6.3	6.9	4.9	7.2	7.2	6.9
1996–1997	4.9	4.2	4.9	6.6	5.0	6.5	5.0	6.7	6.9	6.6
1997–1998	5.3	5.3	6.9	5.1	5.9	7.0	5.5	6.7	7.4	6.9
1998–1999	6.9	13.4	7.6	3.8	7.3	8.0	5.3	7.1	9.5	7.7

[a] Excludes permit hunt harvest.

Table 12 Unit 20D moose harvest[a] chronology percent by month/day, regulatory years 1990–1991 through 1998–1999

Regulatory	Harvest chronology percent by month/day				
year	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
1995–1996	41	20	33	6	138
1996–1997	51	23	23	3	208
1997–1998	44	24	30	3	196
1998–1999	44	30	24	2	223

[a] Excludes permit hunt harvest.

Table 13 Unit 20D moose harvest percent[a] by transport method, regulatory years 1987–1988 through 1998–1999

Regulatory year	Method of transportation									
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Airboats	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	<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
1995–1996	6	2	33	18	0	8	28		5	142
1996–1997	4	<1	27	28	0	8	31		2	210
1997–1998	5	1	23	32	0	5	31	<1	2	202
1998–1999	7	1	26	26	0	4	34	0	2	227

[a] Excludes permit hunt harvest.

LOCATION

GAME MANAGEMENT UNIT: 20E (10,680 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 during 1965 through 1976, reaching an estimated low of 2200 moose. During 1976–1997, the moose population in Unit 20E remained at low densities (0.2–0.6 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 limiting factor and other variables had little to no impact.

During the early 1980s, in response to declining moose and caribou populations, the Alaska Department of Fish and Game initiated 2 predator management programs. Between 1981 and 1983, the wolf population was reduced by 54% in a 3800-mi^2 area of Unit 20E using a combination of aerial gunning and public trapping. In addition grizzly bear hunting regulations were liberalized in 1981, causing moderate harvest increases in portions of the subunit, probable local declines in grizzly bear numbers, and changes in the bear population age and sex structure (Gardner 1999).

Between 1981 and 1990 the moose population increased by about 4–9% per year. The increase was probably due to combined effects of favorable climatic conditions, reduced predation, and an increased number of alternate prey, i.e., Fortymile caribou. During this period the moose population did not increase beyond the ability of wolves and bears to maintain the population at low densities, and between 1990 and 1997 it remained at 0.5–0.6 moose/mi^2.

Prior to 1992, moose in Unit 20E were primarily hunted by local residents as well as residents from Fairbanks and Southeast Alaska. Historically, harvest was low in relation to the moose population and was largely restricted to the Taylor Highway corridor and the Mosquito Fork drainage. Since 1992, more hunters from Southcentral Alaska have traveled to Unit 20E to hunt moose in response to more restrictive moose hunting regulations in the southcentral units and for the opportunity to hunt both moose and caribou simultaneously.

During the 1960s, high moose densities supported a long hunting season and a bag limit of 1 moose. As moose numbers began to decline, harvests were first reduced by shortening the season length in 1973 and then by eliminating cow seasons in 1974. However, the population continued to decline throughout Unit 20, 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. The season was lengthened to 15 days in 1991. Between 1982 and 1996, 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.

- Continue sustained opportunities for subsistence use of moose.

- Maximize sustained opportunities to participate in hunting moose.

- Maximize opportunities for the nonconsumptive use of moose.

MANAGEMENT OBJECTIVES

- Maintain a posthunting ratio of at least 40 bulls:100 cows in all survey areas.

METHODS

POPULATION STATUS

We conducted various moose population estimation surveys (Gasaway et al. 1986; Mark McNay, ADF&G, personal communication; Jay Ver Hoef, ADF&G, personal communication) in southwestern Unit 20E (Mosquito Flats study area) in 1981, 1988, 1992, and 1995 and in southeastern Unit 20E (Ladue River study area) in 1992, 1996, and 1998. I expanded the Ladue River study area in 1998 to include the most popular hunting areas along the Taylor and Alaska Highways. To reduce confusion I named the larger area Tok East. Yukon Department of Renewable Resources staff used the same spatial sampling technique (Jay Ver Hoef, ADF&G, personal communication) in a 900-mi^2 area adjacent to our study area during 1999. This allowed us to expand the moose population size and composition estimates to include more of the White and Ladue River drainages in the Yukon.

I calculated population growth rates by comparing the 1992 and 1995 Mosquito Flats superstratification and mini-census results with identical portions of the 1981 and 1988 stratified random sampling survey area and by comparing results from the 1992 Ladue River superstratification survey to the 1996 prestratification population estimation survey. I also compared population density and trend between the Mosquito Flats and Ladue River study areas. The 2 study areas differ in habitat quality, grizzly bear population densities and composition, and hunter use.

To monitor the effects of an ongoing nonlethal wolf control program (1997–2001), I conducted moose population estimation surveys using the spatial distribution method (Jay Ver Hoef, ADF&G, personal communication) within the southern portion of the Fortymile Caribou Wolf Treatment Area (Boertje and Gardner 1999) in 1998 and 1999. This area (Tok West) includes the western portion of the Mosquito Flats study area and northeastern Unit 20D (upper Goodpaster River drainages) and will be surveyed annually until 2005 to determine moose population and composition trends.

During 1997 and 1999, moose population trend and composition was monitored in northern Unit 20E within the Yukon-Charley National Preserve by the National Park Service (NPS) (John Burch, personal communication).

COMPOSITION SURVEYS

Sex and age composition was estimated in 2–10 traditional count areas during October and November 1993, 1994, 1996, and 1999, using aerial composition surveys, and in 1995, 1996, 1998, and 1999 while conducting population estimation surveys in the Mosquito Flats and Ladue River. All moose observed were classified as large bulls (antlers >50"), medium bulls (antlers larger than yearlings but <50"), yearling bulls (spike, cerviform, or small palmate antlers without brow separation), cows without calves, cows with 1 calf, cows with 2 calves, lone calves, or unidentified moose.

HARVEST

Harvest was estimated using harvest report cards with the benefit of reminder letters. Information obtained from the reports was used to determine total harvest, harvest location, hunter residency and success, harvest chronology, and transportation used. Harvest data were summarized by regulatory year, which begins 1 July and ends 30 June (e.g., RY99 = 1 Jul 1999–30 Jun 2000).

HABITAT ENHANCEMENT

Three prescribe burns were ignited in Unit 20E using aerial firing from a Ping-Pong sphere dispenser. Firing activities were conducted following a strict burn prescription developed specifically for each of the 3 areas and based on the Fire Weather Index and Fire Behavior Prediction modules of the Canadian Forest Fire Danger Rating System (Stocks et al. 1989).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

During 1981–1995, 4 population estimation surveys were conducted in a 964–2978 mi^2 (2500–7700 km^2) area in southwestern Unit 20E (Gardner 1998). The annual rate of increase during 1981–1987 was 1.08, and during 1988–1995 it was 1.01 indicating the moose population in southwestern Unit 20E increased through the 1980s until 1988 and remained relatively stable during 1989–1995.

In 1992 we conducted the first population estimation survey in a 735-mi^2 area in southeastern Unit 20E. The 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 southwestern portion of the subunit. We conducted a population estimate survey in southeastern Unit 20E again in 1996 (944 ± 26%, 90% CI), but results are not directly comparable because during 1992 we did not estimate a sightability correction factor. Based on estimates generated from observed moose, moose numbers in this area increased by 12.9% during 1992–1996, an annual rate of increase of 1.03.

A combination of nonlethal wolf control (fertility control and relocation) and public trapping was implemented in western Unit 20E, northeastern Unit 20D, eastern Unit 20B and southeastern Unit 25C in winter 1997–1998. As of December 1999, wolf numbers had been reduced by 78% within 14 wolf pack territories. Prior to wolf reduction efforts, moose population estimates (0.2–0.5 moose/mi^2) were obtained from portions of this area (Gardner 1998). Brown and black bear harvest records indicate harvest was below sustainable levels in most of the wolf control area. The 1998 and 1999 Tok West (the southern portion of the wolf control area) moose population estimates were 1094 ± 22% (90% CI) and 824 ±19% (90% CI), respectively. Mean densities were 0.55/mi^2 and 0.43/mi^2. The confidence limits of the 2 population estimates overlap. Computer modeling of this population also indicates a population decline between fall 1998 and fall 1999.

The 1998 Tok East (Alaska only) moose population and density estimates were 1444 ± 22% (90% CI) and 0.52 moose/mi^2. Including the Yukon data, the 1999 density estimate within the White and Ladue River drainages and along the Alaska Highway in both Alaska and Yukon was 0.48 mi^2. These data indicate little difference between moose densities across the border and that little change in moose numbers occurred between 1998 and 1999.

The NPS conducted population estimation surveys in northern Unit 20E within the Yukon-Charley Rivers National Preserve west of Washington Creek and south of the Yukon River in 1994, and 1997. They found about 0.30 moose/mi^2 during both years (Bruce Dale, ADF&G, personal communication). The NPS surveyed both north and south of the Yukon River in 1999 and the estimate for the entire area was 0.37 moose/mi^2.

No formal surveys were conducted in the northeastern portion of Unit 20E (approximately 15% of the unit). I estimated moose population size (0.3 moose/mi^2) in that area by using a combination of data including the amount of suitable moose habitat, harvest, and the number of moose concentration areas in comparison to the areas in the subunit that were sampled.

Combining population estimation and trend count data, the 1999 population estimate for Unit 20E was 4600–5500 moose (0.48–0.58 moose/mi^2 of moose habitat). The 1997 estimate was 5700–6000 moose. The difference between the estimates could be due to either sampling error or a moose population decline. McNay and DeLong's (1998) PredPrey model indicated the population declined by 4% annually over the past 2 years.

The Alaska Board of Game has identified the moose population within the Fortymile and Ladue River drainages as important for high levels of human consumptive use under the Intensive Management Law (AS 16.05.255(e)–(g). This designation means that the board must consider intensive management if regulatory action to significantly reduce harvest becomes necessary because the population is depleted or has reduced productivity. The board will decide the population and harvest objectives for Unit 20E moose within the Fortymile and Ladue River drainages in March 2000. It appears based on proposals submitted by the Department and by the public, the moose population and harvest objectives will be higher than current levels. Based on modeling data and on current human use of the Unit 20E moose population, current harvest restrictions are necessary to protect the bull population especially in the more accessible areas of the subunit. To accomplish sustained increased harvest, intensive management will be required.

Gasaway et al. (1992) reported that the Unit 20E moose population was being maintained at a low density dynamic equilibrium (0.2–1.0 moose/mi^2) by wolf and grizzly bear predation and that habitat, harvest, and disease were not limiting population growth. They determined predator management was necessary to increase the moose population and maintain it at a higher abundance level. There has been much public and scientific debate over whether wolf control combined with public grizzly bear harvest would cause a moose population increase in Unit 20E. Gasaway et al. (1992) recommended altering wolf and bear predation simultaneously. Reducing predation of only 1 species may result in compensatory predation by another species. Opponents of wolf control argue that reducing wolves will not benefit the moose population because grizzly bears are the primary predator. They based their conclusions on results of the wolf control program conducted in Unit 20E during 1981–1983. Unfortunately, this program was terminated prematurely due to political decisions and, therefore, results are nebulous and difficult to interpret.

To predict the outcome of different methods of intensive management on moose numbers in the Fortymile/Ladue drainages, I modeled current population status and trend data for moose and their predators using the McNay and DeLong (1998) Predprey model. The model predicts that the Fortymile/Ladue moose population continues to be primarily limited by grizzly bear predation on calves. Gasaway et al. (1992) estimated that between 1981 and 1988, 65% of calf mortality was due to grizzly bears. In order for the model to track current population status, grizzly bears had to cause 60% of the calf mortality during 1997–1999.

Assuming grizzly bear predation rates remain relatively constant during the next 5 years, the model predicts that the effect of nonlethal wolf control will be minimal on population trend (annual growth rates = 0.97–1.00). Calf:cow ratios will range in the low to mid-20s:100 cows and the bull:cow ratio will decline due to harvest. Increasing the intensity of wolf control to include 80% removal throughout the area including the removal of entire packs would allow the population to increase 2–3% annually. The small increase in the calf:cow ratio (25–28 calves:100) would still not be adequate to maintain the bull:cow ratio under current harvest rates.

The 2 factors that appear to limit the effects of wolf control on moose are high predation rates on calves by grizzly bears and wolf preferences for caribou as their primary prey item. The effect of wolf control would be greater if wolves consumed primarily moose. There is a also the possibility that the model is not an accurate predictor in this situation. It may not be able to accurately predict the effects of reducing the current moderate wolf predation rates that are occurring throughout the year on all moose sex and age classes in relation to continued high grizzly bear predation on calves.

In contrast, moose numbers would increase 8–10% annually if the number of grizzly bears or their predation efficiency were significantly reduced. This would cause the mortality rate on calves to decline from 60% to 45%. This was the objective for liberalizing the Unit 20E grizzly bear regulations in 1981, i.e., to try to reduce the grizzly bear population through harvest. Harvest did increase in portions of the unit. Sex and age composition data collected from harvested bears indicate that in the area where the greatest harvest occurred, the bear population declined (Gardner 1999, see Nonregulatory section). Apparently, reducing the bear population reduced adult moose mortality but it did not appear to substantially reduce calf mortality. Both population and modeling data indicate the same number of moose calves were being killed by grizzly bears before the bear reduction as after. This low recruitment of calves resulted in a slowly increasing or stable population. Also, because few bulls were being recruited annually, harvest was sufficient to cause a decline in the bull:cow ratio. If the intensive management law is implemented in Unit 20E, bear predation rates on calves must be reduced. It does not appear elevated grizzly bear harvest, under the current harvest regulations and access, is a proven method for increasing moose calf survival.

To reduce the effects of grizzly bear predation on calves, either the number of bears would have to be reduced to a level at which compensatory bear predation is no longer a factor, or bear efficiency as a predator on calves would have to be reduced. Based on personal observations during moose calf mortality studies where grizzly bears were translocated, fewer bears can kill more calves per bear. Therefore, overall predation rates may not decline with fewer bears. Boertje et al. (1988) reported that there were no differences in calf moose kill rates between sex and age classes of grizzly bears. These data indicate restricting harvest to males and females not accompanied by cubs may not reduce the bear population sufficiently to override the predation efficiency and compensatory abilities of the remaining bears. To reduce bear predation efficiency other methods would be necessary. Two possibilities for Unit 20E are supplementary feeding bears or creating a situation where bears are not as efficient as a predator. Bear predation efficiency declined in early successional habitats following wildfires (Schwartz and Franzmann 1989). Combining liberal grizzly bear harvests with habitat enhancement programs may increase moose calf survival.

Population Composition

During 1999 we collected composition data using standard aerial contour surveys in 2 areas in eastern Unit 20E and spatial distribution sampling in western Unit 20E/eastern Unit 20D and in eastern Unit 20E/adjacent western Yukon, Canada (Table 1). During the report period, calf recruitment was poor ranging between 17–26 calves:100 cows. Composition data collected during the population estimation surveys indicate cows with calves selected for areas away from the large concentrations of moose. In 1999 the calf:cow ratio was 42 calves:100 cows in the low strata compared to 12 calves:100 cows in the high strata. Calf:cow ratios may be underestimated if based entirely on aerial contour surveys that do not include areas with few moose.

The Unit 20E bull:cow ratio remains above the management objective. Access into Unit 20E is beginning to increase as new trails are being pioneered. Overall, most of the subunit is still difficult to access and harvest is generally concentrated along a few trails and landing areas. In more popular hunting areas (Nine-Mile Trail, Mitchell's Ranch, and along the Taylor Highway) bull populations declined, but still met or exceeded the management objective of

40:100 in all areas except possibly the Nine Mile Trail area. The bull population in the Nine Mile area has increased from 27 bulls to 39 bulls:100 cows, probably because of access regulations enacted in 1993.

Modeling data indicates that if calf recruitment remains below 30 calves:100, the bull:cow ratio will decline with current harvest levels. Hunter participation, harvest, and access have all increased since 1992 in Unit 20E. I expect the bull population to decrease and the bull:cow ratio to decline below 50 bulls:100 cows within 5 years.

In Unit 20E the average calf:cow ratios increased from 12.7:100 during 1973–1981 to 19.3:100 during 1982–1988, and 28.7:100 during 1989–1993. Average calf ratios declined between 1994 and 1999 to 21:100. During 1982–1989, grizzly bear harvests were high and possibly caused a 10–16% reduction in the bear population in the central portion of Unit 20E. The increase in calf survival was attributed to several factors, including a possible decline in the grizzly bear population in the central part of the subunit (Boertje et al. 1995). In contrast, the grizzly bear population in the eastern portion of the subunit was lightly harvested and probably remained stable. If reducing bear numbers by harvest reduced bear predation on calves, there may have been a difference in calf recruitment between the areas that received high versus low bear harvests. I analyzed this data for 1981–1997 (Gardner 1999) and found no significant difference between the 2 areas. However, the area of low bear harvests was extensively burned and had a much higher moose density, possibly because of decreased efficiency of predators (Boertje et al. 1995).

Distribution and Movements

Moose are distributed throughout Unit 20E below elevations of 4500 feet. Most radiocollared moose 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, 1992, and 1999 early deep snowfall (>22 inches) caused moose to move to lower elevations earlier than in previous years. During 1995 and 1998, low snowfall allowed moose to remain at higher elevations until at least January.

MORTALITY

Harvest

Season and Bag Limit.

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 20E, in the Ladue River Controlled Use Area. 1 bull per regulatory year, only as follows:		
1 bull with spike-fork antlers.	15 Aug–28 Aug	

Units and Bag Limits	Resident Open Season	Nonresident Open Season
1 bull.	1 Sep–15 Sep	
1 bull by drawing permit only.	1 Nov–30 Nov	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.		5 Sep–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.	15 Aug–28 Aug	
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.		5 Sep–25 Sep
Remainder of Unit 20E RESIDENT HUNTERS: 1 bull with spike-fork antlers.	15 Aug–28 Aug	
1 bull.	1 Sep–15 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.		5 Sep–15 Sep

Board of Game Actions and Emergency Orders. During the spring 1998 meeting, the Board of Game extended the August spike-fork season to 15–28 August. Also during spring 1998, the board designated the Unit 20E moose population within the Fortymile and Ladue River drainages as important for high levels of human consumptive use under the Intensive Management Law. This designation means that the board must consider intensive management if regulatory action to significantly reduce harvest becomes necessary because the population is depleted or has reduced productivity. The board will decide the population and harvest objectives within the Fortymile and Ladue River drainages in March 2000. The board will also discuss management possibilities in relation to increasing hunter participation and harvest due to regulatory changes in Southcentral Alaska game management units and in relation to the threat of an excessive incidental harvest once the Fortymile caribou hunt is substantially liberalized in 2001.

Hunter Harvest. During RY97 and RY98 the reported harvest in Unit 20E was 144 bulls and 1 cow and 145 bulls and 5 unclassified sex, respectively (Table 2) or 2.7–3.3% of the 1999 estimated population. The average reported harvest for the last 5 years was 129 (94–150), a 74% increase from the previous 5 years (RY89–RY93). Higher harvests and participation rates began in RY91. Greater participation and harvest by nonlocal residents explains most of the increase. Probable causes for the higher harvest were: 1) hunters were displaced by stricter regulations throughout Southcentral Alaska, especially in nearby Unit 13; 2) the Fortymile caribou season was open concurrently with the moose season, which attracted hunters interested in hunting both species simultaneously; 3) maintaining a 1 bull bag limit with relatively liberal season dates gave hunters a false impression about the number of moose in the area; and 4) more hunters came to the area looking for large antlered bulls. The preliminary reported harvest during RY99 was 123 bulls.

The Board of Game created 2 winter drawing permit hunts (DM794 and DM796) within the Ladue River Controlled use area in spring 1994. The harvest objective was to allow greater hunting opportunity in an area that supported a high number of bulls (bull:cow ratio > 60:100) but was rarely hunted due to difficult access during the fall. The hunts were to be managed so that winter harvest would not affect the bull populations in areas commonly hunted during the fall.

During RY95–RY99, 10 winter permits were offered annually for DM794. Due to the low number of permits and difficult access, harvest was only 0–4 bulls annually. This additional harvest did not significantly affect moose numbers in the DM794 area.

During RY95–RY98, 50 winter permits were offered annually for DM796. Access into the central portion of this area is difficult but the southern and northern portions are readily accessible by several snowmachine trails. These trails are used extensively by moose hunters during fall. During the first 2 seasons (RY95 and RY96) only 4 bulls were taken each year. There was no impact on bull numbers. During RY97 and RY98, 14 (35 hunters) and 10 (20 hunters) bulls were taken and harvest was concentrated along the 2 trails that access the northern and southern portions of the area and are used extensively by hunters during the fall hunt. This level of harvest reduced the number of large bulls present in the areas hunted during fall.

During RY99 we attempted to reduce the winter harvest of moose along these trails by reducing the number of DM796 permits to 35 and by requesting that all DM796 permit recipients consider hunting more remote areas. The harvest was 8 bulls and half were taken in more remote areas. During RY00 and RY01, the number of DM796 permits will be reduced to 25 and the area open for hunting will be further refined to separate the winter harvest from the areas hunted during fall.

During spring 1994, the board extended the Unit 20E moose season to include an early August season for spike-fork bulls. During RY95–RY98, the season dates were 20–28 August. Only 0–1 spike-fork bulls were harvested annually. The board extended the season to 15–28 August for RY99 but harvest remained at 0 spike-fork bulls.

Of the 145 and 150 moose harvested during the general season in RY97 and RY98, 35 and 43 (24% and 29% of the harvest) were taken in the Mosquito Fork and 27 and 31 (19% and 21% of the harvest) were taken in the Dennison drainages. In northern Unit 20E, 28 and 36 moose 19% and 24% of the harvest) were taken along the Yukon, Charley, and Seventymile Rivers. The combined take in these 5 drainages was 62% and 74% of the annual harvest. Traditionally, 60–70% of the annual harvest comes from these 5 drainages. The remainder of the harvest during both years was spread out across the subunit.

During RY97 and RY98 the mean antler spreads of bulls taken in Unit 20E were 47.4 and 46.3 inches, respectively. The 5-year mean was 46.5 inches. In the RY98 harvest 15 bulls (9.9%) were yearlings (antlers <30 inches), 66 (43.7%) were 2–4 years old (antler spread 30.0–49.9 inches), and 70 (46.4%) were mature bulls (antler spread >50 inches). Of the mature bulls, 26 (37.1%) had antler spreads >60 inches. Antler spreads were estimated for 214 and 296 bulls observed during posthunting aerial composition surveys in fall 1998 and 1999, respectively. Age composition was 23% and 25% yearlings, 37% and 39% 2- to 4-year-olds, and 38% mature bulls. Based on RY98 harvest results, hunters either selected against yearlings or yearlings were less vulnerable to harvest than large or medium bulls. Because moose density was low in Unit 20E and most hunters were state residents primarily looking for meat, I doubt many hunters were selective.

Antler data also indicates that a 50-inch regulation in Unit 20E would not stop a declining bull:cow ratio. Much of the bull population is comprised of mature bulls that would be vulnerable to harvest. Calf recruitment has been poor since the 1970s resulting in few bulls growing into the 50-inch class each year.

The greatest potential moose harvest management problem in Unit 20E is excessive incidental take of moose by caribou hunters. Beginning in 2001, the Fortymile caribou hunt will be liberalized and thousands of caribou hunters are expected to participate compared to hundreds during the past 4 years. The incidental take of moose is expected to increase especially along the Taylor Highway, along trails and around several well know landing strips. The subunit's moose population will not be able to sustain this sudden increase in harvest. During spring 2000, the board will be deciding on how to handle this problem. The department's and local advisory committee's recommendation is to manage both the caribou and moose hunt under a registration permit that requires the hunter to choose either to hunt caribou or moose.

Hunter Residency and Success. Of the 145 and 150 bulls harvested during the general season in RY97 and RY98, 59% and 61% were taken by nonlocal Alaskan residents. Historically, most nonlocal hunters were from Interior and Southeast Alaska, but since RY92 most of the nonlocal hunters were from Southcentral Alaska. During the RY97 and RY98 general season hunts, hunters from Southcentral Alaska represented 30% and 38% of the hunters and took 31% and 33% of the harvest each year. The remaining nonlocal harvest was primarily split between hunters from Southeast Alaska (12% and 14%) and Interior Alaska (13% and 17%). Nonresident hunters were prohibited from hunting moose in Unit 20E during RY83–RY90. During RY91–RY96, nonresidents represented 6% of the hunters and accounted for an average of 7% of the harvest. During RY97 and RY98, nonresidents represented 10% and 11% of the hunters and took 8% and 12% of the harvest.

During the report period, 472 and 477 hunters reported hunting moose in Unit 20E during the general season (Table 3). The 5-year average was 459. Since RY90, an average of 431 hunters hunted moose annually in Unit 20E compared to the RY83–RY89 average of 258 (range = 151–350). Most of the increase was in nonlocal hunters, primarily from Southcentral Alaska. Numerically, more southcentral hunters were affected by the more restrictive moose regulations in Southcentral Alaska compared to the number of interior or Southeast hunters who quit hunting there due to regulatory changes.

Hunter success was 30% and 32% during RY97 and RY98, respectively. The 5-year average was 28%. During the report period, success rates of local residents were 27% and 38% compared with a 31% success rate for nonlocals. Both local and nonlocal resident success rates averaged 27% over the past 5 years.

Harvest Chronology. During RY90–RY94, 27–50% (x = 40%) of the harvest occurred during the first week of the season (Table 4). However, since RY95, 52–63% (x = 55%) of the harvest occurred the second week and on 14 and 15 September. I do not know why harvest timing has changed. Possibly more of the Southcentral hunters who began hunting the area in 1991 have learned that harvest success is greater later in the season. Since RY91, harvest during 16–25 September in the northern portion of Unit 20E has remained at 10–20 bulls annually.

The Board of Game will act on a proposal during the March 2000 meeting to split the moose season in most of Unit 20E to 24–28 August and 8–17 September. The justifications for the proposal are to offer an August season allowing more families to hunt together before the school year begins and to maintain harvest between 115–125 bulls annually. The 2 openings balance periods that historically have lower participation rates but differing success rates. The early season is expected to have a lower success rate compared to the 1–7 September portion of the current season and the later season is expected to have a higher success rate. During the past 5 years, 45% of the reported harvest that occurred during 1–15 September occurred during 1–7 September. If the purpose of the present split season is to maintain the same level of harvest, the combined take in the expected lower harvest in the early portion of the season and the expected higher harvest in the later season can still not exceed the total harvest limit of 115–125 bull moose.

Transport Methods. During the report period, of the 143 and 149 hunters reporting the type of transportation used to access Unit 20E, 32–34% used highway vehicles, 26% 4-wheelers, 13–17% airplanes, 14% boats, and 7% other ORVs. There has been little change in the percent transportation use since RY95. During RY97–RY98, hunters using highway vehicles had the lowest success rate (22–27%), while hunters using airplanes (41–48%) and ORVs (36–45%) had the highest success rates. Hunters using 4-wheelers had success rates of 32–37%. The success rates in Unit 20E during these 2 years were 30% and 32%.

The number of hunters using 4-wheelers increased in RY94 and has remained between 120–125 annually. Between RY92 and RY93 an average of 82 hunters used a 4-wheeler. Hunters who used highway vehicles to access the area during the early 1990s have obtained or have been replaced by hunters using 4-wheelers. The number of hunters using the other transportation types have remained constant. Hunters using 4-wheelers or highway vehicles were responsible for the greatest harvest (Table 5).

The increasing number of hunters who use 3- or 4-wheelers has become a concern in certain areas of Unit 20E. This group of hunters tend to have a greater effect on local populations of moose because they tend to concentrate their efforts more than other hunters.

Other Mortality

Predation by wolves and grizzly bears is the greatest source of mortality for moose in Unit 20E and is presently maintaining the population at a low density (0.48–0.58 moose/mi^2). Using the model presented by McNay and DeLong (1998), I estimated about 27% of the postcalving moose population is being killed by wolves and grizzly bears each year and about 1% is being harvested by humans.

HABITAT

Assessment

Presently in Unit 20E, availability of browse is not limiting moose population growth. Recent browse studies found that most preferred browse plants were not being utilized. Use of current year's growth was less than 5% (Boertje et al. 1985). Habitat quality is greatest within the southeastern portion of the subunit due to 2 large wildfires (>1,000,000 acres) that occurred during the mid-1960s. This area supports the greatest moose densities in the subunit (about 1.1 moose/mi^2). There are areas within the central and northeastern portions of the unit where the habitat has degraded to poor moose habitat due to wildfire suppression activities.

Enhancement

The Alaska Interagency Fire Management Plan restored a near-natural wildfire regime to over 60% of Unit 20E. Under the plan, most state and federal land was accorded limited fire protection. This agreement allowed nearly 300,000 acres to burn naturally during 1998 and 1999. Nearly all land selected by or conveyed to Native corporations was accorded modified or full-suppression status. However, Native corporations in Units 20E and in adjacent Unit 12 have recently consented to allow fire on their land, except in areas where there is marketable timber. More acceptance of fire as a management tool has occurred throughout local communities because of the well known increase in moose numbers near Tetlin and Tok as a result of the 1990 Tok Wildfire. This change in attitude allowed us to prescribe burn 90,000 acres during 1998 and 1999 in central Unit 20E. These fires were completed within prescription. Costs of the prescribe burns were 35 cents/acre for the 52,000-acre East Fork Burn, 46 cents/acre for the 7000-acre Mosquito Flats burn, and 38 cents/acre for the 31,000-acre Ketchumstuk burn. Moose densities in these areas are expected to increase within 5–15 years.

CONCLUSIONS AND RECOMMENDATIONS

During 1981–1987, the moose population in Unit 20E increased 5–9% annually reaching a density of 0.33–0.49 moose/mi^2. During 1988–1999, the population growth rate slowed and was estimated at 0.48–0.58 moose/mi^2 in fall 1999. Research has shown that predation by wolves and grizzly bears was the primary factor limiting the subunit's moose population. Grizzly bear predation on calves needs to be reduced if the moose population is to substantially grow. Combined wolf and bear predation is taking about 27% 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 possibly caused bear numbers to decline and altered the male age structure toward younger bears. Moose calf survival increased during 1982–1989. However, it does not appear that the increase in bear harvest in portions of Unit 20E was the primary cause of the increase in moose calf survival. Modeling indicated that the reduced bear population may have reduced adult moose mortality but was inadequate to cause a reduction in calf moose mortality. We do not know how low a grizzly bear population must be reduced before the predation rate on moose calves will decline substantially. However, modeling predicts the moose population in Unit 20E could grow 8–10% annually and escape the low density dynamic equilibrium within 5 years if grizzly bear predation rates on calves were reduced 25% in combination with the ongoing nonlethal wolf control program. Assuming we could reduce the grizzly bear kill by 25%, grizzly bears would still be the primary predator on calves and would be responsible for 45% of the calf mortality.

Human-induced mortality had little impact on the subunit's moose population. Annual harvest rates were historically less than 2% of the fall population estimate but increased above 2% in RY95 and were about 3% during RY97 and RY98. The bull:cow ratio declined in portions of Unit 20E due to moderate harvest rates in more accessible areas.

The number of moose hunters in Unit 20E increased since RY91. Most of the additional hunters were from Southcentral Alaska. The preferred transportation type became 4-wheelers. Twenty-six percent of the hunters used 4-wheelers to gain access and they took 40–46% of the harvest. Harvest pressure was high enough in most of Unit 20E to cause a decline in the bull:cow ratio. Additional hunting pressure is expected in 2001 when the Fortymile caribou hunt will be liberalized, attracting hunters who desire the opportunity for a moose/caribou combination hunt. Hunter numbers could also increase if moose hunting regulations are further restricted in Unit 13. The board will decide the best management course during the spring 2000 meeting.

An early season spike-fork hunt was authorized by the board in 1994 and began during 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 about 1.5% of the harvest. This hunt was primarily by local residents. Little success has occurred since the hunts inception. Only 1 spike-fork has been taken during the early season.

To maintain harvest and prevent a strong decline in the bull:cow ratio, we will be asking the board for a split season in most of Unit 20E. An August season is scheduled when few moose hunters are historically in the field and harvest success is lower. To reduce confusion and the possibility of illegal take, the spike-fork season will be eliminated. Based on the amount of harvest that occurred during the early spike-fork season, this change will have little impact on hunters.

The board also authorized a winter permit hunt in eastern Unit 20E that began in November 1995. Harvest was low the first 2 years due to severe weather conditions and lack of knowledge of the area by most hunters. More nonlocal hunters became aware of the quality of the hunt and the chance of seeing large trophy bulls. Subsequently, more people applied for the hunt and the participation and harvest rates increased substantially in RY97 and RY98 resulting in an overharvest along 2 of the more popular trails. The intent of allowing hunters to hunt moose in areas inaccessible in fall was not met in RY97 and RY98. In RY99 the number of permits were reduced in the more popular area and harvest declined. Additional reductions in permit numbers and hunt area will occur in RY00 to reduce the competition between the winter and fall hunts and to better meet the winter permit hunt's harvest objectives.

More community acceptance of fire has occurred during the past 5 years in Unit 20E. During 1998 and 1999, 3 prescribe burns covering about 90,000 acres were completed in areas that traditionally supported high moose densities. In addition, over 300,000 acres were allowed to burn by wildfire in 1999. Under the current Division of Forestry and Bureau of Land Management leadership, the interagency fire management plan has a great chance to succeed in benefiting wildlife and people.

The Unit 20E moose goals and objectives were met during this report period. Population trends were monitored and necessary changes to hunt structure were proposed. Habitat enhancement programs were implemented to benefit local moose populations. Hunting seasons and bag limits were established that allowed maximum hunting opportunity and met subsistence needs. Moose watching opportunities were shared with visitors and local residents and several oral presentations were given annually to local schools and tourist groups.

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Table 1 Unit 20E aerial moose composition counts, fall 1988–1999

Year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1988[a]	78	13	22	117	11	931	1048[a]	30
1989[b]	56	11	43	43	21	158	201	22
1990[b]	64	9	30	105	16	566	671	30
1991[b]	65	14	28	120	14	714	834	42
1992[c]	59	11	17	19	12	141	160	
1992[d]	75	15	28	32	14	200	232	
1993[b]	63	10	28	126	15	727	854	40
1994[c]	74	16	23	65	12	488	553	48
1995[e]	70	16	15	29	8	329	358	
1996[f]	61	10	19	44	10	377	421	
1996[b]	56	6	27	47	15	270	317	45
1997[b]	61	14	26	70	14	438	508	49
1998[g]	64 (53)[i]	18 (10)[i]	19 (23)[i]	36	13	242	278	
1998[h]	59 (51)[i]	14	23 (26)[i]	67	15	383	450	
1999[g]	80 (74)[i]	16 (17)[i]	22 (14)[i]	27	7	338	365	
1999[b]	54	13	17	38	10	340	378	60

[a] Mosquito Flats Study Area sampled using stratified random sampling (Gasaway et al. 1986).
[b] Various trend count areas sampled using contour sampling.
[c] Mosquito Flats Study Area sampled using superstratification sampling.
[d] Ladue River Study Area sampled using superstratification sampling (Mark McNay, ADF&G, personal communication).
[e] Mosquito Flats Study Area sampled using prestratification sampling (Jay Ver Hoef and Rod Boertje, ADF&G, personal communication).
[f] Ladue River Study Area sampled using prestratification sampling (Jay Ver Hoef and Rod Boertje, ADF&G, personal communication).
[g] Fortymile Nonlethal Wolf Control Study Area sampled using spatial sampling (Jay Ver Hoef, ADF&G, personal communication).
[h] Ladue River Study Area sampled using spatial sampling (Jay Ver Hoef, ADF&G, personal communication).
[i] Number in parenthesis is the observed ratio.

Table 2 Unit 20E moose harvest and accidental death, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest by hunters							Drawing permit hunts		Accidental death		Total
	Reported				Estimated							
	M (%)	F (%)	Unk	Total	Unreported	Illegal	Total	DM794	DM796	Road	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 (100)	0 (0)	1	129	0–5	5–15	5–20			0	0	134–149
1994–1995	93 (100)	0 (0)	1	94	0–5	5–15	5–20			0	0	99–114
1995–1996	139 (99)	0 (0)	1	140	0–5	5–10	5–15	0	4	0	0	149–159
1996–1997	116 (99)	0 (0)	1	117	0–5	5–10	5–15	2	4	0	0	128–138
1997–1998	144 (99)	1 (1)	0	145	0–5	5–10	5–15	4	14	0	0	168–178
1998–1999	145 (96)	0 (0)	5	150	0–5	5–10	5–15	1	10	0	0	166–176

Table 3 Unit 20E moose hunter residency and success during the general season, regulatory years 1990–1991 through 1998–1999

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
1995–1996	36	93	9	140 (31)	72	208	34	318 (69)	458
1996–1997	40	70	7	117 (29)	97	165	24	286 (71)	403
1997–1998	42	85	18	145 (30)	112	189	31	332 (70)	477
1998–1999	47	91	12	150 (32)	76	205	39	322 (68)	472

[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 month/day during the general hunt, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest chronology by month/day						Total[a]
	8/15–8/27	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
1995–1996	0	46	58	27	3	0	140
1996–1997	1	33	49	23	6	0	118
1997–1998	1	48	50	36	6	0	144
1998–1999	0	35	78	23	6	2	150

[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 during the general season, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest percent by transport method								
	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
1995–1996	29 (21)	0 (0)	19 (14)	39 (28)	1 (1)	16 (11)	34 (24)	2 (1)	140
1996–1997	26 (22)	3 (3)	18 (15)	26 (22)	0 (0)	13 (11)	30 (26)	1 (1)	117
1997–1998	29 (20)	3 (2)	13 (9)	46 (32)	0 (0)	15 (10)	36 (25)	3 (2)	145
1998–1999	32 (21)	0 (0)	23 (15)	40 (27)	1 (1)	12 (8)	41 (27)	1 (1)	150

LOCATION

GAME MANAGEMENT UNIT: 21B (4871 mi^2)

GEOGRAPHIC DESCRIPTION: Lower Nowitna River, Yukon River between Melozitna and Tozitna Rivers

BACKGROUND

In this portion of Interior Alaska, even the earliest human accounts of the area discussed a presence of moose. Moose had apparently become 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 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 were a major force affecting the productivity and diversity of moose habitat in this area. Large fires burned a major portion of the area before the 1950s when effective fire suppression substantially altered this fire regime. 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 to the east of Ruby is a popular 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 was the focus of much of the management effort in Unit 21B over the years.

Aerial moose surveys during 1977–1979 indicated moose numbers were declining in the Nowitna. Wolves were abundant compared to the number of moose available, and predation by wolves was believed responsible for the decline in moose numbers.

A moose population estimation survey in 1980, using methods described by Gasaway et al. (1986), estimated 2386 ± 429 moose in a 2774-mi^2 portion of the subunit in the lower Nowitna drainage. A 1986 population estimation survey conducted in a 1556-mi^2 portion of the 1980 survey area indicated a reduction in moose numbers. A 1990 population estimation survey in the same area surveyed in 1980 indicated a decline that was significant at the 80% probability level, but not at the 90% level. Results of a 1995 population estimation survey in a 1338-mi^2 portion of the subunit were not significantly different (90% confidence) from those of the 1990 survey.

Besides the lower portion of the Nowitna 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 36–46% of the reported Unit 21B 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 AND RELATED ACTIVITIES

- In the floodplain area of the Yukon and Nowitna Rivers: Conduct annual trend area surveys. Maintain an average annual harvest of 40 moose from the desired population of 1000–1600 moose. Monitor harvest with harvest reports and checkstations.
- Remainder of the Nowitna drainage: Conduct annual trend area surveys. Maintain an average annual harvest of 20 moose from the desired population of 1100–1300 moose. Monitor harvest with harvest reports and checkstations.
- Remainder of Unit 21B: Conduct annual trend area surveys. Maintain a minimum annual harvest of 30 moose from the desired population of 1600–1700 moose. Monitor harvest with harvest reports.

METHODS

Established trend count areas were surveyed cooperatively with US Fish and Wildlife Service to assess population status and trend. Piper PA-18 (or equivalent) aircraft were used, and contiguous survey units of approximately 12 mi^2 each were searched at a rate of at least 4 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 developed by ADF&G biometricians that uses a probability sample (Särndal et al. 1992:p 93) and regression estimator (Särndal et al. 1992:p 245).

We monitored harvest by checking moose harvest reports and collecting information on hunter residency, moose ages, and antler sizes at a moose hunter checkstation. We monitored mortality caused by predation by interviewing wolf trappers.

Survey and harvest data were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY99 = 1 Jul 1999–30 Jun 2000).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The last population estimation survey was completed in November 1995 and covered 1338 mi^2. The area surveyed was based on a polygon of moose calf radio relocations. By using these relocations, we attempted to include the area used by moose in the floodplain of the Nowitna River. The area surveyed was also important because Tanana residents reported that moose were difficult to find during the September hunting season. Results of the survey indicated that 908 ± 19% moose were present (Table 1).

Using the results of the 1995 population estimation survey and one conducted in 1990, Woolington (1998) estimated there were 2324–3530 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, and a density of 0.64 moose/mi^2 was applied to the remainder of the subunit that was not surveyed. Higher moose densities exist in favorable habitat along the Nowitna floodplain and immediately adjacent to the Yukon River. Densities are low to moderate away from the river.

Survey data collected in the fall from established trend areas along the lower Nowitna suggested stable or slightly increasing moose densities during 1991–1998 (Tables 2 and 3). Surveys conducted in fall 1998 indicated very little change, except yearling recruitment indicators were lower. Density estimates were lower in the fall 1999 surveys and recruitment indicators were mixed. However, survey conditions were very poor due to inadequate snow coverage, and results were not reliable.

Population Composition

Composition data were available from aerial surveys conducted with FWS staff in established trend areas on the Nowitna National Wildlife Refuge (Tables 2 and 3). Fall 1996 survey results indicated bull:cow ratios along the river increased from the previous year while calf:cow ratios decreased. Yearling bull:100 cow ratios indicated poor overwinter survival and poor recruitment. The occurrence of twin calves among moose observed in these early winter surveys has been very poor since the trend areas were established in 1992, particularly at the Nowitna Mouth Trend Count Area.

The 1995 population estimation data indicated the sex and age composition over the entire area was not as depressed as that along the river. The bull:cow ratio was 32:100, the yearling bull:cow was 7:100, and the calf:cow ratio was 28:100. These ratios indicated a stable population.

Distribution and Movements

Based on the movements of radiocollared cow-calf pairs, most cows spend their summer months around open grass and brush meadows on the floodplain, but away from the river (Woolington 1998). In October they move to the riparian areas, where they remain until early

May. Relatively few cow moose wintered in the hills to the north and south of the Nowitna River.

MORTALITY

Harvest

Season and Bag Limit.

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 21B that portion within the Nowitna River drainage:		
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–20 Sep
Remainder of 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. Subsistence and general registration hunts were established for the Nowitna River drainage in Unit 21B by the Board of Game in March 1996. This action was to counter the possibility of the Federal Subsistence Board closing federally managed lands in the Nowitna River drainage to nonlocal hunters because of perceived declines in moose. Two separate registration hunts were established. The subsistence registration hunt was open to all Alaskan residents, with a season of 5–25 September and a bag limit of 1 bull. All the meat had to remain on the bones, the head had to be salvaged, and the antlers were to be cut to destroy the trophy value. The general registration hunt was open to all hunters, with a season of 5–20 September and a bag limit of 1 bull moose with spike fork antlers or antlers at least 50 inches wide, or 4 brow tines on at least 1 side for residents. For nonresidents the bag limit was 1 bull with antlers at least 50 inches wide, or 4 brow tines on at least 1 side. Registration hunts were then discontinued beginning in RY98. Seasons and bag limits for the remainder of the subunit remained unchanged.

Harvest. Reported harvest for the subunit was fairly stable and averaged 61 (range = 46–72) moose annually during RY92–98 (Table 4). The Unit 21B unreported harvest was estimated at 5 moose/year for Ruby residents, and 10 moose/year for Tanana residents. The Nowitna drainage produced 58–88% ($\bar{x}$ = 71%) of the subunit's reported harvest during RY90–98 (Tables 5 and 6).

The estimated RY99 harvest by residents of Unit 21B was about 35 moose (Anderson et al. 2000). The estimated unreported harvest (Table 4) incorporates the RY99 Division of Subsistence estimated moose harvest data for Ruby and Tanana (approximately 35 moose annually), less the reported harvest by those same villages (approximately 20 moose annually). Because subsistence harvest remains relatively constant, the difference of approximately 15 unreported moose between the RY99 subsistence data and the local reported harvest was extrapolated across all years.

Checkstation Results. Since RY88 a moose hunter checkstation has been located at the mouth of the Nowitna. During RY96–RY97 the checkstation was mandatory because it was the only place Nowitna River registration hunt permits were available. Except for RY97, hunting pressure and success rate of hunters passing through the Nowitna checkstation was relatively constant (Table 5). It is unclear why there was a brief decline in the number of hunters in RY97.

Hunter Residency and Success. Based on harvest reports, the majority of Unit 21B hunters were Alaskan residents who resided outside the subunit, particularly Fairbanks (Table 6). Average success rate during RY90–RY98 was 46.6% ($s_{\bar{x}}$ = 3.4) (range = 34–60%). Residency data from harvest reports and from the Nowitna River checkstation were consistent. This was expected because a majority of the harvest in Unit 21B occurs along the river.

Harvest Chronology. During RY96–RY98, hunter reports indicated that most moose were shot in the last half of the September season (Table 7). This was probably due to relatively little movement of bulls in the earlier part of the season compared to the later part of the season.

Harvest was not reported for the winter months, but it was probably close to 20% of the annual kill. Winter harvest likely occurred during October–March (Anderson et al. 1998).

Transportation Methods. Not surprisingly, the majority of hunters used boats to hunt moose (Table 8). It is undetermined why a relatively large proportion of transportation methods were unknown RY98 (33%), but I do not believe any significant changes in the mode of transportation occurred. Snowmachines were used during the winter, but winter reporting rates are low and therefore snowmachine use is underrepresented.

Other Mortality

Predation mortality on moose calves is significant in the subunit (Osborne et al. 1991). During calf mortality studies of radiocollared newborn moose, 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. A single pack of 25 wolves was observed during the fall 1999 trend count survey at the mouth of the Nowitna. Wolf surveys conducted in neighboring Units 21D and 24 during RY99 and RY00, demonstrated an increase in wolves (ADF&G files, Galena, 30 May 2000). Local residents have reported similar observations regarding wolf numbers in Unit 21B.

HABITAT

Assessment

No new data were collected on habitat conditions during this reporting period. Observations indicated browse availability is not currently limiting the moose population in the subunit. Regeneration from a fire that burned in 1986 east of the Nowitna River in the Little Mud River drainage provided excellent moose browse. During November 1995 surveys, this area was classified as high moose density. Several adjacent sample units were classed as medium. There is a dense stand of black spruce between the 1986 burn and the Nowitna River that should be considered for a prescription burn.

CONCLUSIONS AND RECOMMENDATIONS

Analysis of data from 1991–1998 fall surveys of permanent trend count areas showed the density of moose along the heavily hunted Nowitna River was relatively stable, despite different conclusions in a previous management report (Woolington 1998). Bull:cow ratios in fall 1996 improved slightly from the previous 2 years. Away from the river, the bull:cow ratio was slightly higher. Yearling recruitment parameters appeared to be declining by fall 1999, like most other trend count areas in Units 21D and 24, and indicated a decline in the population could be expected in the future.

Predators remain abundant and continue to be the primary factor limiting moose abundance in the area. Currently the harvest of wolves within the subunit is very low and few black bears are harvested. The moose calf mortality study indicated black bears were the major predator of moose calves (Osborne et al. 1991). Efforts should be made to increase the harvest of predators if more moose are desired.

I recommend a prescribed burn in the upland area east of the Nowitna floodplain and north of the Little Mud River to Bering Creek. This area is adjacent to several old burns that are currently reaching peak browse production.

Generally, the goals for the current reporting period were met. The moose population was stable and was capable of providing for all of the goals identified. Although a population estimation survey was not completed that would have allowed a determination of the number of moose for the areas identified in the objectives, trend area surveys indicated relatively stable populations. We met the objective of conducting trend area surveys and monitoring harvest through the harvest reporting system and at checkstations.

Because the goals and objectives of the current report period were either realized or they did not allow for quantitative evaluation, the goals and objectives for the next report period will be changed to the following:

MANAGEMENT GOAL

- Manage Unit 21B moose on a sustained yield basis to provide both hunting and other enjoyment of wildlife in a manner that complements the wild and remote character of the area and that minimizes disruption of local residents' lifestyles.

MANAGEMENT OBJECTIVES

- Alert relevant wildlife agencies, boards, and advisory committees if the moose population declines below 3000–4000 moose.

  Activity 1: Conduct trend count surveys annually or population estimation surveys when funding is available.

- Provide for human harvest, not to exceed 150 moose or 5% of the annual moose population estimate.

- In combination with Unit 21C, implement at least 2 habitat enhancement activities every 5 years.

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Table 1 Unit 21B Nowitna River moose population estimate, November 1995

Unit	Area mi^2	Population	90% CI[a]	Density	SCF[b]	Variance
Upper	365.9	96.3	16.8	0.26	1.00	96.8
Middle	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 Unit 21B Nowitna/Sulatna confluence (75.5 mi^2) aerial moose composition counts, regulatory years 1991–1992 through 1999–2000[a]

Regulatory year	Bulls:100 cows	Yrlg bulls: 100 cows	Calves:100 cows	Twins:100 cows	Percent calves	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	2.5
1995–1996	15	4	33	6	22	148	2.0
1996–1997	18	8	23	6	13	216	2.9
1998–1999	19	2	28	6	19	180	2.5
1999–2000	6	1	23	12	18	106	1.5

[a] US Fish and Wildlife Service.

Table 3 Unit 21B Nowitna mouth (59 mi^2) aerial moose composition counts, regulatory years 1992–1993 through 1999–2000[a]

Regulatory year	Bulls:100 cows	Yrlg bulls:100 cows	Calves:100 cows	Twins:100 cows	Percent calves	Moose	Moose/mi^2
1992–1993	21	0	31	0	20	138	2.9
1993–1994	32	6	32	6	20	189	3.2
1994–1995	19	8	23	0	22	148	2.5
1995–1996	16	5	26	0	18	116	2.0
1996–1997	21	7	22	0	16	185	3.1
1998–1999	20	3	12	0	9	182	3.0
1999–2000	11	8	21	0	16	87	1.4

[a] US Fish and Wildlife Service.

Table 4 Unit 21B moose harvest, regulatory years 1990–1991 through 1998–1999

Regulatory	Harvest by hunters					
year	Bull	Cow	Unk	Total	Unreported	Total
1990–1991	81	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	63	0	0	63	15	78
1995–1996	66	0	0	66	15	81
1996–1997	63	0	0	63	15	78
1997–1998	58	1	0	59	15	74
1998–1999	53	2	2	57	15	72

Table 5 Unit 21B Nowitna River checkstation hunter residency (R), harvest (H) and success (S%), regulatory years 1990–1991 through 1999–2000

Regulatory	Local villages[a]			Fairbanks			Other residents			Nonresident			Total		
year	R	H	S%	R	H	S%	R	H	S%	R	H	S%	R	H	S%
1990–1991	23	7	30	67	32	48	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
1996–1997	19	2	11	54	21	39	36	12	33	20	2	10	129	37	29
1997–1998	16	1	6	57	29	51	21	8	38	7	3	43	101	41	41
1998–1999	17	4	24	57	26	46	27	17	63	22	3	14	123	50	41
1999–2000	24	3	13	57	21	37	60	17	28	14	4	29	155	45	29

[a] Tanana, Ruby, and Galena.

Table 6 Unit 21B moose hunter residency and success, regulatory years 1990–1991 through 1998–1999

Regulatory year	Successful					Unsuccessful					Total hunters
	Local resident[a]	Nonlocal resident	Nonresident	Unk	Total	Local resident[a]	Nonlocal Resident	Nonresident	Unk	Total	
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	45	3	1	72	7	47	11	0	65	137
1994–1995	12	44	5	2	63	7	44	2	0	53	116
1995–1996	15	43	8	0	66	11	60	6	0	77	143
1996–1997	16	44	3	0	63	38	68	17	0	123	186
1997–1998	9	46	4	0	59	27	73	8	0	108	167
1998–1999	7	46	3	1	57	10	24	4	0	38	95

[a] Tanana, Ruby, and Galena.

Table 7 Unit 21B moose harvest chronology percent by month/day, regulatory years 1996–1997 through 1998–1999

Regulatory year	Harvest chronology percent by month/day		
	9/1–9/14	9/15–9/25	*n*
1996–1997	42	58	59
1997–1998	31	69	55
1998–1999	39	61	49

Table 8 Unit 21B moose harvest percent by transport method, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest percent by transport method								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	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	65
1992–1993	10	0	76	1	0	0	8	4	46
1993–1994	9	0	82	3	1	0	3	1	72
1994–1995	21	0	69	2	0	0	6	3	63
1995–1996	12	0	79	3	0	0	4	1	66
1996–1997	4	0	92	2	0	0	0	2	63
1997–1998	5	0	88	0	0	0	5	5	59
1998–1999	4	0	60	0	0	0	4	33	57

LOCATION

GAME MANAGEMENT UNIT: 21C (3671 mi^2)

GEOGRAPHIC DESCRIPTION: Dulbi River above Cottonwood Creek and Melozitna River above Grayling Creek

BACKGROUND

Moose have been present in Unit 21C throughout the recent history of Interior Alaska (S Huntington, personal communication). Moose densities are low due to poor habitat and predation by bears and wolves, and population trends are unknown. Access into the subunit is limited and is mostly by aircraft. Thus, hunting pressure and harvest has been low and probably does not adversely impact the moose population. Because of low hunting pressure, there has been little need to extensively monitor the moose population in this area.

Terrain in the subunit is hilly and mountainous, with peaks as high as 5000 ft. Two large rivers, the Melozitna and the Dulbi, represent the main summer habitat. Numerous fires have resulted in large expanses of potentially good winter habitat.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide a sustained opportunity to participate in hunting moose.
- Document uses of moose.

MANAGEMENT OBJECTIVES

Management objectives were formulated during this reporting period.

METHODS

POPULATION STATUS AND TREND

We conducted a moose stratification survey on 18 and 19 April 2000 using the "Geo-Statistical Population Estimator (GSPE)" which is a modification of the "Gasaway" technique (Gasaway et al. 1986) using spatial statistics (J Ver Hoef, ADF&G, personal communication). The stratification provided the basis for a rough population estimate of the subunit, and will be used to conduct population estimation surveys in the future. It was conducted in a Cessna 206 flown at 95–120 mph at altitudes of 500–1000 ft, with 2 observers in the back seat and 1 observer/recorder in the front seat. Prior to the flight, we divided Unit 21C into a grid of 658 sample units (3671 mi^2) that were approximately 5.5 mi^2. We flew on the boundary between 2 sample units, and each sample unit was identified as "low" or "high" moose density, based on number of moose observed, number of tracks observed, and habitat. If moose were spotted in the sample unit during the flight, it was designated a "high" moose density unit. Alternatively, if there were no moose observed it was typically designated a "low" moose density unless it was judged to be good habitat and >5 sets of tracks were observed. We surveyed 438 sample units (1971 mi^2). The area not surveyed was primarily high mountainous terrain in the Kokrine Hills. It will be stratified based on known habitat type and type of habitat estimated from a topographic map. Sex and age of moose were not recorded. No other surveys have been completed in Unit 21C.

HARVEST

We monitored harvest and hunting pressure using harvest reports submitted by hunters. Total harvest, residency and success, chronology, and transportation were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY99 = 1 Jul 1999–30 Jun 2000).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

No surveys were completed in Unit 21C prior to this reporting period. Survey conditions for the April 2000 stratification were fair rather than good or excellent because hilly and mountainous terrain and bright light adversely affected sightability of moose. However, conditions were not poor because the bright light was an advantage for locating fresh tracks, which are a stratification criteria. This stratification can only be used for spring surveys because moose distribution during fall is probably different.

We identified 39 sample units as high density and 399 as low density from a total of 438 sample units. Moose were concentrated on the north side of the Melozitna River on the hills that divide the drainages of the Melozitna and Dulbi Rivers. Additional moose and tracks were observed on the western end of the subunit within the Dulbi River drainage as we approached the Koyukuk River. However, only 31 moose were observed during the survey. This was lower than expected for the area and was probably partially a result of low sightability.

We estimated moose density was 0.35–0.45/mi^2 (1284–1651 moose) by using the results of this survey and by comparing similar habitat to known densities elsewhere in the state where bears and wolves are lightly harvested (Gasaway et al. 1992). This density is lower than what the previous area biologist estimated (0.5–1.0 moose/mi^2; Osborne 1996).

MORTALITY

Harvest

Season and Bag Limit.

Units and Bag Limits	Resident Open Season	Nonresident Open Season

RY90–99

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. During the March 2000 Board of Game meeting, harvest of 600–800 moose was established as the amount reasonably necessary for subsistence uses in Unit 21.

Hunter Harvest. Harvest was relatively stable with a mean kill of 23 ± 8.7 ($\bar{x} \pm 1s$) moose annually for the past 10 years (RY90–RY99; Table 1). Two seasons that fluctuated dramatically from the mean were RY92, when only 9 moose were harvested, and RY97, when 41 moose were harvested. The high harvest in RY97 may have been caused by an additional big game guiding operation that was established in the Melozitna drainage. In RY98 and RY99, 21 and 30 moose were harvested, respectively. Number of hunters was also stable during the past 10 years with a mean of 40 ± 8 ($\bar{x} \pm 1s$) and a range of 31–54.

Annual harvest during this time period was < 5% of the estimated number of moose in the subunit. If harvest was excessive, the proportion of large bulls in the harvest would decline. Instead, the proportion of large bulls (≥ 50") has remained high (r = 61–85%) during the past 5 years (RY95–RY99).

Hunter Residency and Success. Currently, no one lives within the subunit; however, residents from Ruby in adjacent Unit 21B hunt the Melozitna River occasionally. Nonresidents comprised an average of 35% ± 11% ($\bar{x} \pm 1s$) of the hunters during RY90–RY99. The past 3 years has been higher (48% nonresidents), although total number of hunters has not increased much (Table 1). Percent success has been >50% for the past 10 years (RY90–RY99), except in RY92 when percent success was 29%. High success rates were probably due to relatively low hunting pressure and moose being concentrated along the river corridors in September.

Harvest Chronology. Moose were harvested throughout the season, but the highest percent of harvest occurred during mid-September (Table 2).

Transport Methods. Hunters mainly used aircraft for transport (Table 3). A waterfall near the mouth of the Melozitna River restricts travel up the river and extensive sandbars impede boat access into the upper Dulbi River.

Other Mortality

Wolves and grizzly and black bears are throughout the subunit. In 1995, Osborne (1996) estimated a minimum of 60 wolves in the subunit and estimated grizzly bear density at 1/40 mi^2. Numbers of wolves and black bears have increased in adjacent Units 21D and 24 (G Stout, ADF&G, personal communication) and have probably increased in Unit 21C.

Predation has probably influenced population status in the past and may be increasing. Harvest of wolves and bears was low (< 10 annually) because hunter access is limited.

CONCLUSIONS AND RECOMMENDATIONS

Moose density in Unit 21C was low (0.35–0.45 moose/mi^2) with an estimated 1284–1651 moose present in the subunit. Human use of the moose population was low and recent hunting pressure could be sustained even if the population experienced a substantial reduction.

For example, if harvests were not sustainable, the proportion of large bulls in the harvest would decline. Instead, large bulls (≥ 50" antler spreads) comprised most of the harvest (69–85%) during RY95–RY99. We achieved our first management goal to protect, maintain, and enhance the moose population and its habitat by monitoring moose harvest pressure, by maintaining open seasons for bear and wolf hunting and trapping, and by encouraging a "let wildfire burn" policy with the Department of Forestry. We achieved our second goal to provide a sustained opportunity to participate in hunting moose by maintaining opened hunting seasons. We accomplished our third goal to document uses of moose by requiring harvest reports. Because this is a routine activity, we are eliminating this as a goal for the next reporting period.

Although hunting pressure has remained low, we recommend obtaining a population estimate and a bull:cow ratio in order to monitor possible effects of harvest on the population. In addition, a management objective to maintain a harvest of bulls that is ≤ 6% of the estimated population will be adopted for the next reporting period.

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Table 1 Unit 21C moose hunter residency and success, regulatory years 1990–1991 through 1999–2000

Regulatory year	Successful					Unsuccessful					Total hunters
	Local resident[a]	Nonlocal resident	Nonresident	Unk	Total (%)	Local resident[a]	Nonlocal resident	Nonresident	Unk	Total	
1990–1991	1	18	5	1	25 (67)	0	9	3	0	12	37
1991–1992	0	15	5	0	20 (50)	0	17	3	0	20	40
1992–1993	0	7	2	0	9 (29)	0	15	7	0	22	31
1993–1994	0	11	9	0	20 (51)	0	13	6	0	19	39
1994–1995	0	17	10	0	27 (57)	4	14	2	0	20	47
1995–1996	0	12	13	0	25 (61)	0	13	3	0	16	41
1996–1997	0	10	5	0	15 (56)	0	9	3	0	12	27
1997–1998	1	14	26	0	41 (76)	0	10	3	0	13	54
1998–1999	1	8	12	0	21 (58)	0	9	6	0	15	36
1999–2000[b]	0	15	15	0	30 (62)	0	14	4	0	18	48

[a] Local resident resides in Units 21C or 21B.

[b] Preliminary data.

Table 2 Unit 21C moose harvest chronology percent by month/day, regulatory years 1995–1996 through 1999–2000

Regulatory	Harvest chronology percent by month/day				
year	9/5–9/10	9/11–9/15	9/16–9/20	9/21–9/25	*n*
1995–1996	29	33	25	12	24
1996–1997	7	33	40	20	15
1997–1998	12	36	34	17	41
1998–1999	25	35	30	10	20
1999–2000[a]	21	27	27	24	29

[a] Preliminary data.

Table 3 Unit 21C moose harvest percent by transport method, regulatory years 1990–1991 through 1999–2000

Regulatory	Harvest percent by transport method							
year	Airplane	Horse	Boat[a]	3- or 4-wheeler	Snowmachine	ORV	Unknown	*n*
1990–1991	90	0	10	0	0	0	0	21
1991–1992	83	0	4	0	0	0	13	23
1992–1993	89	0	11	0	0	0	0	9
1993–1994	70	10	20	0	0	0	0	20
1994–1995	89	0	11	0	0	0	0	27
1995–1996	84	0	4	0	0	0	12	25
1996–1997	93	7	0	0	0	0	0	15
1997–1998	85	0	10	0	0	0	5	41
1998–1999	90	0	10	0	0	0	0	21
1999–2000[b]	77	0	23	0	0	0	0	30

[a] Includes airboats.
[b] Preliminary data.

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

Moose are abundant in much of Unit 21D. However, high densities are a relatively new occurrence. Local residents 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, allowing a rapid expansion of the moose population during the late 1950s and on through the 1960s. Expansion may have begun slowing in 1959 when statehood brought an end to federal wolf control. The moose population reached peak numbers about 1970 (S Huntington, personal communication to T Osborne, ADF&G) and then stabilized or declined slightly in localized areas in response to increased predation and hunting pressure. Increased predation may have been related to passage of the Federal Airborne Hunting Act in 1972, which halted aerial shooting of predators.

Moose trend count areas (TCA) established in 1981 in the Three Day Slough and Yukon floodplain areas indicated generally increasing moose densities through about 1993 (Tables 1–8). Initially, we thought this increase was due to better surveys, but a population estimation survey of the Kaiyuh Flats and the lower Koyukuk River in 1987 supported data from the TCAs (Osborne 1996). Moose densities were high along the Yukon River floodplain (3–6 moose/mi^2) and were very high on the Koyukuk River in the Three Day Slough TCA, where densities reached 13.3 moose/mi^2 in early winter 1993. We estimated that 6340 moose inhabited the survey area, and extrapolation of the data suggested a unitwide population of 9000–10,000 in 1993.

Results from a second survey in fall 1997 in the lower Koyukuk drainage and the Kaiyuh Flats indicated moose numbers were similar to the 1993 estimate (Huntington 1998). However, declining recruitment parameters from the TCAs since 1997 indicated the population was closer to 8000–9000 moose during winter 1999–2000.

There are 4 villages within the subunit (Kaltag, Nulato, Koyukuk, and Galena) and the residents of each village have traditional hunting areas. However, Galena residents tend to travel farther afield in the direction of the Koyukuk River. Nonresidents and Alaskans residing outside Unit 21D, primarily hunt the Koyukuk River between the Kateel River and the Dulbi Slough. Hunting pressure appears to be gradually shifting further upriver as hunters from outside the unit learn to deal with the logistics of accessing the area. In 1979 the Koyukuk Controlled Use Area (KCUA) was established in an attempt to reduce participation of nonlocal hunters by prohibiting the use of aircraft. However, by 1986 the hunters arriving by boat from outside the unit equaled the number of hunters who previously accessed the area by aircraft.

Reported harvest prior to 1981 was largely inaccurate because many local residents either did not obtain licenses or failed to report. In 1981 a program was initiated that made it easier for residents of the area to obtain hunting licenses and harvest reports. Educational and enforcement efforts improved the reporting rate by local residents, but at least 25% of the harvest is still unreported.

A hunter checkstation has been operating on the Koyukuk River since 1983. In 1990 the Ella's Cabin checkstation on the Koyukuk River became a mandatory stop for all hunters. The checkstation enables accurate determination of the number of hunters using the river to access the KCUA within Unit 21D. It is also used to educate local residents concerning licensing and reporting requirements, and to inform nonlocal hunters about regulations specific to the area and about the locations of private property near the river.

The fall hunting season dates changed several times between 1975 and 1981. From 1981 through 1996 there was a 21-day fall season for the entire subunit. Harvest of cows was allowed during the last 5 days. A 10-day season in early March also provided hunting opportunity for Alaska residents only. In 1991, nonresidents were restricted to bulls with an antler spread of ≥50-inches, or at least 3 brow tines on 1 side. In 1992 the minimum number of brow tines on 1 side was increased to 4. Also beginning in 1992, meat of the hindquarters, forequarters, and ribs of any moose taken in the KCUA had to remain on the bone. In 1996, due to increasing moose hunter numbers and moose harvest, subsistence and general registration hunts were established for the KCUA, downstream from Huslia. To distinguish the 2 hunts, we placed several conditions on the subsistence registration permit that the general registration permit did not have. Those conditions included mandatory salvage of the head, destruction of the trophy value of antlers, and all meat remaining on the bone. Unfortunately, the combined effect of all the regulations did little to slow the drastic increase of hunters into the area.

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

Koyukuk River Drainage

- Maintain a posthunt ratio of at least 30 bulls:100 cows in the population being monitored by the Three Day Slough TCA.

- Develop guidelines for maximum winter browse use within the Three Day Slough area.

METHODS

Previously established TCAs, of 4–6 contiguous "Gasaway" sample units, were surveyed from small fixed-wing aircraft (PA-18 or similar aircraft) to assess moose population parameters (Gasaway et al. 1986). Surveys were flown at an altitude of approximately 500 feet and at ground speeds of 70–80 mi/hr. Moose were classified as cows, calves, yearling bull (<30" antler spread and no brow tine definition), medium bull (<50" antler width), or large bull (≥50" antler width). Sample units of approximately 12 mi^2 each were searched at a rate of approximately 5 min/mi^2 to ensure reasonably high sightability, minimal bias, and data comparability among years. Data was recorded on standard data forms and moose locations were also recorded on 1:63,000 USGS quadrangle maps. Surveys were not conducted until a minimum snow cover of approximately 12 inches had accumulated. This level of snow cover is important because snow depth influences sightability and moose distribution.

Twinning surveys were flown in May to determine the proportion of moose calf twins in the TCA. Search and survey techniques and sample units were similar to those used in early winter. Observation of 50 cows with calves was the desired minimum, but funding and weather often prevented us from achieving that goal. Moose were classified as bull, yearling, calf, cow, cow w/1 calf, or cow/w 2 calves, etc. The timing of the surveys was critical. The surveys occurred when calving progressed to the point that approximately 50% of the cows observed had calves, yet mortality factors such as early black bear predation did not strongly influence the results.

Hunting mortality and harvest distribution were monitored through the statewide harvest ticket system, registration harvest tickets, door-to-door subsistence surveys, and checkstations. General season hunters received 1 reminder letter to report harvest. Hunters with registration, drawing, or Tier II permits received 1 postcard reminder, a telephone call, and a certified letter. The permittee was prohibited from receiving the following year's permit if no harvest information was relayed to ADF&G. Information obtained from the reports and surveys was used to determine total harvest, harvest location, hunter residency and success, harvest chronology, and transportation used. Harvest data were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY99 = 1 Jul 1999–30 Jun 2000). Data collected at the checkstation included hunter residency, harvest chronology, time in the field, hunting party size, sex and age structure of harvest, antler size, method of harvest, location of harvest, caliber of weapons, and method of transportation.

We evaluated predation by interviewing trappers, by field observations, and aerial wolf reconnaissance surveys in cooperation with the US Fish and Wildlife Service (FWS).

No habitat assessment work was conducted during this reporting period.

We implemented an intensive planning process during the reporting period to address concerns over the continual increase of hunters in the Koyukuk River Drainage. The planning process was initiated in winter 1999, and a Koyukuk River Moose Hunter's Working Group (KWG) was formed from members of the state's advisory committees, the Federal Western Interior Subsistence Council, and a local commercial hunting representative. The planning group developed a draft 5-year Koyukuk River Moose Management Plan (ADF&G files) that was submitted to the Board of Game during the March 2000 meeting. The draft plan was used as a guide for management goals, objectives, activities, and biological decision-making criteria in this management report.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The unitwide moose population increase that was observed for almost 2 decades has ended. Some localized areas are now experiencing marked declines. Peak densities of moose were apparently reached between 1993 and 1997, but declining calf numbers and recruitment of yearlings began to be apparent in fall 1998 and 1999 in most TCAs (Tables 1–8). Estimates of the numbers of calves and yearlings that were apparently lost in 1998 and 1999 in the Three Day Slough area suggested a decline of as much as 25%. Since 1997, the population may have declined by 10–15%, and the population trend is likely downward. Estimates from several TCAs during 1997–1999 support this conclusion.

I estimated the current population by extrapolation of data from the 1997 population estimation survey (Huntington 1998) and data from TCAs surveyed in 1997 and 1999. I calculated the percent decline of 5 TCAs that were located within the boundaries of 5 distinct sub-areas of the 1997 population estimate. The percent decline, calculated from the change in the TCA, was multiplied by the 1997 population estimate of the corresponding sub-areas. The product of that multiplication provided the 1999 estimate for those 5 sub-areas (Table 9). There are obviously limitations to this population estimation method (i.e., there are no confidence intervals), but in the absence of a comprehensive population estimation survey it provides some measure of the current status of the population.

Among the 5 sub-areas, the largest declines were areas with the highest moose density. On average, the decline was 15% among the sub-areas, and I estimated 3713 moose in 1999 (Table 9). In 1997 the population estimate for the 5 sub-areas was 46% of the total population of Unit 21D. Because the average decline of the 3 lowest areas was 10.6%, I estimated the decline for the remaining 54% of the population (5130 moose in 1997) in Unit 21D to be 10%, which totaled 4617 moose. The total for the entire unit is then estimated to be 4617 + 3713 = 8330 (or 8000–9000).

Population Composition

The following guidelines were used to interpret sex and age indices (Franzmann and Schwartz 1998).

- Bull:cow ratios in some of the high density TCAs were in excess of 30–40 bulls:100 cows after the fall hunting season. Ratios of 15 bulls:100 cows are sufficient for breeding (Woolington 1998) in these areas, with higher ratios providing increased harvest or trophy hunting opportunity. High numbers of bulls are sometimes misleading in terms of harvest effects on the population because the area is subject to either-sex hunting which can inflate bull ratios.

- The calf:cow ratio observed during November surveys provides an index to calf survival during the calf's first 5 months. Black bears, grizzly bears, and wolves were the primary predators that reduced calf numbers (Osborne et al. 1991). A November calf:cow ratio of 20–40 calves:100 cows will usually allow a population to remain stable. Calf:cow ratios may indicate population change if subsequent overwinter mortality is either consistent or negligible. Ratios of <20 calves:100 cows may indicate a decreasing population and ratios of >40 calves:100 cows can be found in growing populations.

- 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 4–8%, with anything less indicating poor recruitment and with anything higher indicating good recruitment.

- The number of twins born in May is a good indication of herd nutritional status. In general, the twinning rates are 25–90% in populations below carrying capacity, 5–25% in populations near carrying capacity, and <5% in populations above carrying capacity (Gasaway et al. 1992).

Since 1995 the posthunt bull:cow ratio for the Three Day Slough TCA was generally declining, with the fall 1999 ratio being the lowest recorded (Table 1). Bull:cow ratios vary widely between other TCAs (Tables 2–8), but most indicate some level of decline since 1995 or 1996. The percentage of large bulls (≥50") observed in the Three Day Slough TCA was 15–30% in the 1990s, while the percentage of large bulls in the harvest from Three Day Slough was 45–68% (Table 10). Three Day Slough yearling ratios in fall 1999 were the lowest recorded for the past 10 years. Additionally, fall 1999 calf ratios were lower than the average for the same period. Calf twinning rates in spring 1998 suggested declining productivity in the Three Day Slough. No conclusions were possible concerning spring 1999 rates because the survey was conducted later than normal and calves were subjected to a longer period of potential predation by black bears that congregate on the calving area (Table 11).

Distribution and Movements

Movement patterns of moose in the Three Day Slough area are based on data from radiocollared animals (Osborne and Spindler 1993). 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 10–60 miles north or south 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 suspect some moose observed on the Kaiyuh Flats migrate seasonally to the south.

Generally, moose congregate along the river corridors in the late fall with the approach of peak rutting season. With the accumulation of snow, moose are in high concentrations within the riparian corridor of the Yukon and Koyukuk Rivers, where they remain throughout the winter. With spring break-up, bulls are the first to leave the riparian areas and are followed by cows that have calved. Osborne and Spindler (1993) found that approximately 58% of the cows became migratory after calving and that approximately 83% of all moose were migratory.

MORTALITY

Harvest

Season and Bag Limit.

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 21D, that portion within the Koyukuk Controlled Use Area		
1 antlerless moose or 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side by registration permit.	5 Sep–25 Sep (General hunt only)	5 Sep–25 Sep
1 moose per regulatory year; however, moose may be taken by registration permit only during the period 1 Sep–25 Sep.	1 Sep–25 Sep 1 Feb–10 Feb (Subsistence hunt only)	
Remainder of 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–	5 Sep–25 Sep 1 Feb–10 Feb	

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
10 Feb; moose may not be taken within ½ mile of the Yukon River during the 1 Feb–10 Feb season.		
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 antlerless moose hunting seasons were reauthorized by the Board of Game for RY98 and RY99. The fall 1998 antlerless season was opened 5 days early by emergency regulation because of a poor salmon run. An emergency season extension of the February 1999 hunt was also authorized because extreme cold weather made hunter access difficult.

Because of the concern of increasing number of hunters and harvest sustainability, the department limited the number of general registration permits available at any one time to a maximum of 250 beginning in RY97, and permits were issued on a first-come first-serve basis. Similar modifications of the registration hunt requirements also occurred in nearby parts of Unit 24. Also, taking antlerless moose downstream of the Gisasa River was prohibited before September 1997 because the number of cow moose taken in the downstream portion of the registration hunts during RY96 was considered in excess of the sustainable harvest of cows. Seasons and bag limits were unchanged for the rest of the unit. In RY99, the department used discretionary authority to further limit the number of available permits to 215, which also proved to be ineffective at limiting hunter participation.

Hunter Harvest. The reported harvest of moose in Unit 21D increased substantially since the early 1990s (Tables 12–14). Increased hunter numbers occurred primarily in the lower Koyukuk River drainage and to a lesser degree in the remainder of the unit. Interest in hunting the Koyukuk River has grown particularly in the last decade, and the bull segment of the population declined in some TCAs.

Cow harvest regulations were liberalized because of the relatively high density of moose (by Interior Alaska standards) in the lower Koyukuk River and because of the reduced bull:cow ratio. This resulted in a record harvest of 110 cows in RY96. This was a dramatic increase from the average harvest of 24 cows during RY89–RY94. Most of this harvest took place on the lower Koyukuk River, the area targeted for desired cow harvest increases. The success rate for hunters through the checkstation changed little, indicating the relative ease with which hunters can harvest moose in the area.

Wounding loss was a concern of the KWG. During their meetings, it was established that an evaluation of wounding loss constituted an important portion of the harvest that should be documented. Literature values for wounding loss were 10–20% (Franzmann and Schwartz 1998). Gasaway et al. (1983) estimated 15% wounding loss and unreported harvest in Alaska. The KWG adopted a 15% wounding loss estimate as used in this report (Table 12).

Checkstation Results. Ella's Cabin checkstation, located 15 miles upstream from the village of Koyukuk on the Koyukuk River, was made mandatory in RY90. Hunters checking in at Ella's Cabin increased in all but 3 of the last 17 years and reached an all-time high in RY99. The additional hunters coming into the KCUA were primarily nonlocal Alaskan residents and, secondarily, nonresidents (Table 14). Numbers of local residents (residents of Unit 21D) remained relatively constant. Harvest success was high (>60%) for nonresidents and nonlocal residents. Local resident harvest success that was reported for the fall hunt was low, because they can hunt in both fall and winter seasons.

The Three Day Slough area is well known as an excellent area to hunt for large (≥50-inch antlers) moose. One-fifth to one-third of the bulls observed in the Three Day Slough TCA have large antlers (Table 10). Consistently over the past 18 years, more than 16% of the bulls checked annually at Ella's Cabin, have antler spreads >60 inches.

Three regulations monitored closely at the checkstation were antler width, salvage of meat, and destruction of trophy value of bulls harvested under subsistence registration permits. The regulation requiring meat to be left on the bone improved enforcement efforts to stop waste of moose meat. This regulation was passed in 1992 to address the increase of moose hunters and harvest in the KCUA, and to address the problem of some hunters removing only part of the meat from the carcass so they could carry lighter loads in their boats. All hunters coming through the checkstation were notified of this regulation at the time permits were distributed. Hunters were then checked for compliance of the regulation upon departure. Destruction of the trophy value of antlers at the checkstation was a controversial regulation when applied and seldom resulted in a positive public contact for the department.

Permit Hunts. Use of the subsistence registration permit (RM832) or the general registration permit (RM830) hunts was required in the fall within the Koyukuk Controlled Use Area downstream of the village of Huslia. The number of permits issued for RY99 increased by 17.6% from the previous year (Table 15). Moose harvested, on the 2 permits combined, increased by 7.0%. Continual increases in the number of Alaska resident hunters using the subsistence permit alternative may exceed the sustainable yield of the moose population and has been a critical management issue. However, the continual increases in the number of nonresidents could be managed through implementation of a limited drawing permit hunt.

Hunter Residency and Success. Hunter residency and success can be misleading because Unit 21D residents often do not report unsuccessful hunt information (Table 16). Harvest and hunter participation by Unit 21D residents was relatively constant over the period presented, according to Subsistence Division surveys (Anderson et al. 1998; Table 16). In contrast, nonresident and nonlocal resident hunter participation has increased steadily since 1983. The increase in "nonlocals" has created tension among user groups in the area and was the impetus for creating the KWG.

Harvest Chronology. Harvest reporting rate was low during the winter seasons and was probably only 20% of the annual harvest (Table 17). Much of the unreported harvest was likely taken during October–March (Anderson et al. 1998).

Transportation Methods. The presence of the KCUA and the area's extensive river system makes boats the primary transportation method (Table 18). Snowmachines were the main transportation method during the winter hunt.

Other Mortality

Unit 21D has high populations of wolves and black bears. Grizzly bears were common in the upland areas of the Nulato Hills and Kaiyuh Mountains. Wolves and grizzly bears prey heavily on both calf and adult moose. Black bears were shown to kill more than 40% of moose calves annually (Osborne et al. 1991). Twenty-nine black bears were observed along the Koyukuk River during a reconnaissance boat trip on the Koyukuk River during 19 July–23 July 1999. Eight black bears were observed during the 2 spring twinning surveys of RY96–RY98. Although a reliable estimate of the number of black bears residing in Unit 21D was not available, the high number of observations of this normally secretive animal suggested the population was high. Additionally, moose hunters harvested 26 black bears during the fall 1999 moose season and reported seeing bears often. Hunters also reported increased observations of grizzly bear during the fall moose season. Anecdotal reports from Unit 21D residents also suggested grizzly bears were increasing and becoming more common intruders at their fish camps.

We estimated 208–304 wolves in 37 packs in a portion of the unit during 1994 (Becker et al. 1998). Local residents with intimate knowledge of the unit's game populations report wolf numbers have substantially increased since then. Packs in excess of 20 wolves were observed during fall 1999 moose surveys. We counted 126 wolves during a wolf reconnaissance survey in March 1999. This minimum count indicates an increase of at least 17% since 1994.

HABITAT

Assessment

Feltleaf willow is an important species for moose due to its nutritional quality and use (Kielland 1997). Chemical analysis of 0.08- to 0.32-inch diameter twigs typically browsed by moose in Three Day Slough found crude protein was 8–12%, which was twice as much as found in the same willow species on the Tanana River. Consumption in Three Day Slough survey areas was 24–28% of the annual twig production (Kielland 1997). These factors may partly explain the sustained high numbers of moose in the Three Day Slough area. Annual forage production for a measurable area is unknown.

MANAGEMENT PLANNING

The KWG identified the primary issues of concern in the Koyukuk River Drainage. The issues identified were the basis for developing a draft 5-year Koyukuk River Moose Management Plan (ADF&G files). The issues of concern were also the bases for developing draft goals and activities for moose management in Unit 21D. Although the KWG area of concern was specifically within the Koyukuk River drainage, the issues were characteristic of concerns throughout Unit 21D and portions of nearby Unit 24.

The primary issues of concern identified and agreed upon by the KWG

- The combined mortality factors of human harvest and predation may lead to a decline in Koyukuk River moose populations, particularly if combined with severe winter weather.
- There has been a great increase in the number of hunters along the Koyukuk River, particularly on the lower river, and the number of hunters may adversely impact the moose population.
- Fish and game regulations and guiding laws are not being adequately enforced within the Koyukuk River drainage and, as a result, illegal guiding and/or transporting is increasing.
- Wanton waste of game meat is occurring on the Koyukuk River.
- Commercial guiding and transporting operations are increasing on the Koyukuk River.
- There are increasing numbers of moose hunters on the Koyukuk River and they affect traditional subsistence hunting and land use patterns.
- There are gaps in the existing biological information and harvest data concerning Koyukuk River moose.
- Environmental impacts along the river may affect moose conservation.

Management goals, objectives, and activities for the next report period will be changed to address the concerns listed above, according to KWG recommendations. The draft Koyukuk River Moose Management Plan (ADF&G files) contains details of the intent and rationale of the goals and objectives. Following is a summarization of the draft Koyukuk River Moose Management Plan's goals and activities that will be adopted for the next reporting period.

GOAL 1: ***Manage Koyukuk River drainage moose on a sustained yield basis to provide both hunting and other enjoyment of wildlife in a manner that complements the wild and remote character of the area and that minimizes disruption of local residents' lifestyles.***

Objective 1: Maintain a moose population of 9000–10,000.

Activity 1: Conduct trend count surveys annually or population estimation surveys when funding is available.

Objective 2: Provide for a high level of human harvest, not to exceed 700 moose or 7% of the annual moose population estimate.

Activity 1: Monitor hunter use levels in the Koyukuk River drainage.

Activity 2: Monitor impacts (social and environmental) to private property and local residents by Koyukuk River moose hunters.

Activity 3: Develop programs to improve population and harvest data for moose in Unit 21D.

Objective 3: Provide for moose hunting opportunity, not to exceed 950 hunters per regulatory year.

GOAL 2: ***Protect and enhance moose habitat.***

Objective 1: In combination with Unit 24, implement at least 2 habitat enhancement activities every 5 years.

GOAL 3: ***Reduce meat spoilage by hunters.***

Objective 1: Reduce, by 10% annually, the amount of spoiled meat observed at Ella's Cabin and hunting camp contacts.

Activity 1: Implement monitoring program at Ella's Cabin checkstation to monitor percentage of meat lost due to spoilage.

GOAL 4: ***Maintain opportunities for wildlife viewing, photography, and other nonconsumptive uses of wildlife within the Koyukuk River drainage.***

Objective 1: Increase, by greater than 1% annually, the number of people engaging in nonconsumptive uses of wildlife.

Activity 1: Implement a program to monitor long-term trend and establish a baseline of the current level of nonconsumptive use, through collaboration with the Koyukuk/Nowitna National Wildlife Refuge and commercial operations in Unit 21D.

CONCLUSIONS AND RECOMMENDATIONS

Moose were relatively numerous in the riparian lowlands of Unit 21D. I estimated 8000–9000 moose in the unit. However, unitwide populations are declining as a result of declining recruitment. Four years of liberalized cow harvest removed an important reproductive component of the population. Also, declining recruitment parameters such as calf:cow ratios and yearling bull:cow ratios indicated predation was having an increasingly negative influence on the moose population. This conclusion is supported by the increase in wolves observed during the aerial wolf reconnaissance survey in 1999, observations of black bear predation during spring twinning surveys, observations of black bears in the field, and increased observations of grizzly bears by hunters. The population will continue to decline unless an effort to control predation is implemented and the harvest of antlerless moose is substantially decreased.

All hunters in the KCUA use boats, and during years with low water levels there is competition for camping sites and moose calling areas, and other problems associated with crowded hunting conditions. Historically, the area has been known for its remote qualities, 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 moose more wary and are compromising our viewing and photography goal.

The objective of maintaining the bull:cow ratio in Three Day Slough at 30 bulls:100 cows was not achieved in 1999. Increasing hunting pressure in excess of sustainable harvest levels, declining recruitment, and increased predation are causes for concern.

The objective of developing a maximum winter browse use level in the Three Day Slough area was not achieved. Although this is an important management concern, the cost effectiveness for implementation on the level necessary is not practical with current budget and personnel constraints.

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Table 1 Unit 21D Three Day Slough trend count area aerial moose composition counts, regulatory years 1981–1982 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 Cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
1981–1982[a]	85.1	35	12	42	10	24	327	3.8
1982–1983[a]	85.1	43	13	24	2	14	415	4.9
1983–1984	84.8	31	9	37	12	22	530	6.3
1984–1985	57.8	30	13	31	10	19	332	5.7
1985–1986	83.3	39	11	17	4	11	501	6.0
1986–1987	83.3	39	7	45	13	25	660	7.9
1987–1988[a]	83.3	36	13	32	11	19	791	9.5
1988–1989	83.3	33	13	45	14	25	832	10.0
1989–1990	83.3	28	8	25	11	16	763	9.2
1990–1991	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1991–1992[a]	83.3	34	10	31	6	19	909	10.9
1992–1993	83.3	35	10	31	7	18	1088	13.1
1993–1994[a]	83.3	38	8	25	4	16	1106	13.3
1994–1995	83.3	36	9	28	5	17	1026	12.3
1995–1996	83.3	23	7	36	6	23	1054	12.7
1996–1997	83.3	24	8	23	4	15	928	11.1
1997–1998	83.3	20	9	24	3	17	721	8.7
1998–1999	83.3	30	9	13	0	9	990	11.9
1999–2000	83.3	17	3	17	18	13	568	6.9

[a] Huntington and Spindler 1997.

Table 2 Unit 21D Dulbi River mouth trend count area aerial moose composition counts, regulatory years 1982–1983 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 Cows	Twins/100 cows with calves	Percent calves	Moose	Moose/mi^2
1982–1983	42.1	36	7	29	12	17	166	3.9
1983–1984	57.1	39	7	29	8	17	230	4.0
1984–1985	42.1	36	4	44	10	24	184	4.4
1987–1988	38.9	55	17	44	15	22	283	7.3
1992–1993	51.7	41	6	43	21	23	271	5.2
1996–1997	51.7	34	11	36	6	21	281	5.4
1997–1998	52.4	28	6	32	4	20	283	5.4
1999–2000	52.4	24	2	42	2	25	225	4.3

Table 3 Unit 21D Kateel River mouth aerial moose composition counts, regulatory years 1984–1985 through 1997–1998 (Huntington and Spindler 1997)

Regulatory year	Survey Area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 Cows	Twins/100 cows with calves	Percent calves	Moose	Moose/mi^2
1984–1985	47.8	21	8	54	5	31	68	1.4
1987–1988	38.0	41	20	41	12	23	84	2.2
1996–1997	49.4	46	15	29	14	16	152	3.1
1997–1998	61.1	26	10	34	0	21	188	3.1

Table 4 Unit 21D Long Stretch (Koyukuk River) aerial moose composition counts, regulatory years 1984–1985 through 1997–1998 (Huntington and Spindler 1997)

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 Cows	Twins/100 cows with calves	Percent calves	Moose	Moose/mi^2
1984–1985	51.5	94	31	31	25	14	36	0.7
1996–1997	51.3	36	6	61	25	31	65	1.3
1997–1998	62.5	47	7	33	0	18	77	1.2

Table 5 Unit 21D Koyukuk River mouth aerial moose composition counts, regulatory years 1984–1985 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 Cows	Twins/100 cows with calves	Percent calves	Moose	Moose/mi^2
1984–1985	65.5	27	10	41	5	25	183	2.8
1987–1988	37.8	28	8	49	12	28	69	1.8
1993–1994	51.2	43	10	36	6	20	175	3.4
1996–1997	51.2	42	6	45	7	24	181	5.1
1997–1998	66.5	35	6	50	10	27	284	4.3
1999–2000	65.6	36	10	19	6	13	288	4.4

Table 6 Unit 21D Squirrel Creek aerial moose composition counts, regulatory years 1981–1982 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 Cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
1981–1982	40.7	93	49	34	8	15	93	2.3
1982–1983	37.3	57	18	41	0	21	87	2.3
1983–1984	37.3	58	14	35	14	18	137	3.7
1985–1986	49.3	78	30	11	13	6	185	3.8
1987–1988	38.4	76	20	67	20	27	131	3.4
1993–1994	37.2	49	4	22	0	13	195	5.2
1995–1996	48.8	43	14	31	8	18	222	4.6
1997–1998	48.6	28	24	32	8	17	283	5.4
1999–2000	52.4	24	2	42	2	25	225	4.3

Table 7 Unit 21D Pilot Mountain Slough aerial moose composition counts, regulatory years 1983–1984 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 Cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
1983–1984	36.5	21	8	52	11	30	133	3.6
1984–1985	36.5	11	2	47	39	30	84	2.3
1985–1986	36.5	27	11	9	0	7	90	2.5
1987–1988	35.7	36	18	49	11	26	185	5.2
1991–1992	23.2	24	8	54	14	30	161	6.9
1993–1994	35.4	21	1	39	10	24	135	3.8
1995–1996	34.3	20	14	57	14	32	203	5.9
1997–1998	47.3	12	4	32	11	22	222	4.7
1998–1999	47.3	18	6	28	2	19	297	6.3
1999–2000	47.3	18	8	39	3	25	243	5.1

Table 8 Unit 21D Kaiyuh Slough aerial moose composition counts, regulatory years 1985–1986 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 Cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
1985–1986	50.8	54	17	8	0	5	78	1.5
1987–1988	39.1	28	7	33	7	20	74	1.9
1992–1993	50.8	36	18	24	22	15	72	1.4
1994–1995	50.8	44	12	31	0	18	119	2.3
1996–1997	64.3	60	13	67	6	30	125	1.9
1997–1998	64.3	35	12	39	10	23	146	2.3
1998–1999	64.3	42	18	48	10	25	173	2.7
1999–2000	64.3	39	12	22	13	14	123	1.9

Table 9 Unit 21D moose population estimate based on 1997 population estimation survey and changes in trend count areas (TCA) from 1997 and 1999

Survey area	1997 Population estimate	1997 Sub-area (mi^2)	TCA change 1997–1999	1999 Population estimate
Three Day Slough portion	2010	504	-21%	1590
Koyukuk River mouth portion	900	509	-9%	819
Pilot Mountain portion	964	522	-7%	896
Kaiyuh Slough portion	221	530	-16%	185
Dulbi River mouth	283	52	-21%	223
Totals	4378	2117		3713
	(46% of all Unit 21D moose)			(15% decline from 1997)

Table 10 Unit 21D large bull[a] moose percent harvested and number measured during the hunting season and percent counted during aerial surveys in the Three Day Slough area, regulatory years 1990–1991 through 1999–2000

Regulatory year	% Harvested (Sep)	Number measured (Sep)	% Counted (Nov)
1990–1991	54	91	–[b]
1991–1992	45	134	15
1992–1993	54	88	15
1993–1994	53	107	18
1994–1995	67	88	28
1995–1996	61	150	27
1996–1997	68	123	20
1997–1998	63	120	16
1998–1999	61	209	30
1999–2000	65	220	21

[a] 50-inch or greater antler spread.
[b] No survey.

Table 11 Unit 21D moose aerial twinning surveys in the Three Day Slough trend count area, regulatory years 1989–1990 through 1999–2000

Regulatory year	Cows w/o calves	Cows w/1 calf	Cows w/twins	Twinning %[a]	Yearlings	Dates in May
1989–1990		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
1995–1996	200	39	13	26[b]	51	22,24
1996–1997	180	30	9	23	58	23–24
1997–1998	70	29	4	12	11	20–30
1998–1999	28	37	3	8	14	4–7[c]
1999–2000	101	53	8	13	47	27–29

[a] Percent of cows with calves that had twins.
[b] Including 1 cow w/3 calves.
[c] The 1999 survey was delayed to 4–7 June due to weather.

Table 12 Unit 21D moose harvest, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest by hunters Bull	Cow	Unk	Total	Unreported	Potlatch stickdance	Wounding loss (15%)[a]	Total
1990–1991	258	24	1	283	40	4		327
1991–1992	269	34	0	303	40	11		354
1992–1993	193	22	1	216	40	11		267
1993–1994	235	23	2	260	40	9		309
1994–1995	248	26	1	275	40	8		323
1995–1996	329	21	1	351	40	4		395
1996–1997	315	110	1	426	150[b]	4	87	667
1997–1998	336	73	1	410	150[b]	4	85	649
1998–1999	340	80	3	423	150[b]	1	86	660

[a] Based on estimate by KWG.
[b] Unreported harvest based on Subsistence Division's door-to-door survey.

Table 13 Ella's Cabin checkstation moose harvest, regulatory years 1990–1991 through 1999–2000[a]

Regulatory year	Bull	Cow	% Cow	Total
1990–1991	177	6	3	183
1991–1992	199	10	5	209
1992–1993	161	6	4	167
1993–1994	179	6	3	185
1994–1995	192	10	5	202
1995–1996	279	8	3	287
1996–1997	263	90	25	353
1997–1998	257	49	16	306
1998–1999	284	61	18	345
1999–2000	275	94	25	369

[a] Contains moose harvested in Units 21D and 24.

Table 14 Ella's Cabin checkstation[a][b] moose hunter residency and success, regulatory years 1983–1984 through 1999–2000

Regulatory year	Unit 21D resident		Alaska resident[c]		Nonresident		Total	
	Hunter	Moose	Hunter	Moose	Hunter	Moose	Hunter	Moose
1983–1984[d]	132	43	29	20	3	2	164	65
1984–1985[d]	92	61	67	36	9	9	168	106
1985–1986[d]	117	32	74	37	4	3	195	72
1986–1987[d]	140	48	80	51	9	7	229	106
1987–1988[d]	151	68	92	61	21	16	264	145
1988–1989[d]	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
1996–1997	213	90	306	198	89	66	608	353
1997–1998	157	66	278	185	89	55	524	306
1998–1999	155	58	344	213	126	74	625	345
1999–2000	180	68	383	210	173	91	736	369

[a] Includes hunters from both Units 21D and 24.
[b] Includes hunters reporting at Huslia.
[c] Other than Unit 21D residents.
[d] Check not mandatory prior to 1990.

Table 15 Unit 21D/24 Koyukuk Controlled Use Area moose harvest by permit hunt, regulatory years 1998–1999 and 1999–2000

Hunt/Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
RM832	1998–1999	295	0	45	55	125	38	0	163
	1999–2000	356	0	49	51	127	54	1	182
RM830	1998–1999	330	0	45	55	159	23	0	182
	1999–2000	380	0	51	49	148	39	0	187
Total for all permit hunts	1998–1999	625	0	45	55	284	61	0	345
	1999–2000	736	0	50	50	275	93	1	369

Table 16 Unit 21D moose hunter residency and success, regulatory years 1990–1991 through 1998–1999

	Successful					Unsuccessful					
Regulatory year	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total	Total hunters
1990–1991	103	135	35	10	283	34	27	4	6	71	354
1991–1992	105	150	42	6	303	60	97	16	3	176	479
1992–1993	72	111	23	10	216	56	82	14	15	167	383
1993–1994	87	141	24	8	260	55	27	7	2	91	351
1994–1995	80	148	44	3	275	47	68	13	0	128	403
1995–1996	90	203	54	4	351	41	77	9	0	127	478
1996–1997	135	218	70	3	426	127	143	34	1	305	731
1997–1998	127	226	57	0	410	110	104	52	0	266	676
1998–1999	100	232	88	3	423	124	180	76	1	381	804

[a] Subunit resident only.

Table 17 Unit 21D moose harvest chronology percent by month/day, regulatory years 1996–1997 through 1998–1999

Regulatory year	Harvest chronology percent by month/day			
	9/1–9/14	9/15–9/25	2/1–2/10	*n*
1996–1997	53	43	4	423
1997–1998	59	37	4	446
1998–1999	50	49	1	386

Table 18 Unit 21D moose harvest percent by transport method, regulatory years 1990–1991 through 1998–1999

Regulatory year	Harvest percent by transport method								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1990–1991	4	0	88	0	3	0	2	2	283
1991–1992	5	0	86	0	5	0	2	2	303
1992–1993	3	0	88	1	3	0	2	3	216
1993–1994	3	0	88	1	5	0	1	2	260
1994–1995	4	0	85	0	7	1	2	1	275
1995–1996	3	0	91	1	2	1	2	0	351
1996–1997	2	0	91	1	4	0	2	1	426
1997–1998	4	0	90	1	4	0	1	0	410
1998–1999	5	0	88	0	3	1	2	1	423

LOCATION

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

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

BACKGROUND

Before 1930 very few moose were observed on the Seward Peninsula. However, by the late 1960s much of the suitable habitat in Unit 22 contained moose. During the 1970s and early 1980s the population grew rapidly and peaked during the late 1980s. Severe winters in 1989, 1990 and 1992 caused a decline in moose densities when winter browse was insufficient to maintain such large populations in Units 22B and 22D. In the mid to late 1990s data indicated Unit 22 moose populations were generally stable, but below previous peak densities. Current information suggests a gradual decline may be occurring in parts of the unit.

Although moose have been present in Unit 22 for a relatively short time, they rapidly became an extremely important food source for many Seward Peninsula residents and demand for moose by subsistence and sport hunters is high throughout the unit. Gravel roads, trails, and navigable rivers provide hunters with easy access to suitable moose habitat. Annual harvests reported from 1969 through 1998 ranged from a low of 44 moose in 1972 to a high of 408 moose in 1986 (Table 1). In recent years unit residents have accounted for 70% or more of the annual reported harvest.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

The management goal for Unit 22 is to maintain a minimum population size of 5700–7300 moose. In Unit 22A, the goal 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 goal is to stabilize the population size at 1500–2500 and 2500–3000 moose, respectively, with a minimum bull:cow ratio of 30:100. In Unit 22C, the goal is to maintain a population of approximately 480 animals with a minimum bull:cow ratio of 20:100. In Unit 22E, the goal is to maintain the existing population of 250–350 moose.

MANAGEMENT OBJECTIVES

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

- Estimate moose abundance, sex and age composition, and yearling recruitment and determine trends in population size and composition.
    - Complete censuses in the 5 subunits of Unit 22 on a rotational basis to estimate moose abundance.

- Complete aerial surveys throughout the unit during late fall and early spring to provide an index of moose population status and trends, sex and age composition, and yearling recruitment.
- Continue the radiotelemetry project in western Unit 22B to investigate low moose recruitment.

- Monitor human and natural mortality factors affecting the population.
  - Evaluate hunting mortality by analyzing all moose harvest data.
  - Improve harvest reporting through public education and improved communication and by conducting village harvest surveys.

METHODS

We conducted aerial surveys in the spring to estimate short yearling recruitment in portions of Unit 22 during the report period. In March of 1999, a moose census of western Unit 22B was completed using the geo-statistical population estimator technique (J. VerHoef, ADFG, pers. commun.). We summarized harvest reports returned by hunters and harvest data collected during big game harvest surveys in Koyuk and Shaktoolik.

Limited observations were made of radiocollared moose in the Niukluk and Fish River drainages as part of a continuing study to investigate poor calf survival in western Unit 22B.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

We do not have a full understanding of the factors limiting population size, productivity and recruitment of moose in Unit 22. Although moose numbers in Units 22A, 22C, and 22E increased during the late 1980s, densities have never been as high as the densities observed in Units 22B and 22D during the mid to late 1980s.

In Unit 22A, between censuses in 1989 and 1994 data indicates the population remained stable at 600–800 moose. No recent density data have been obtained for Unit 22A so the current status of moose in the unit is unknown. When Unit 22A drainages were surveyed in spring 2000 recruitment estimates were low, similar to those in Units 22B and 22D. We believe the population remains below the management goal of 1000 moose for the unit. Historically moose densities have been lower in Unit 22A than in many other parts of the unit. Some longtime local residents report a greater abundance of moose during the fall hunting season in the Unalakleet River drainage during the last several years. It is possible that some of the moose present in the Unalakleet River drainage in the summer and fall, winter in the Anvik and Yukon River drainages in Unit 21.

Moose densities in Units 22B and 22D have declined since the dramatic increases observed in the 1980s. The winters of 1989, 1990, and 1992 were particularly severe on moose and limited observations suggest winter mortality was higher than normal during those years. Census data from western Unit 22B show a 50% decline between 1987 and 1999 with continued low recruitment. Although we have no density estimates for eastern Unit 22B, recruitment estimates in 1999 and 2000 in the Koyuk drainage were similar to those in the western portion of the unit. Based on this information and comments by local residents we suspect poor calf survival may also be affecting moose densities in eastern Unit 22B.

In Unit 22D census data from the Kuzitrin and American river census areas showed a 35% decline in moose numbers between 1988 and 1993. A census in 1997 indicated the population had stabilized 35% below 1988 densities. However, 1999 and 2000 spring surveys found low recruitment in the Kuzitrin drainages suggesting a population decline may be imminent or occurring.

In Unit 22C between censuses in 1990 and 1995, the moose population was estimated to have increased by 18% to 479 moose. In the last few years, observations by staff and the public indicate the wintering population in Unit 22C may have continued to grow above our population goal of 480 moose, creating concern that the population may exceed the carrying capacity of the winter range. Yearling recruitment is highest in Unit 22C and frequently exceeds 20%. However, the bull:cow ratio is low, varying between 10–20 bulls:100 cows.

No additional population data is available for Unit 22E since the last survey in March 1996. The population remained relatively stable between surveys of moose habitat in 1991 and 1996. In 1996, the survey resulted in a direct count of 196 moose and an estimated recruitment rate of 16%. In 1998 and 1999, most Unit 22E residents questioned indicated no big changes in moose abundance had been noticed. However, in spring 2000 some residents from Wales and Shishmaref commented there seemed to be fewer moose.

Population Size

A census of Unit 22B scheduled for March 1998 was postponed for the second year in a row due to poor flying weather. Weather throughout the unit was unsuitable for census work so no alternate area was attempted.

In March 1999 a census of 2404 mi^2 in Unit 22B west of the Darby Mountains was completed using the geo-statistical population method developed by Jay VerHoef. An estimate of 802 moose ± 19% at the 90% confidence interval was obtained. This estimate indicates a 50% decline occurred since the same area was censused in 1987. In 1992, an 856 mi^2 eastern portion of the original area was censused. Between 1992 and 1999, this smaller area showed a 29% decline in moose numbers. In 1992 the reduced area yielded an estimate of 698 moose ± 15% at the 90% confidence interval. In 1999 the estimate for that area was 496 moose ± 15% at the 90% confidence interval. Short-yearling recruitment was estimated at 8%.

A census of Unit 22A scheduled for March 2000 was cancelled due to poor flying weather.

Population Composition

Lack of snow in October and November prevented fall composition counts from occurring in Unit 22 during this reporting period. In spring 1999 and 2000, recruitment surveys were flown in Units 22A, 22B, 22C and 22D (Table 2). As in past spring surveys, we counted moose found in the riparian habitat along selected drainages to obtain rough recruitment estimates.

Because of the nonrigorous method no attempt was made to draw conclusions about population status from these surveys.

In late March 2000 in lieu of the cancelled Unit 22A census, recruitment surveys were flown in the Unalakleet, North, Egavik, Tagoominik, Shaktoolik and Ungalik river drainages. Of the 174 moose seen, only 8% (14) were short-yearlings. Although relatively few moose were seen, that can in part be attributed to sightability problems in the trees and movement of moose away from the river bottoms due to the late date of the survey. However, the low recruitment estimate is consistent with results from similar surveys in other parts of the unit and leads us to believe that poor calf survival is a widespread problem in the unit.

An April 2000 recruitment survey along the Niukluk River in Unit 22B found 90 moose with 10% (9) short-yearlings. This recruitment estimate is slightly higher than survey and census estimates obtained in the 1990s but due to the imprecise survey technique, we do not know if calf survival has actually increased.

In March 1999 for the first time, a recruitment survey was completed in the Koyuk River drainage in eastern Unit 22B including the main Koyuk River, the East Fork of the Koyuk and the Peace River. It was repeated in April 2000. In 1999 observers counted 229 moose of which 21 (9%) were short-yearlings. In March 2000, 242 moose were counted of which 19 were short yearlings (8%). We believe that low recruitment is affecting moose densities in eastern Unit 22B, as has been documented in western Unit 22B. Koyuk residents have commented that moose numbers appear to be declining and report increasing difficulty harvesting moose in their area.

In March 1999 we surveyed the riparian habitat along the Kuzitrin River above the Kuzitrin bridge in Unit 22D to assess yearling recruitment. Eight of the 80 moose seen (10%) were short-yearlings. In April 2000 Unit 22D surveys of the Kuzitrin, above and below the bridge, and along the Noxapaga found 505 moose and 31 (6%) short-yearlings. Along the lower Kougarok River we found 184 moose and 16 (9%) short-yearlings. These data alert us to the possibility that the moose population in eastern Unit 22D, which we believed to be stable at the time of the last census in 1996, may be declining or poised to decline if such low recruitment continues.

An April 1999 survey of the Snake River drainage in Unit 22C found 125 moose of which 33 (26%) were short-yearlings. The Snake River drainage has consistently been an important wintering area for moose, but in 1999 considerably more moose were found than during previous spring surveys. At the time of the survey, moose appeared to be in fair condition, but following heavy snows in April and late snow melt in May, some moose in Unit 22C were noted to be in poor condition. Willows in the Snake River drainage were heavily browsed. In April 2000, 119 moose were found in the Snake River drainage and 21 (18%) yearlings. Although a similar number of moose were found in the drainage both years during our surveys, in the winter of 1999–2000 the ground was snow free until mid January and moose didn't move into the drainage in large numbers until late January. As a result, the willows appeared less heavily browsed and moose looked in better condition in spring 2000 than the previous spring. The large number of moose wintering in the Snake River drainage, the routinely high recruitment and condition of browse create concern that the population in Unit

22C may have grown in excess of our management goal, and may be approaching the carrying capacity of the winter range.

Distribution and Movements

In April 1995 the department began a radiotelemetry study to investigate high calf mortality and low calf recruitment in western Unit 22B. Twenty-seven cow moose in the Fish and Niukluk river drainages were radiocollared in April 1995. During April 1996 an additional 10 collars were placed on cow moose in the upper Niukluk River and Boston Creek drainages. During the previous reporting period cows were located periodically throughout the year to determine calving success and subsequent calf survival. Preliminary results were summarized in the previous segment report (Persons 1998). However, during this reporting period, observations were substantially reduced by limited availability of suitable survey aircraft in Nome and the study was not completed.

Between May 30 and June 13, 1997, we observed 26 calves (9 sets of twins and 8 single calves) produced by 17 of 30 radiocollared cows. During that period 3 calves are known to have died. When the collared cows were relocated between September and November 8 of the 26 calves (31%) including one set of twins were still living. Four of the collared cows died between June and September. No further observations of the collared cows were possible.

MORTALITY

Harvest

Season and Bag Limit. Seasons and bag limits were the same throughout the reporting period. However, in preceding years, antlerless moose could be taken throughout Units 22B and 22D during the month of December.

1997-1998 and 1998-1999 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22A	1 Aug–30 Sep	
Residents: 1 bull	1 Dec–31 Jan	
Nonresidents: 1 bull with 50-inch antlers or with 4 or more brow tines on at least one side		1 Aug–30 Sep
Unit 22B, That portion west of the west bank of the Fish River and west of the southwest shore of Golovin Bay from the mouth of the Fish River to Rocky Point		
Residents: 1 antlered bull	1 Aug–31 Jan	
Nonresidents: 1 bull with 50-inch antlers or with 4 or more brow tines on at least one side		1 Aug–31 Jan

1997-1998 and 1998-1999 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Remainder of Unit 22B,		
Residents: 1 antlered bull or 1 moose	1 Aug–31 Jan 1 Dec–31 Dec	
Nonresidents: 1 bull with 50-inch antlers or with 4 or more brow tines on at least one side		1 Aug–31 Jan
Unit 22C		
Residents: 1 bull	1 Sep–14 Sep	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least one side		1 Sep–14 Sep
Unit 22D		
That portion within the Kougarok, Kuzitrin and Pilgrim River drainages		
Residents: 1 antlered bull	1 Aug–31 Jan	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least one side		1 Aug–31 Jan
Remainder of Unit 22D,		
Residents: 1 antlered bull or 1 moose	1 Aug–31 Jan 1 Dec–31 Dec	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least one side however, antlerless moose may be taken only from 1 Dec–31 Dec.		1 Aug–31 Jan
Unit 22E		
Residents: 1 moose, however no person may take a cow accompanied by a calf	1 Aug–31 Mar	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least one side however, antlerless moose may only be taken 1 Dec–31 Dec.		1 Aug–31 Mar

Board of Game Actions and Emergency Orders. The only Board of Game actions effective during the reporting period were reauthorizations of antlerless seasons in portions of Units 22B, 22D and in 22E and a clarification of the area in Unit 22B where antlerless hunting is permitted. However, in October 1999 the board made a number of changes to Unit 22 moose seasons and bag limits that will go into effect for the 2000 regulatory year.

For the 2000–2001 regulatory year, the antlerless moose season in Unit 22B was eliminated due to the continued decline in moose densities. In Unit 22B west of the Darby Mountains, the resident moose season was shortened to 1 Aug–30 Sep and 1 Dec–31 Jan. and the nonresident season was shortened to the month of September. In Unit 22B east of the Darby Mountains, the resident season will be 1 Aug–30 Sep and 1 Nov–31 Dec and the nonresident season was shortened to 1 Nov–31 Dec.

In Unit 22D the nonresident moose season was shortened to the month of September. This prevents an increase in harvest by nonresident hunters who could have been displaced by the shortened nonresident season in Unit 22B.

Also for the 2000–2001 regulatory year, a registration hunt for up to 20 antlerless moose in Unit 22C was established from 15 Sep–30 Sep. This hunt was initiated because of concern that moose in Unit 22C are approaching the carrying capacity of their winter range. Stabilizing the population will hopefully prevent a serious decline in moose numbers such as that which occurred 10 years ago in parts of Units 22B and 22D when winter browse was insufficient to maintain the populations.

Brown bear hunting regulations were liberalized in Unit 22, partly in hope of reducing predation on moose. During the fall 1997 Board of Game meeting in Nome, the general season was lengthened in all but Unit 22C and Unit 22 (except 22C) was included in the Northwest Alaska Brown Bear Management Area for subsistence hunting. During the fall 1999 Board of Game meeting in Barrow, the resident tag fee requirement was eliminated for all of Unit 22 and the number of nonresident brown bear drawing permits was increased for Units 22B/22C and Units 22D/22E.

No emergency orders affecting moose hunting regulations were issued during the reporting period.

Hunter Harvest. During the 1997–1998 season, harvest ticket data shows that 423 hunters harvested 203 moose (197 males, and 6 females). A harvest of 211 moose (195 males, 13 females and 3 of unknown sex) was reported taken by 510 hunters during the 1998–1999 season (Table 1). Harvest data for 1999–2000 is incomplete at the time of writing and will be summarized in the next segment report.

Hunter effort and harvest peaked in the mid 1980s when the Unit 22 moose population was at its height. Harvests during this reporting period were up slightly over the previous two years, but were still 48%–50% lower than the peak harvest of 408 moose in 1986. Additionally, the number of individuals hunting moose in Unit 22 has declined significantly in recent years. In 1997, only 423 people reported hunting for moose, the fewest since the mid 1970s. In 1998, the number of hunters increased to 510 but is still 61% below the peak of 1,292 hunters in

1983. Declining numbers of moose in easily accessible areas is largely responsible for the reduction in hunter effort and harvest. Although the size of the harvest and the number of hunters has declined in Unit 22 during recent years, hunter success rates have remained fairly constant and relatively high over the last 14 years, ranging from 39–50%. Hunter success was 48% for the 1997–1998 season and 41% for the 1998–1999 season (Table 1).

Compliance with license and harvest reporting requirements by Nome residents is believed to be high, but harvest reporting by village residents has always been incomplete. During this reporting period, the department and Kawerak Inc. initiated a village based harvest assessment program to obtain more accurate big game harvest data from Unit 22 villages. In April 1999 household surveys were conducted in Koyuk and Shaktoolik. In April 2000 White Mountain, Elim and Shaktoolik households were surveyed, but results from the spring 2000 surveys are not available for this report. In 1999 Koyuk residents reported harvesting 23 moose. Half the households that reported hunting moose were successful. In 1999 Shaktoolik residents reported 21 moose harvested and 62% of the households that hunted moose were successful. Only 9% (2 moose) of the moose taken by Koyuk residents and 5% (1 moose) of the moose harvested by Shaktoolik residents were reported with harvest ticket hunt reports (Georgette 1999). Similar reporting patterns likely exist in other villages, indicating that actual harvest is likely significantly higher than reported harvest in Unit 22.

Since the early 1990s when antlerless moose seasons were shortened, the reported cow harvest in Unit 22 has been small. In 1997–1998 3% (6 cows) of the reported harvest was cows and in 1998–1999 6% (13 cows) of the harvest was cows (Table 1). No cows were reported taken Koyuk and Shaktoolik households interviewed during 1999 big game harvest surveys. Some unreported cow harvest is known to occur, but we believe that most hunters prefer to harvest bulls and take cows when that is all they can readily find.

The presence of wintering Western Arctic herd caribou in Units 22A and 22B in 1997–1998 and 1998–1999 and in Unit 22B in 1999–2000, may have reduced the demand for moose during the winter months.

Permit Hunts. There were no permit hunts for moose in Unit 22 during the reporting period. A registration permit hunt for up to 20 antlerless moose in Unit 22C is planned for the 2000-2001 regulatory year.

Hunter Residency and Success. No residency calculations were made for the 1997–1998 regulatory year because a local vendor failed to return overlays for the harvest tickets they issued and the residency of 17% of 1997–1998 hunters is unknown. During 1998–1999 Unit 22 residents accounted for 73% of the harvest (Table 3). The proportion of the harvest attributable to local residents has remained remarkably constant during the last 9 years, ranging from 70–74% of the harvest. Alaska residents accounted for 89% of the reported harvest during the 1998–1999 regulatory year.

Harvest Chronology. Most of the hunter effort and reported harvest (83% during 1997–1998 and 85% during the 1998–1999) occurred during August, September, and October when access by roads and rivers is most favorable (Table 4). Some hunting activity also occurred during December and January when snow machine access is possible and antlerless moose hunting is allowed in December in parts of Units 22B and 22D. Only in Unit 22E does this harvest pattern differ, with most of the harvest occurring during January, February and March when hunting is possible by snowmachine. There are no roads in Unit 22E and river access to moose habitat is limited. Similar harvest patterns were reported by Nelson (1995) and Machida (1996) for the previous reporting periods.

Data from 1999 village harvest surveys in Koyuk and Shaktoolik indicate that the majority of village harvest occurs in August and September (82% in Koyuk and 90% in Shaktoolik). Respondents indicated that moose are seldom hunted after late September because the meat is considered unpalatable during the rut.

Transport Methods. Hunters using highway vehicles, off-road vehicles and four-wheelers, boats equipped with jet units, and snow machines accounted for over 90% of the harvest in Unit 22 during the reporting period (Table 5). Only 2% of successful hunters reported using aircraft for access. Typically few hunters in Unit 22 use aircraft for access since suitable landing sites are few.

The number of moose harvested by hunters using only highway vehicles for transportation has declined steadily over the last decade. Hunters using highway vehicles accounted for 30% of the harvest (90 moose) during the 1991–1992 season. During this reporting period, hunters using highway vehicles accounted for 17% of the harvest (35 moose) in 1997–1998 and 19% of the harvest (40 moose) in 1998–1999. Moose densities are now very low along the road corridor and hunters often must travel to areas far from the road system for successful hunts.

During this reporting period, 32% of successful hunters used boats, 31% used four-wheelers, and 13% used snowmachines. 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. In Unit 22E, the use of four-wheelers (20%) and boats (20%) increased, but snow machines are still the most frequently used mode of transportation (52%) for moose hunting.

Other Mortality

No surveys were attempted to determine natural mortality rates of Seward Peninsula moose. The winter of 1997–1998 was mild with little snow accumulation until April. Moose appeared to come through the winter in good condition. In late April and early May of 1999 much of Unit 22 received heavy snowfall. For a period of about 1 month, browse availability was significantly reduced. Moose appeared to go into this period in good condition, but some moose, particularly in Unit 22C, appeared gaunt by the time the snow receded. The winter of 1999–2000 was colder than average with little snow fall until mid January. Moose remained dispersed at higher elevations until snow accumulation late in January drove them to the river bottoms. Snow accumulation for the remainder of the season was average and moose observed during spring surveys generally were lively and appeared in good condition. In some years severe winter weather and limited availability of winter browse have resulted in high over-winter mortality rates, but these factors are not thought to be significant during this reporting period.

We believe that bear density in Unit 22 has increased over the last decade. Throughout this reporting period, heavy snowfall and accumulation late in the spring likely facilitated predation on adult moose by bears. Staff and hunters observed numerous bears feeding on moose carcasses in April and May though it is unknown in most cases whether bears killed or scavenged. In several cases kills were observed, two by large boars and one by a sow with two 2- or 3- year-old cubs. Wolves are also becoming more numerous on the Seward Peninsula, especially in areas occupied by wintering caribou from the Western Arctic Herd. It is probable that predation, particularly by bears, contributes significantly to the stabilization or decline of moose populations in many parts of the unit.

HABITAT

Assessment

No browse surveys or quantitative range assessments were undertaken to determine availability and quality of winter range in Unit 22. During winters of heavy snow accumulation, winter ranges have been heavily browsed. When willows in lowland riparian habitats are not available to moose because of heavy snowfall, moose are forced to browse on large-diameter, less nutritious willow branches. This occurred in the late 1980s and early 1990s and more recently in the winter of 1994–1995 when over-winter mortality was believed to have been substantial, particularly in Units 22B and 22D. During the winters of 1998–1999 and 1999–2000 staff noted the riparian habitat in the small drainages of Unit 22C was heavily browsed. Because snow accumulation did not drive large numbers moose into these river bottoms until relatively late in the season, overwinter mortality was probably not excessive. However, repeated, increasingly heavy use of riparian habitat in Unit 22C raises concerns that the carrying capacity may be exceeded.

Enhancement

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

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

There were no nonregulatory management issues considered in Unit 22 during the reporting period.

CONCLUSIONS AND RECOMMENDATIONS

The moose population on the Seward Peninsula grew steadily in size from the 1960s, through the early 1980s and began to decline during the late 1980s and early 1990s. Data from censuses and surveys during the late 1980s show the population reached a maximum size of 7000–10,000 moose on the Seward Peninsula. Subsequent declines caused by winter mortality, reduced productivity, low recruitment and increased predation reduced the population size to between 5000 and 7000 animals (Nelson 1995). Noticeable declines in density are evident in portions of Unit 22, particularly in Units 22B and 22D.

Low recruitment rates found in Units 22A, 22B and 22D indicate a widespread problem with calf survival in the unit. In a large portion of Unit 22 it is likely that harvest and natural mortality are exceeding recruitment.

Preliminary results from the research study in western Unit 22B indicate several factors are contributing to low recruitment in that portion of the unit. Most of the calf mortality occurred during the summer months, much of it during the first month after birth. Predators, especially bears, are believed to be increasing in numbers in the area, and are probably responsible for most of these losses. However, the factors of a population dominated by older aged cows, frequent severe winter snow conditions, and poor winter range quality may be acting in combination to lower productivity and produce calves that are less vigorous at birth and with subsequent lowered survival (Persons 1998). Some or all of these factors may influence recruitment in other parts of the unit.

Concern about declining moose numbers in the most accessible parts of Units 22B and 22D, led to closure of the antlerless season in Unit 22B and portions of Unit 22D. Effective for the 2000-2001 regulatory year, the resident bull season was shortened in Unit 22B and the nonresident season was shortened in both Units 22B and 22D. More substantial reductions in hunting opportunity were not recommended because natural factors such as weather, range and predation are probably affecting moose abundance more than hunting. However, additional restrictions may be needed if we detect further declines. Efforts have been made and should continue to educate the public about the population decline and the importance of abiding by the new regulations. Additionally, brown bear hunting regulations were liberalized in Unit 22. Further liberalization of brown bear regulations may be recommended if current regulatory changes do not result in a noticeable reduction in bears in the unit.

Unit 22C is the only portion of Unit 22 where recruitment estimates remain high and the population appears to be increasing. Concern about overuse of limited winter habitat and the low bull:cow ratio in Unit 22C led to establishment of a registration hunt for up to 20 antlerless moose during the 2000–2001 season. After an updated population estimate is obtained from the 2001 census planned for Unit 22C, the number of antlerless permits may be revised.

More frequent moose density estimates throughout the unit would be desirable. Presently, if weather is not a factor, each subunit is censused at best, once every 5 years. This is not often enough to identify and respond promptly to downward trends. Consideration should be given to initiating more frequent, less precise censuses over larger areas to get more timely information on population trends. Although we do not believe that low bull:cow ratios are influencing productivity in Unit 22, it has been 5 years since fall composition surveys have been completed. Composition surveys in the most heavily hunted drainages of Units 22B, 22C, and 22D should be a priority if conditions are suitable.

Interest in hunting moose in Unit 22 was moderate throughout the 1970s. Hunter effort and harvest peaked in the mid 1980s when the moose population was at it height. As moose densities, harvest, and effort decreased, hunter success rate has remained fairly constant and relatively high, from 39–50% over the last decade (Table 1).

The number of bulls along the road system is now low. Since their introduction during the 1980s, the use of four-wheelers has become extremely popular among Seward Peninsula residents, and their use has allowed hunters to extend their hunting area. Because of open terrain throughout 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 may be necessary, including, but not limited to, antler size restrictions for bulls, shorter seasons, and vehicle access restrictions. The department should work closely with the public, Advisory committees, and the Regional Advisory Council to ensure that recommendations and future regulations will be acceptable to the widest possible range of users.

Compliance with regulations and harvest reporting is thought to be reasonably high in the Nome area. However, illegal and unreported harvests remain problems in the remainder of the unit where some residents take moose out of season and do not acquire licenses and harvest tickets before hunting. Public education programs and a visible enforcement effort must be maintained to gain compliance with current regulations. The community-based big game harvest assessment program started in 1999 should be continued and extended to provide more accurate estimates of moose harvest and subsistence use of moose by village residents.

If we have sufficient staff time and money, assessment of moose habitat in Units 22B and 22C should be initiated. It would be desirable to examine critical wintering areas and determine the quantity and quality of available browse and ultimately determine the carrying capacity for the most heavily hunted portions of the unit.

In summary, the following actions are recommended:

- Conduct more frequent, less precise censuses over larger areas to get more timely information on population trends
- Resume fall composition surveys in Units 22B, 22C and 22D
- Expand the community-based big game harvest assessment program
- Work with the public to ensure recommendations and future regulations will be acceptable to the widest possible range of users
- Begin habitat assessment of critical wintering areas in Units 22B and 22C

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Table 1 Unit 22 historical moose harvest by sex, hunter effort, and success rate for regulatory years 1969–1999

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

[a]Minimum known number of hunters.

Table 2 Unit 22 short yearling recruitment surveys, spring 1991–2000

Survey area	Nr calves	Nr adults	Total	Percent calves
Unalakleet, Egavik, Tagoomenik, Shaktoolik, Ungalik (Unit 22A)				
2000	14	160	174	8
Fish River (Unit 22B)				
1991	12	202	214	6
1993	11	227	238	5
1994	15	255	270	6
1995	16	384	400	4
Niukluk River (Unit 22B)				
1991	30	319	349	9
1995	13	133	146	9
1997	6	77	83	7
2000	9	81	90	10
Koyuk River (Unit 22B)				
1999	21	208	229	9
2000	19	223	242	8
Snake River (Unit 22C)				
1993	15	63	78	19
1994	18	39	57	32
1999	33	92	125	26
2000	21	98	119	18
Lower Kougarok River (Unit 22D)				
1991	14	103	117	12
1994	33	153	186	18
1995	42	227	269	16
2000	16	168	184	9
Kuzitrin/Noxapaga River (Unit 22D)				
1991	23	191	214	11
1994	16	71	87	18
2000	14	203	217	6
Kuzitrin Below Bridge (Unit 22D)				
2000	17	271	288	6
American River (Unit 22D)				
1995	51	248	299	17

Table 3 Residency and success of moose hunters in Unit 22, regulatory years 1997–1998 and 1998–1999

Regulatory Year/Unit	Residency of successful hunters					Residency of unsuccessful hunters				
	Unit[a]	State[b]	Nonresident	Unknown	Total	Unit[a]	State[b]	Nonresident	Unknown	Total
1997–1998										
22A	17	2	3	0	22	36	2	4	0	42
22B	33	16	14	9	72	32	10	7	3	52
22C	14	5	0	8	27	25	7	0	4	36
22D	37	9	3	16	65	61	6	4	5	76
22E	14	0	1	1	16	3	0	0	0	3
22 unknown	0	1	0	0	1	8	2	0	1	11
Total	115	33	21	34	203	165	27	15	13	220
1998–1999										
22A	12	3	1	0	16	50	3	8	0	61
22B	38	6	14	0	58	54	14	5	0	73
22C	31	8	0	0	39	37	9	1	2	49
22D	63	17	8	1	89	90	11	7	1	109
22E	9	0	0	0	9	2	1	0	0	3
22 unknown	0	0	0	0	0	4	0	0	0	4
Total	153	34	23	1	211	237	38	21	3	299

[a] Resident of Unit 22
[b] Other Alaska resident

Table 4 Chronology of Unit 22 moose harvest by month, regulatory years 1997–1998 and 1998–1999

Regulatory year/	Month of harvest									
Unit	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Unknown	Total
1997–1998										
22A	4	15	0	0	2	0	0	0	1	22
22B	5	43	9	9	3	2	0	0	1	72
22C	0	26	0	0	0	0	0	0	1	27
22D	10	41	9	1	2	1	0	0	1	65
22E	4	2	1	0	3	1	1	4	0	16
Unknown	0	0	0	0	0	0	0	0	1	1
Total	23	127	19	10	10	4	1	4	5	203
1998–1999										
22A	6	9	0	0	1	0	0	0	0	16
22B	3	33	9	7	5	1	0	0	0	58
22C	0	38	0	0	0	0	0	0	1	39
22D	4	67	7	0	7	3	0	0	1	89
22E	2	1	0	0	0	2	0	4	0	9
Total	15	148	16	7	13	6	0	4	2	211

Table 5 Means of transportation reported by successful Unit 22 moose hunters, regulatory years 1995–1999

Regulatory Year/Unit	Aircraft	Horse	Boat	3- or 4-Wheeler	Snowmobile	Off-road vehicle	Highway vehicle	Unknown	Total
1995–1996									
22A	0	0	19	4	1	0	0	0	24
22B	8	0	10	18	11	2	1	2	52
22C	0	0	0	9	0	2	5	1	17
22D	6	0	19	19	10	2	18	2	76
22E	0	0	0	3	12	0	0	0	15
Unknown	0	0	0	0	0	0	0	1	1
Total	14	0	48	53	34	6	24	6	185
1996–1997									
22A	2	0	7	0	1	0	0	0	10
22B	4	0	7	26	14	2	5	3	61
22C	0	0	4	4	0	3	14	0	25
22D	2	0	15	29	14	1	21	1	83
22E	0	0	2	0	17	0	0	0	19
Total	8	0	35	59	46	6	40	4	198
1997–1998									
22A	0	0	16	3	2	0	1	0	22
22B	3	0	22	26	11	1	7	2	72
22C	1	0	2	9	0	3	10	2	27
22D	1	0	22	21	3	1	17	0	65
22E	1	0	4	3	7	0	0	1	16
Unknown	0	0	1	0	0	0	0	0	1
Total	6	0	67	62	23	5	35	5	203
1998–1999									
22A	0	0	10	6	0	0	0	0	16
22B	3	0	16	21	16	1	1	0	58
22C	0	0	11	6	0	3	19	0	39
22D	1	0	26	30	10	2	20	0	89
22E	0	0	1	2	6	0	0	0	9
Total	4	0	64	65	32	6	40	0	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 currently rank second to caribou as a source of meat for most local residents. Nonlocal residents and nonresident hunters also avidly hunt moose. Moose hunting provides significant income to guides, outfitters and transporters who operate in Unit 23. The wide distribution and abundance of moose along river corridors makes them important to nonconsumptive users, such as viewers and photographers.

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

MANAGEMENT DIRECTION

MANAGEMENT GOALS AND OBJECTIVES

- Assess whether to continue department involvement in the Noatak and Tagagawik moose radiotelemetry projects.
- Monitor the size and sex/age composition of moose populations in the Noatak, Squirrel, upper Kobuk, Selawik/Tagagawik rivers and Northern Seward Peninsula drainages through aerial censuses.
- Maintain a minimum November bull:cow ratio of 40:100 and a minimum density of 0.5–1.0 moose/mi^2 in each major Unit 23 drainage.

METHODS

Population trend and sex/age composition data were obtained from aerial moose censuses. In November 1997, the National Park Service (NPS) used the Gasaway technique (Gasaway et al. 1986) to census the Salmon drainage (891.4 mi^2) with assistance from the Selawik National Wildlife Refuge (SNWR) and Bureau of Land Management (BLM). The Squirrel River drainage was censused during November 1998 by the department with assistance from BLM, NPS and SNWR. The 1998 Squirrel census was the first time the spatial census technique (VerHoef unpub.) was used to census moose in Unit 23. The upper Selawik River drainage (1045.9 mi^2) was censused by SNWR with assistance from the department and NPS during November 1999 (after this reporting period) using the Gasaway technique.

A 1627.9-mi^2-census area was delineated in the middle and lower portion of the Noatak River drainage in 1993. This area was censused using the Gasaway technique in November 1993 as well as April–May 1997 and 1998. This census area was extended downstream to include the riparian corridor of the Noatak River (i.e. high quality habitat) for the spring 1999 census, and the spatial technique was employed. This expansion increased the total area to 2386.9 mi^2. For all spring censuses: 1) sample units were stratified as 'high' or 'low;' 2) 'desktop' stratification was employed; and 3) observer sightability was not estimated. The primary purpose of spring censuses was to estimate calf recruitment rather than density.

Natural mortality, distribution and movements of moose in the Noatak and Tagagawik river drainages were determined using standard radiotelemetry techniques (Dau and Ayres 1993). 'Collar year' was defined as April 1–March 31. The cooperative agreement established in 1992 between the department and NPS for the Noatak moose telemetry project lapsed in 1995. The objectives of this study were to: 1) evaluate moose distribution and movements to establish a census area in the middle-lower Noatak drainage; and 2) monitor adult moose mortality. In April 1998 the NPS and SNWR initiated a separate moose telemetry study in the western portion of the 1992 Noatak study area to: 1) evaluate moose calf production and early survival and 2) describe habitat characteristics of calving locations; and 3) monitor age specific mortality and productivity of cow moose. We felt the cumulative impacts of 2 independent moose telemetry studies in the same area were excessive. Therefore, in April 1999 the department and NPS removed 26 collars in the state frequency band. All collars on Noatak bulls were removed at this time. The remaining 'state' collars on Noatak cows will be removed without replacement when their deployment approaches 4 years.

The cooperative agreement established in 1993 between the department and SNWR regarding the Tagagawik moose telemetry project also lapsed. The objectives of this project were similar to the objectives of the 1992 Noatak moose telemetry project. The department has had no involvement in this project since 1996, and the SNWR began removing collars in the state frequency band during April 1998. The SNWR continued to collar moose along the Tagagawik and Selawik rivers in 1998 and 1999 using federal transmitter frequencies.

Harvest information was derived from hunter harvest reports, the Noatak and Tagagawik moose telemetry projects, community harvest estimates and casual conversations with local residents. The term "nonlocal hunter" collectively refers to Alaskan residents who reside outside Unit 23, as well as nonresident and alien hunters.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Fall moose censuses indicate Unit 23 moose densities currently range about 0.5–1.0 moose mi^2 (Table 1). This is lower than most other portions of Alaska (Dau and Ayres 1996). The subjective impression of department staff, federal agency biologists, local residents and some commercial operators is that moose populations in most of Unit 23 are stable. The exception to this is the Noatak River drainage where moose appear to be declining. Without additional census information, only large changes in moose population size or composition will likely be detectable in any drainage and we will be unable to quantify such changes when they occur.

In 1992 we abandoned trend counts for monitoring moose populations in Unit 23 and began conducting Gasaway censuses. Our approach was to census moose each fall in 1 of 5 portions of Unit 23 on a rotating basis. We emphasized fall censuses to estimate bull:cow ratios. In addition, we intended to supplement large (1400–2000 mi^2) fall censuses with reduced (800–1000 mi^2) fall censuses (i.e., subsets of original census areas) using modified techniques whenever possible during intervening years. During the last 9 years it has become apparent this approach will not provide estimates of abundance or composition frequently enough for management purposes throughout the unit. Many biologists feel ≥ 5 data points are necessary to evaluate population trend. Therefore, under the current approach it will be 2012 before this is possible in any portion of Unit 23. Realistically, the current approach will probably require much longer than this to complete 5 censuses in any drainage because weather or snow conditions sometimes delay censusing an area for years. Also, fall weather conditions rarely allow a full census to be completed in 1 area and a reduced census in another area during any single year.

Although Gasaway census areas are much larger than the trend count areas used to monitor moose populations during the 1980s, they may still be influenced by changes in distribution of moose. Distribution is usually considered with regard to snow-induced movements affecting census results over a span of days or weeks. Distribution may also change over longer periods, e.g. years, in relation to density. For example, during the late 1980s moose were abundant in the Anisak River, Aklumayak Creek and many small creeks in the Baird Mountains. Now, it appears substantially fewer moose occur in these areas. In contrast, during this same period moose density in the Mulgrave Hills appears to have declined to a much lesser degree. I suspect the Mulgrave Hills are higher quality moose habitat (by virtue of vegetation, predator numbers, snow conditions, etc.) than areas e.g. the Anisak River. It appears moose density in the Noatak River drainage has not uniformly declined throughout all habitats. Instead, declines have first occurred and been most pronounced in marginal habitats. The current Noatak census area includes a large proportion of high quality moose habitat so is probably less sensitive to changes in abundance than areas having a larger proportion of marginal habitat.

An alternative to the current moose census approach is to cover fewer (e.g., 2 or 3), but much larger areas (e.g., 5000–10,000 mi^2) on a rotating basis using the spatial estimation technique. For example, census areas might be 1) that portion of the Noatak drainage below and including the Anisak River; 2) that portion of the Kobuk River between Nutuvukti Lake and the Kobuk Sand Dunes; and 3) the Buckland-Tagagawik-Selawik drainages. The spatial moose census technique appears better suited to covering very large areas than the Gasaway technique. The informational costs of this approach would probably be reduced precision of individual density and composition estimates. Hopefully, this would be more than offset by more frequent censuses for larger areas. Where bull:cow ratios are not a concern, this approach may provide comparable estimates of moose density during spring and fall. If so, this would more than double the likelihood of completing a census during the year it was scheduled.

As noted above, moose in the middle and lower Noatak drainage are probably declining. Telemetry information in the lower and middle Noatak drainage indicates the mean adult cow mortality rate was about 15% annually (range 0–26%; SD = 10) between 1992 and 1998 (Table 2). In contrast, spring censuses indicate recruitment in this area has averaged only 9% annually (range 6–12%; SD = 3; Table 3). Recent reports of declining moose and low calf survival in the Noatak River drainage from local residents and some commercial operators are consistent with our census and telemetry results. Unfortunately, we do not have >1 fall or spring population estimate to allow for a direct comparison of density. However, comparison of the November 1993 and April/May 1999 censuses (Tables 1 and 3, respectively) indicate moose are declining in the Noatak River drainage.

Sightability of moose was poor during the spring 1997 and 1998 Noatak censuses and we probably underestimated the total population for both censuses; therefore, we do not report them in Table 3. Survey conditions were good to excellent during the 1999 spring Noatak census and we completed it within an 8-day time span. Therefore, we have no reason to suspect the 1999 spring population estimate is biased.

We looked at telemetry information for moose collared within the 1999 census area collected between 1992 and 1999 to evaluate whether spring and fall census areas were missing moose due to seasonal movements, and whether the November 1993 and April/May 1999 density estimates are comparable. During spring (February 1 to May 31, all years combined) we recorded 593 locations (285 for bulls and 308 for cows) for 139 moose. One hundred twenty one locations (20%) for 52 moose (32 bulls and 20 cows) occurred outside the November 1993 census area. By expanding the census area in 1999, 15% of spring locations occurred outside the census area. During fall (October 1–December 31, all years combined), we recorded 265 locations (127 for bulls and 138 for cows) for 90 moose. Fifty fall locations (19%) for 26 moose occurred outside the 1993 census area. By expanding the census area in 1999 this percentage was reduced to 16%. These results suggest we miss approximately the same proportion of moose (15–20%) through local movements during spring and fall censuses.

Two considerations reduce comparability of the November 1993 and April/May 1999 censuses. First, telemetry information indicates moose that spend the summer in upper portions of the Squirrel River drainage spend the winter in that portion of the lower Noatak drainage included by the 1999 census extension. Second, the extension is essentially all preferred habitat. Both factors should have increased the number and density of moose during the April/May 1999 census relative to the November 1993 census. In contrast, the total estimated population declined from 1125 to 1000 moose from November 1993 to April/May 1999 despite the addition of 759 mi^2 of high quality habitat to the census area (Tables 1 and 3). Also, adult density declined from 0.59 to 0.47 moose/mi^2 during this period (total density declined from 0.69 to 0.50 moose/mi^2 during this period).

Population Composition

Fall censuses indicate bull:cow ratios are above or near the population objective of 40:100 throughout Unit 23 (Table 1). In areas only recently exploited by nonlocal hunters and commercial operators, e.g. the Selawik and upper Kobuk river drainages, bull:cow ratios are similar to lightly hunted areas, e.g. Kobuk Valley National Park. The low bull:cow ratio in the

Noatak River drainage compared to other drainages in Unit 23 is probably attributable to its long history of commercial activity and trophy hunting by nonlocal hunters.

In 1992, the bull:cow ratio in the Squirrel River drainage was 37:100 (Morkill and Dau 1993) while in 1998 it was 50:100. Between 1992 and 1998 the number of nonlocal hunters and commercial operators in the Squirrel River drainage appeared to increase substantially. Therefore, it is hard to believe the bull:cow ratio in this drainage actually increased during this time. I suspect the point estimates slightly underestimate the bull:cow ratio in 1992 and overestimate it in 1998. Indeed, the 80% confidence intervals for the 1992 and 1998 bull:cow estimates overlap (upper range for 1992 = 43 bulls:100 cows; lower range for 1998 = 39 bulls:100 cows). Deep snow and blizzards occurred during the 1992 census while in 1998 there was barely enough snow to conduct the census. These differences probably affected moose movements and distribution to reduce comparability of the 1992 and 1998 censuses. In most years snow-induced emigration of moose from the upper portions of Squirrel River drainages is pronounced. However, the timing of these movements varies among years in relation to temporal patterns of snow accumulation. I think the actual Squirrel bull:cow ratio is currently 40–50:100. The 1992 and 1998 bull:cow estimates indicate bulls have not been depressed by recent increases in hunting effort in this drainage, and that this ratio is above the population objective. The lightly hunted Kobuk Valley National Park may act as a reservoir for moose in the Squirrel River drainage.

The 1997–1999 spring calf:adult ratios in the Noatak River drainage (Table 3) are disturbing in relation to adult cow mortality (Table 2). The perceptions of department and NPS staff as well as many local residents and commercial operators agree that brown bear predation on calves during summer is probably reducing recruitment. Unfortunately, inadequate snow prevented us from censusing moose in the middle and lower Noatak River drainage during November 1998 and 1999. As a result, we are uncertain what the current population size is.

Distribution and Movements

During the reporting period the distribution and movement of collared moose in the Noatak and Tagagawik telemetry projects were similar to previous years (Dau and Ayres unpublished report, Kotzebue office). However, few relocation flights were conducted for either project during this reporting period. Collared moose in the Tagagawik River drainage have generally exhibited more site fidelity than moose in the Noatak River drainage.

MORTALITY

Harvest

Seasons and Bag Limits.

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
1997–1998		
Noatak drainage		
One moose; however,	1 Aug–15 Sep	

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
antlerless moose may be taken only from 1 Nov–31 Mar.; cows with calves may not be taken	1 Oct–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–15 Sep
Remainder of Unit 23		
One moose, cows with calves may not be taken	1 Aug–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–20 Sep
1998–1999		
Unit 23 north of and including the Singoalik River drainage		
One moose; cows with calves may not be taken	1 Jul–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–20 Sep
Noatak drainage		
One moose; however, antlerless moose may be taken only from 1 Nov–31 Mar; cows with calves may not be taken	1 Aug–15 Sep 1 Oct–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–15 Sep
Remainder of Unit 23		

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
One moose, cows with calves may not be taken	1 Aug–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–20 Sep

Board of Game Actions and Emergency Orders. The board reauthorized antlerless moose seasons for the 1997–1998 and 1998–1999 regulatory years. At the fall 1997 meeting in Nome, the board adopted regulations allowing a 1 July season opening for a bag limit of one moose for resident hunters in the area north of and including the Singoalik River drainage. The board adopted a nonresident season and bag limit with antler restrictions similar to the remainder of Unit 23. These changes became effective during the 1998–1999 regulatory year.

Hunter Harvest. A substantial number of moose harvested by unit residents are not reported through the harvest ticket system each year. Community-based harvest assessments indicate approximately 325 moose were harvested annually by local residents during recent years (Table 4). In contrast, during the 1994–1995 through 1998–1999 regulatory years, the mean annual reported harvest for Unit 23 residents was only 20 moose (SD = 6), or 6% of the actual harvest. Although moose harvest ticket data appear to grossly underestimate local effort and harvests, these data probably reflect temporal harvest trends for residents of Unit 23 reasonably well. Harvest report data for nonlocal hunters appear more accurate than for local hunters yet, even so, represent minimum estimates of effort and harvests. Combining harvest report data (to estimate harvests by nonlocal hunters) and community harvest assessment estimates (to estimate harvests by local hunters after subtracting moose reported on the harvest ticket system) indicates a minimum of 450–475 moose were taken annually in Unit 23 during the reporting period.

The community-based estimate of 325 moose harvested by local residents was determined during a period when caribou were readily available. If caribou availability decreases through shifts in distribution or population decline, harvest of moose by local residents will almost certainly increase. Currently, subsistence need for moose in Unit 23 is 325–400 moose annually.

The total Unit 23 moose harvest, as indicated by the harvest report system, increased slowly from the late 1970s until the 1988–1989 regulatory year. Since then, total unit harvest has slowly declined despite an increase in the total number of moose hunters (Fig 1). Total reported moose harvests (from the harvest ticket system) during 1997–1998 and 1998–1999 were within the range of values previously recorded (Table 5, Fig 1). As in the past, the reported harvest of female moose was small during 1997–1998 and 1998–1999 in terms of absolute numbers (Table 5), and in relation to the total harvest (4% and 5%, respectively).

Harvest trends are most meaningful when considered by drainage. The Noatak is the only drainage where harvests have declined since 1988–1989 (Fig 2). Prior to 1996–1997, more moose were harvested in the Noatak River drainage than any other drainage in Unit 23. During 1998–1999, the number of moose harvested in the Noatak ranked third behind the Kobuk and Selawik river drainages. In contrast to the declining trend in harvest from the Noatak, harvests have slowly increased in the Selawik and Kobuk river drainages and remained stable in Wulik/Kivalina rivers and northern Seward Peninsula drainages from 1988–1989 through the present time (Fig 2). The decline in harvest from the Noatak River drainage has been at least partly attributable to restrictions on access and moose hunting seasons and bag limits imposed since the 1988–1989 regulatory year. The decline may also be partly attributable to declining numbers of moose and crowded hunting conditions causing highly mobile nonlocal hunters to find more productive and aesthetically pleasing portions of the unit to hunt.

There has been a gradual decline in the number of medium bulls (30-<50-in.) harvested in Unit 23 (Fig 3). As with total harvest levels, harvests by antler width should be evaluated by drainage to assess their biological significance.

None of 18 collared bulls were harvested in the Noatak River drainage during fall 1997, and 1 of 2 collared bulls was harvested during 1998 (Table 2). No collared cows were harvested during either year. Hunters harvested a mean annual average of 14% (SD = 3) of collared Noatak bulls between 1992 and 1998. This probably overestimates the actual harvest rate for bulls because only large bulls, which are strongly selected by nonlocal hunters, were collared.

In 1997, no collared moose were harvested in the Tagagawik telemetry study (Table 7). In 1998, moose telemetry data were not available from the SNWR.

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

Hunter Residency and Success: The total number of Unit 23 moose hunters exceeded historic levels in both 1997–1998 and 1998–1999 thus continuing a trend of increasing numbers of hunters that began in the late 1970s (Table 5, Fig 1). In contrast, success rates during these years were the lowest ever reported although differences were small. Success rates have gradually declined since the 1988–1989 regulatory year (Fig 4).

Trends in hunter numbers within Unit 23 are most meaningful when local and nonlocal hunters are considered separately. The number of local resident moose hunters, as indicated by the harvest ticket system, declined linearly since the late 1970s ($R^2 = 0.77$, $P<0.001$; Fig 5). This data suggest a lower asymptote in number of local moose hunters may have been reached around the 1994–1995 regulatory year. Local residents report their decline in moose hunting is the result of increased availability of caribou.

Between the late 1970s and 1998–1999 regulatory year the number of nonlocal hunters increased linearly ($R^2 = 0.90$, $P<0.001$) in Unit 23 (Fig 5). The strength of this relationship is surprising given annual variability in hunting conditions (weather, onset of freeze-up, water levels, etc), regulatory changes, availability of commercial services, economic considerations (e.g. the cost of airline tickets) and other factors that affect hunting in Unit 23. Trends in numbers of nonlocal resident Alaskan hunters and nonresident hunters have been similar since the late 1970s. Factors contributing to this increase include 1) more commercial operator activity in Unit 23; 2) increasingly restrictive hunting regulations for moose and other species outside of Unit 23, especially for nonresident hunters; 3) word of mouth advertisement of good hunting in Unit 23; and 4) the scarcity of trophy bulls in other units. The lower bull:cow ratio in the middle Noatak River drainage as compared to the Salmon and upper Kobuk river drainages are probably the result of trophy hunting by nonlocal hunters.

Recent widespread use of float-equipped airplanes by transporters, greater use of 4-wheelers by guides and increasing numbers of village residents transporting nonlocal hunters via boat continued to reduce the number of refugia available to moose in Unit 23. Demand for transporter services by nonlocal hunters continued to exceed availability despite growth of this industry. As in the past, we continued to receive reports of illegal transport of hunters via boat and airplane. The large disparity between transporter supply and demand by nonlocal hunters means Unit 23 could experience rapid and substantial increases in numbers of nonlocal hunters if transporter services suddenly increased. This could further reduce the quality of hunting in Unit 23, intensify conflicts between local and nonlocal hunters and increase moose harvests.

Harvest Chronology: Despite an 8-month moose season in most of the Unit, an average 75% of the reported moose harvest occurred during the month of September between 1988–1989 and 1998–1999. In 1997–1998, 75% of the harvest occurred during September, and in 1998–1999 this percentage was 82%. Virtually all sport hunting occurs during this time because weather is favorable for hunting and conducive to airplane and boat access, it entirely encompasses the nonresident season, and bulls have completely developed antlers free of velvet.

Transport Methods: As in the past, airplanes were the primary mode of transportation for hunters who reported hunting moose in Unit 23 (Table 6). Hunters using airplanes took 94 moose (59% of the total reported harvest) during 1997–1998, and 113 moose (72%) in 1998–1999. Sixty seven percent of all hunters reported using airplanes to access moose hunting areas in 1997–1998; in 1998-1999, this percentage was 73%. Most nonlocal hunters at least initially access hunting areas using airplanes. Snow machines and boats were the next most commonly used means of transportation for taking moose during this reporting period. Local noncompliance with reporting requirements causes harvest data to overestimate reliance on airplanes and underestimate use of boats and snow machines for hunting moose.

Other Mortality

Noatak moose telemetry study. Natural mortality rates were 10% and 7% during the 1997–1998 collar year for bulls and cows, respectively (Table 2). During the 1998–1999 collar year these rates were 22% and 26%, respectively. The age structure of our collared sample of moose has been older than the population, especially for bulls, because: 1) we have not collared obviously young or small bulls; 2) we have not collared adult moose annually; and 3) we have not collared female calves in proportion to population recruitment. As a result, telemetry data have probably overestimated annual mortality rates. Even so, these data are useful as a 'red flag' of high mortality events as occurred during the early 1990s.

Tagagawik moose telemetry study. During the 1997–1998 collar year, natural mortality rate for bulls was 12% and cows were 5% (Table 6). No data were available from the SNWR for the 1998–1999 collar year. As with the Noatak moose telemetry study, the age structure of collared moose is probably older than the Tagagawik moose population, and we probably overestimate mortality as a result.

HABITAT

Assessment

Moose habitat was not evaluated in Unit 23 during this reporting period.

Enhancement

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

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

The major nonregulatory management issue in Unit 23 is controversy over hunting effort and hunting locations among local and nonlocal users. We initiated a user-issues planning process and several meetings were held with the principal stakeholders to discuss the issue. Additional meetings, objectives and planning are needed to complete the process.

CONCLUSIONS AND RECOMMENDATIONS

Numbers of commercial operators, nonlocal hunters and nonconsumptive users are increasing in Unit 23. In addition, greater utilization of float planes, boats and 4-wheelers by commercial operators are reducing refugia available to moose. Despite these trends, current harvest levels appear to be below sustainable levels on a unit-wide basis. However, harvests should be assessed in relation to moose population size and composition for individual drainages, and possibly even portions of drainages where harvest pressure varies (e.g. in the Kobuk River drainage). A unit-wide user issues planning process was initiated in January 1998.

In summary, I recommend the following actions:

- Continue the Unit 23 user issue planning process to address increasing conflicts between local and nonlocal hunters as well as threats to resident wildlife populations, especially moose, from increasing harvest pressure.

- Conduct community-based moose harvest estimates in villages throughout Unit 23.

- Maintain a minimum November bull:cow ratio of 40:100 and a minimum density of 0.5–1.0 moose mi^2 in each major drainage of Unit 23.

- Consider modifying the approach to monitor moose populations in Unit 23 to census larger areas more frequently than the current approach allows. Cooperation with federal agencies will be necessary for this alternative to be effective.

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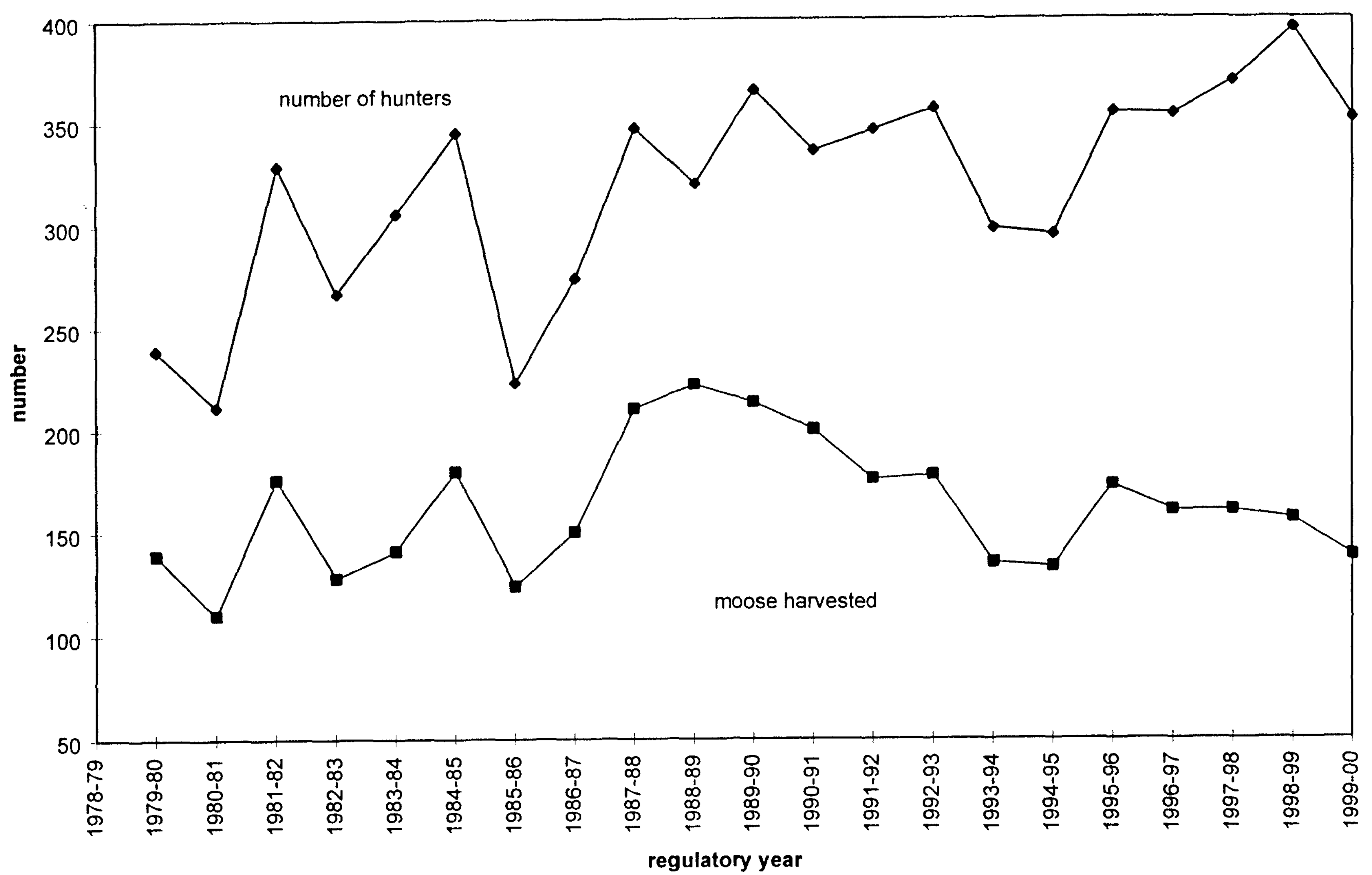

Figure 1 Unit 23 moose hunters and harvests, 1979-80 through1998-99

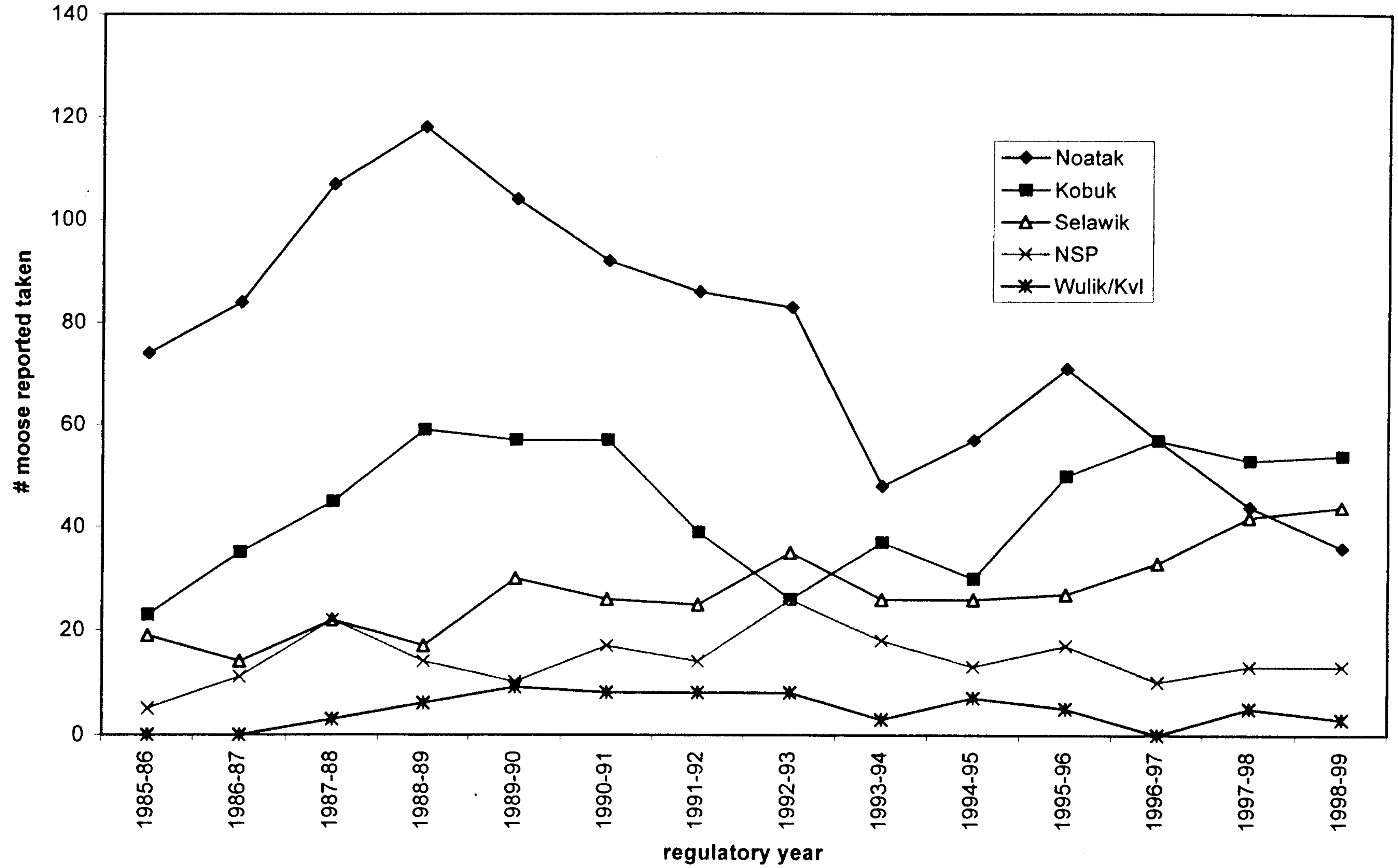

Figure 2 Unit 23 moose harvest by drainage, 1985-1986 through 1998-1999

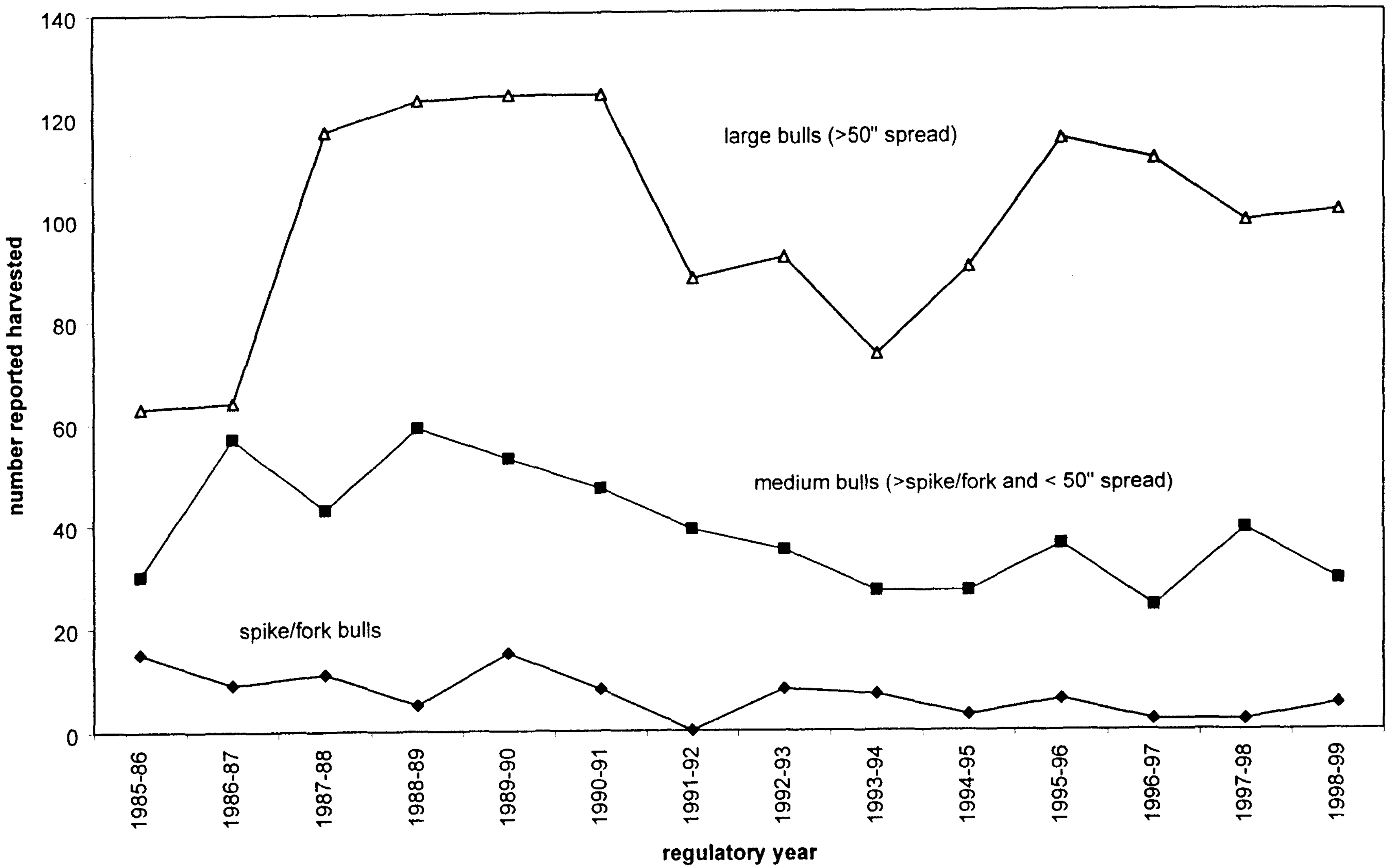

Figure 3 Unit 23 moose harvest by antler-width classes, 1985-1986 through 1998-1999

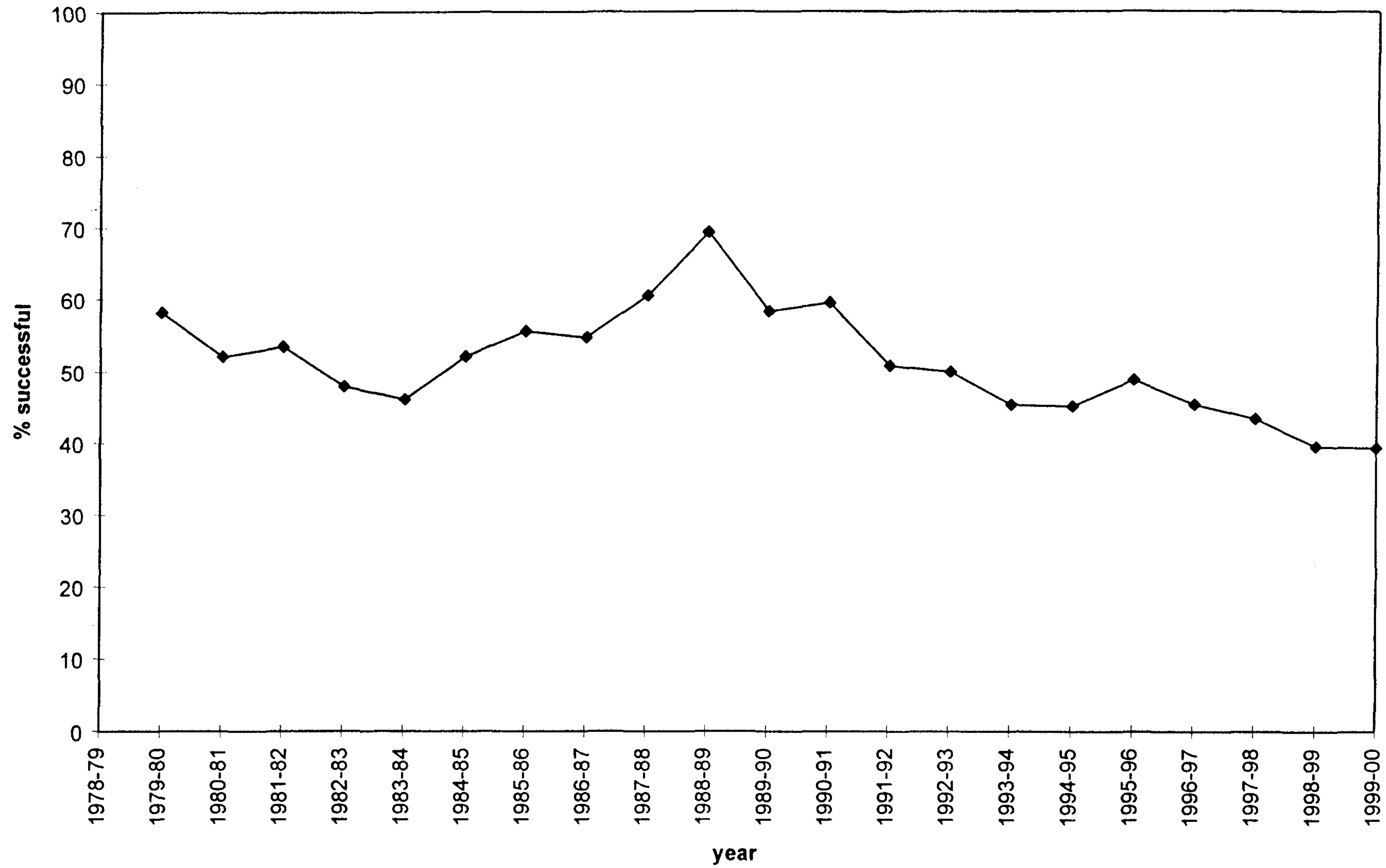

Figure 4 Unit 23 moose harvest success rate, 1978-1979 through 1998-1999

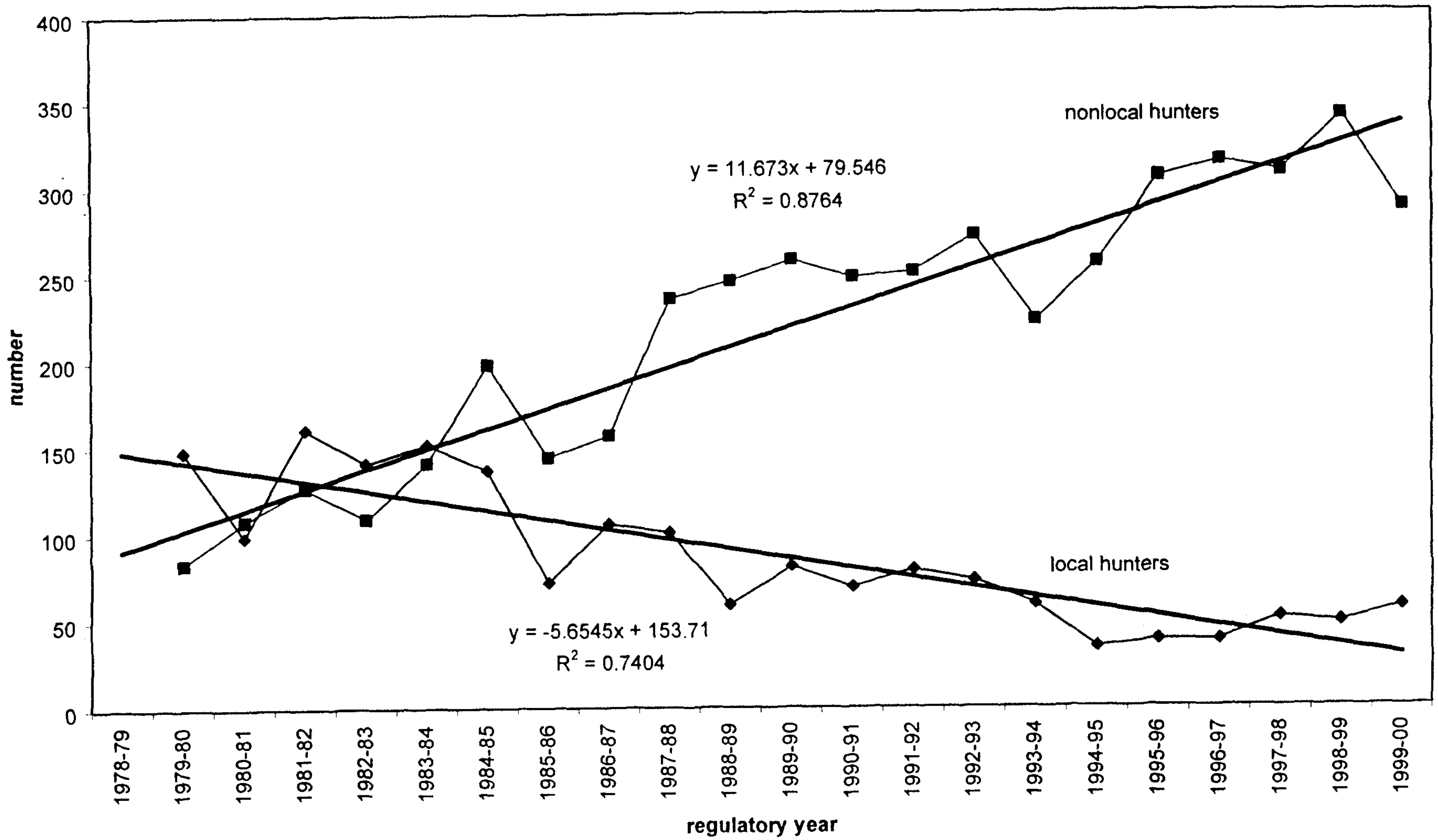

Figure 5 Numbers of local and nonlocal moose hunters in Unit 23, 1978-1979 through 1998-1999

Table 1 Summary of Unit 23 fall moose censuses, 1992–1999

Area	Year	Size (mi^2)	Est. # adults	Est. # calves	Total estimated	Total density ($no.mi^{-2}$)	Adult density ($no.mi^{-2}$)	Bulls:100 Cows	Calves: 100 Cows	Methods
Squirrel	1992	1440.9	1110	262	1372	0.95	0.77	37	33	Std. Gasaway
Squirrel	1998	1440.9	1304	233	1537	1.07	0.90	50	27	Spatial
Middle Noatak	1993	1627.9	956	169	1125	0.69	0.59	43	24	Std. Gasaway
Salmon	1995	891.4	594	186	780	0.87	0.67	78	56	Mod. Gasaway
Salmon	1997	891.4	895	129	1024	1.15	1.00	60	23	Std. Gasaway
Upper Kobuk	1995	1438.0	730	85	815	0.57	0.51	62	19	Linear Regression
Upper Selawik	1999	1045.9	569	80	648	0.62	0.54	68	23	Std. Gasaway

Table 2 Number of radio collared moose by collar-year (April 1–March 31) for the Noatak moose telemetry project, 1992–1993 through 1998–1999 (percentage of moose mortality in parentheses)

	Apr 92–Mar 93	Apr 93–Mar 94	Apr 94–Mar 95	Apr 95–Mar 96	Apr 96–Mar 97	Apr 97–Mar 98	Apr 98–Mar 99	Apr 99–Sept 99
Existing collared moose	0	33	37	45	82	66	64	45
Bulls	0	16	20	18	41	32	22	14
Cows	0	17	17	27	41	34	42	31
Moose collared	51	22	20	59	0	13	0	0
Bulls	26	14	10	37	0	0	0	0
Cows	25	8	10	22	0	13	0	0
Capture mortalities	6	1	0	0	0	1	0	0
Bulls	3	0	0	0	0	0	0	0
Cows	3	1	0	0	0	1	0	0
Missing moose	0	3	1	0	0	2	4	1
Bulls	0	2	1	0	0	1	4	0
Cows	0	1	0	0	0	1	0	1
Collars removed	0	0	0	0	0	0	0	26
Bulls	0	0	0	0	0	0	0	12
Cows	0	0	0	0	0	0	0	14
Total collared moose	45	51	56	104	82	76	60	18
Bulls	23	28	29	55	41	31	18	2
Cows	22	23	27	49	41	46	42	16
Harvest	3 (7)	4 (8)	7 (12)	8 (7)	6 (7)	6 (8)	0 (0)	1 (5)
Bulls	3 (13)	4 (14)	7 (24)	8 (13)	5 (12)	6 (19)	0 (0)	1(50)
Cows	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)
Natural mortality	9 (20)	10 (20)	4 (7)	14 (13)	10 (12)	6 (8)	15 (25)	2 (11)
Bulls	4 (17)	4 (14)	4 (14)	6 (6)	4 (10)	3 (10)	4 (22)	0 (0)
Cows	5 (23)	6 (26)	0 (0)	8 (8)	6 (15)	3 (7)	11 (26)	2 (12)
Total mortality	12 (27)	14 (27)	11 (20)	22 (21)	16 (19)	12 (16)	15 (25)	3 (17)
Bulls	7 (30)	8 (29)	11 (38)	14 (13)	9 (22)	9 (29)	4 (22)	1 (50)
Cows	5 (23)	6 (26)	0 (0)	8 (8)	7 (17)	3 (7)	11 (26)	2 (12)
Surviving moose	33	37	45	82	66	65	45	15
Bull	16	20	18	41	32	22	14	0
Cow	17	17	27	41	43	43	31	15

Table 3 Summary of Unit 23 spring moose censuses, 1997–1999

Area	Year	Size (mi^2)	Est. # adults	Est. # calves	Total estimate	Total density (no. mi^{-2})	Adult density (no. mi^{-2})	Calves: 100 Cows	Method
Tagagawik	1997	1000.9	952	191	1145	1.14	0.95	20	Std. Gasaway
Middle Noatak	1997	1627.9						8	Mod. Gasaway
Middle Noatak	1998	1627.9						12	Mod. Gasaway
Middle Noatak	1999	2386.9	1126	65	1191	0.50	0.47	6	Mod. Spatial

Table 4 Estimated moose harvest in Unit 23 villages (Subs. Div. unpub. data except as noted)

Village	Year of survey	Village pop. in survey year	No. moose reported harvested	Per capita moose harvest	Estimated village pop. in 1998	Estimated moose harvest in 1998
Kotzebue	1986	2681	65	0.024	2964	71
Noatak	1994	379	2	0.005	410	2
Kivalina	1992	344	17	0.049	349	17
Point Hope[a]	1992	685	14	0.020	787	14
Noorvik[b]	1998	598	37	0.062	598	37
Kiana[c]				0.062	402	25
Ambler[d]				0.082	315	26
Shungnak	1998	257	21	0.082	257	21
Kobuk[d]				0.082	102	8
Selawik[c]				0.062	746	46
Buckland[e]				0.102	408	42
Deering	1994	148	15	0.102	156	16
Total					7494	325

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

Table 5 Numbers of moose hunters by residency and success, and moose harvests by sex for Unit 23, 1979–1980 through 1998–1999

Year	Hunter residency				Total number hunters	Hunter success			Sex of moose harvested		
	Unit 23 resident	Nonlocal Alaska resident	Non-resident	Unk		Succ.	Unsucc.	Succ. rate	Males	Females	Unk. Sex
1979–1980	148	51	32	8	239	139	100	58	129	10	0
1980–1981	99	61	47	4	211	110	101	52	97	6	7
1981–1982	161	80	47	41	329	176	153	53	160	15	1
1982–1983	141	81	28	17	267	128	139	48	119	8	1
1983–1984	152	115	26	13	306	141	165	46	129	12	0
1984–1985	137	127	71	10	345	180	165	52	160	17	3
1985–1986	72	98	46	7	223	124	99	56	112	12	0
1986–1987	106	99	58	11	274	150	124	55	139	8	3
1987–1988	101	104	132	10	347	210	137	61	191	14	5
1988–1989	59	114	132	15	320	222	98	69	202	14	6
1989–1990	81	117	141	26	365	213	152	58	200	11	2
1990–1991	69	117	131	19	336	200	136	60	185	14	1
1991–1992	79	130	121	16	346	176	170	51	143	33	0
1992–1993	73	149	123	11	356	178	178	50	154	24	0
1993–1994	59	134	89	16	298	135	163	45	117	17	1
1994–1995	34	144	112	5	295	133	162	45	127	6	0
1995–1996	38	179	126	11	354	173	181	49	164	8	1
1996–1997	38	178	136	1	353	160	193	45	145	14	1
1997–1998	51	165	143	10	369	160	209	43	153	7	0
1998–1999	42	159	181	7	389	154	235	40	142	8	4

Table 6 Number of radiocollared moose by collar-year (1 Apr-31 Mar) for the Tagagwik moose telemetry project, 1994-1995 through 1997-1998 (percentage of moose that died reported by category in parentheses)

	Apr 94-Mar 95	Apr 95-Mar 96	Apr 96-Mar 97	Apr 97-Mar 98	Apr 98-Mar 99
Existing collared moose	0	42	36	45	56
Bulls	0	23	18	21	20
Cows	0	19	18	24	36
Moose collared	50	0	16	18	0
Bulls	25	0	8	3	0
Cows	25	0	8	15	0
Collars removed	0	0	0	0	0
Bulls	0	0	0	0	0
Cows	0	0	0	0	0
Capture mortalities	0	0	0	1	0
Bulls	0	0	0	0	0
Cows	0	0	0	1	0
Missing moose	0	1	0	1	
Bulls	0	1	0	1	
Cows	0	0	0	0	
Total collared moose	50	41	52	61	
Bulls	25	22	26	23	
Cows	25	19	26	38	
Harvest	1 (2)	0 (0)	2 (4)	0 (0)	
Bulls	1 (4)	0 (0)	2 (8)	0 (0)	
Cows	0 (0)	0 (0)	0 (0)	0 (0)	
Natural mortality	7 (14)	5 (12)	5 (10)	5 (8)	
Bulls	1 (4)	4 (18)	3 (11)	3 (12)	
Cows	6 (24)	1 (5)	2 (8)	2 (5)	
Total mortality	8 (16)	5 (12)	7 (13)	5 (8)	6
Bulls	2 (8)	4 (18)	5 (19)	3 (12)	2
Cows	6 (24)	1 (5)	2 (8)	2 (5)	4
Surviving collared moose	42	36	45	56	
Bulls	23	18	21	20	
Cows	19	18	24	36	

Table 7 Number of moose hunters by transportation method in Unit 23, 1997–1998 and 1998–1999

Transportation method	Successful	Unsuccessful	Total
1997–1998			
Aircraft	94	155	249
Horse/dogteam	0	2	2
Boat	43	30	73
3/4-wheeler	10	3	13
Snowmachine	12	6	18
Off-road vehicle	0	0	0
Highway vehicle	0	2	2
Unknown	1	11	12
Total	160	209	369
1998–1999			
Aircraft	113	175	288
Horse/dogteam	1	0	1
Boat	25	51	76
3/4-wheeler	7	4	11
Snowmachine	6	2	8
Off-road vehicle	1	0	1
Highway vehicle	0	0	0
Unknown	3	7	10
Total	156	239	395

LOCATION

GAME MANAGEMENT UNIT: 24 (26,055 mi^2)

GEOGRAPHIC DESCRIPTION: Koyukuk River drainage above Dulbi River

BACKGROUND

Moose are broadly distributed throughout much of Unit 24 with densities (0.5–2.0 moose/mi^2) that are typical of Interior Alaska. Anecdotal evidence indicates the population was low prior to the 1930s, but increased during the 1930s–1950s (Huntington 1993). The rate of increase was probably 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. Populations apparently climbed again in the late 1980s, peaked around 1992, then fell gradually through the remainder of the 1990s.

Naturally occurring wildfires and floods are major forces affecting the productivity and diversity of moose habitat in this area. Habitat is excellent along most of the Koyukuk River lowlands, providing extensive areas of winter browse. Lightning-caused fire is a frequent event and large areas of the burned uplands are productive browse communities. Browse production does not appear to be limiting the size of the moose population at current moose densities based on personal observations.

The Koyukuk River and major tributaries are popular moose hunting areas for unit residents, other Alaska residents and nonresidents. The lower portion of the Koyukuk within Unit 24 has been the focus of most of our management effort because of the long history of use, higher moose densities, and increasing hunting activity. Hunting activity has also been increasing in other areas of the unit, including rivers accessible from the Dalton Highway. Two controlled use areas (CUA), the Koyukuk CUA and the Kanuti CUA, restrict use of aircraft for moose hunting activities. The Dalton Highway Corridor Management Area (DHCMA) prohibits use of off-road vehicles and firearms for hunting within 5 miles on either side of the Dalton Highway. Access to portions of the unit has increased with the opening of the highway.

There are several moose hunting seasons in Unit 24 that reflect the variety of moose densities and human-use patterns. In addition to the usual September hunting season, open seasons in December and March also provide hunting opportunity for residents of Alaska. A registration permit moose hunt was also established in 1996 in the Koyukuk Controlled Use Area, downstream from Huslia.

Annual reported harvests during the past 25 years were 44–230, but did not exceed 100 moose until 1980. Unreported harvests during this period probably were 160–300 moose per year (Woolington 1998). Since 1980, reported harvests have exceeded 100 moose each year. Local residents have become more aware of the importance of harvest reporting, resulting in increased compliance with reporting requirements.

MANAGEMENT DIRECTION

Management goals and objectives were formulated during this reporting period, as part of a planning process.

METHODS

We surveyed established trend count areas (TCA) of 4–6 contiguous "Gasaway" sample units from small fixed-wing aircraft (PA-18 or similar aircraft) to assess moose population parameters (Gasaway et al. 1986). Surveys were flown approximately 500 ft above ground level and at ground speeds of 70–80 mi/hr. Moose were classified as cows, calves, yearling bull (<30" antler width and no brow tine definition), medium bull (<50" antler width), or large bull (≥50" antler width). Sample units of approximately 12 mi^2 each were searched at a rate of approximately 5 min/mi^2 to ensure reasonably high sightability, minimal bias, and data comparability among years. Data was recorded on standard data forms and moose locations were also recorded on 1:63,000 USGS quadrangle maps. Surveys were not conducted until a minimum snow cover of approximately 12 inches had accumulated. This level of snow cover is important because snow depth influences sightability and moose distribution.

We conducted a population estimation survey (ADF&G files, 12 May 2000) in fall 1999 in the northern portion of Unit 24 that covered 8390 mi^2. Data from that survey were analyzed using the Geo-Statistical Population Estimator (GSPE) (J Ver Hoef, ADF&G, personal communication).

Hunter harvest was monitored by checking moose harvest reports and collecting information on hunter residency, moose ages, and antler sizes at a moose hunter checkstation operated on the lower Koyukuk River. We encouraged local residents to increase their harvest reporting by providing information at public meetings, checkstations, and village meetings. Hunting mortality and harvest distribution were also monitored through the statewide harvest ticket system, registration harvest tickets, and door-to-door subsistence surveys. General season hunters are sent 1 reminder letter to return harvest tickets. Hunters of permit hunts (drawing, registration, and Tier II hunts) are sent 1 reminder postcard, then called via telephone, and then sent a certified letter. Their names are withdrawn from the following year's permit hunts if no response is received. Information obtained from the reports and surveys was used to determine total harvest, harvest location, hunter residency and success, harvest chronology, and transportation used. Harvest data were summarized by regulatory year (RY = 1 Jul–30 Jun, e.g., RY99 = 1 Jul 1999–30 Jun 2000).

Predation was evaluated by interviewing trappers, field observations, and aerial wolf reconnaissance surveys in cooperation with the FWS.

No habitat assessment work was conducted during this reporting period.

We implemented an intensive planning process during this reporting period to address concerns over increasing numbers of hunters in the Koyukuk River Drainage. The planning process was initiated in winter 1999–2000, and a Koyukuk River Moose Hunters' Working Group (KWG) was formed with representatives from the state's advisory committees, the federal Western Interior Regional Advisory Council, and local commercial hunting guides. The planning group developed a draft 5-year Koyukuk River Moose Management Plan (ADF&G files) that was submitted to the Board of Game during their March 2000 meeting. The draft plan was used as a guide for management goals, objectives, activities, and biological decision-making criteria in this management report.

An additional outcome of the KWG, was the development of 2 moose management zones within the Koyukuk River drainage (Fig 1). Management zones were established to allow analysis of data and application of management strategies in the 2 areas of the drainage where moose densities, distribution, and harvest patterns were substantially different. The boundary between the 2 units was defined according to Universal Coding Units (UCU). Uniform Coding Units are statistical reporting areas used for data analysis in the statewide harvest reporting system. Management Zone 1 was a high-density moose area, with moose concentrated heavily along the river corridor. Hunter use in this zone was very high and increasing rapidly over the past 10 years. Management Zone 2 was mostly a low-density moose area, with moose broadly dispersed throughout. Hunter use in this zone is low and has been relatively stable over the past 10 years.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Status and trends of the moose population in an area as large and diverse as Unit 24 is difficult to determine with any degree of certainty. Most often, population size is described using generalities, and trends are discernible only for the few areas surveyed.

Moose are numerous in the Koyukuk River lowlands in the southern third of the unit (south of Hughes). The population may be declining in the Dulbi Slough, Huslia River Flats, and Treat Island areas (Tables 1–3). Moose densities often exceed 5 moose/mi^2 in these areas. Further up river, in the Batza Slough and Mathews Slough TCAs, we recently found moose densities of 1.9 and 0.3 moose per square mile, respectively (Tables 4 and 5), with no clear trend.

Moose densities were relatively low in the middle third of the unit (Hughes to Bettles, including the Kanuti CUA and the South Fork Koyukuk River drainage). Apparently, this portion of the population declined during the 1990s.

Population Size

In the previous reporting period, there were 5000–7000 moose in the southern portion of Unit 24. This estimate was based on the results of 1987 and 1997 population estimation surveys (Huntington 1998) and on extrapolations of density estimates obtained during trend count surveys (Woolington 1998). Additionally, there were 3000–4000 moose in the middle portion of Unit 24. This estimate was based on population estimation surveys of the Kanuti National Wildlife Refuge in 1989 and 1993 (Table 6) and the Dalton Highway Corridor in 1991 (Martin and Zirkle 1996). These surveys indicated a rather low overall early winter density of 0.42–0.76 moose/mi^2 (Woolington 1998).

There were 3000–4150 moose in the northern portion of Unit 24, including 1500–2000 moose within the Gates of the Arctic National Park. This estimate was based on the distribution of moose seen during a 1987 stratification survey, and a density estimate of 0.42 moose/mi^2 completed by Dale et al. (1995). Dale et al.'s estimate was based on 1990 data collected during their wolf predation study in the Alatna River drainage within Gates of the Arctic National Park. The total Unit 24 estimate presented in our previous report was 11,000–15,000 moose (Woolington 1998).

I estimated there were 9000 moose ± 1500 (7500–10,500) in Unit 24 during fall 1999 (Table 7). My estimate was based on our moose population estimation survey, which covered 8390 mi^2 of the Upper Koyukuk Drainage, and on Woolington's (1998) data. Separate estimates were made for Management Zone 1 and for Management Zone 2 to facilitate planning discussions with the KWG (Fig 1). Population of the Unit 24 portion of Management Zone 1 was likely 4000 moose, and the population of Management Zone 2 was probably 5000.

Population Composition

Composition data were available from aerial surveys conducted in cooperation with FWS staff from the Koyukuk National Wildlife Refuge and Kanuti National Wildlife Refuge (Tables 1–5). Results from surveys conducted in RY99 were variable. Bull:cow ratios were high, as in previous years, in the Batza Slough and Huslia River Flats TCAs and on the Kanuti Refuge. However, the Dulbi Slough, Treat Island, and Mathews Slough bull:cow ratios declined substantially. Franzmann and Schwartz (1998), suggested 20–30 bulls:100 cows is needed to ensure breeding of all available cows. Calf:cow ratios for the RY99 Mathews Slough TCA were unreliable due to low sample size.

Distribution and Movements

There is little data available on movements of moose within the unit. Thirteen moose radiocollared in winter 1984–1985 in northern Unit 21D migrated into the southwestern parts of Unit 24. Generally, moose are found at treeline in the northern part of Unit 24 during early winter and seem to move into the river bottoms 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, downstream from Huslia:		
RESIDENT HUNTERS: 1	5 Sep–25 Sep	

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
antlerless moose or 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side by permit.		
RESIDENT HUNTERS: 1 moose by permit.	1 Sep–25 Sep	
RESIDENT HUNTERS: 1 moose.	1 Dec–10 Dec 1 Mar–10 Mar	
NONRESIDENT HUNTERS: 1 antlerless moose, or 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side by permit.		5 Sep–25 Sep
Unit 24, the Koyukuk Controlled Use Area, upstream from Huslia:		
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 and Alatna River drainages within the Gates of the Arctic National Park		
RESIDENT HUNTERS: 1 moose.	1 Aug–31 Dec	No open season
Remainder of Unit 24.		
RESIDENT HUNTERS: 1 bull.	1 Sep–25 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or		5 Sep–25 Sep

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
antlers with 4 or more brow tines on 1 side.		

Board of Game Actions and Emergency Orders. Subsistence and general registration hunts were established in the Koyukuk CUA downstream of Huslia by the Board of Game in March 1996. This action was to counter a moose hunting closure by the Federal Subsistence Board. The federal board closed federally managed lands within one-half mile of the Koyukuk River in nearby Unit 21D, from the Kateel River to 40 miles upstream from the mouth of the Koyukuk, for all but local rural residents. This closure was prompted by perceived declines in moose availability for local residents and by an increase in moose hunters. Two separate registration hunts were established. A subsistence registration hunt was opened to all Alaska residents, during 1 September–25 September, with a bag limit of 1 moose. All the meat had to remain on the bones, the head had to be salvaged, and the antlers were cut to destroy the trophy value. A general registration hunt was opened to all hunters during 5 September–25 September, with a bag limit of either 1 antlerless moose or 1 bull with antlers at least 50 inches wide, or at least 4 brow tines on at least 1 side. Seasons and bag limits for the remainder of the unit were unchanged.

Moose hunter numbers and moose harvests for RY96 in the lower Koyukuk River area increased in spite of the new hunting regulations. The increase in hunters heightened concerns for the area. The Middle Yukon River Fish and Game Advisory Committee and the Western Interior Regional Advisory Council both petitioned the Board of Game to take up the Koyukuk moose issue at their next meeting even though it was not on the board's schedule. They asked the board to accept proposals, open discussion on moose hunting in the area, and to address the problems associated with increased hunter numbers and increased harvest. The Board of Game decided to allow ADF&G to modify the registration hunt requirements. The general registration hunt within Unit 24 was restricted to that portion of the Koyukuk River downstream from and including Dulbi Slough. Also, the department limited the number of general registration permits available at any one time to a maximum of 250. In RY99 the department used discretionary authority to further limit the number of available permits to 215, which also proved to be ineffective at limiting hunter participation. Similar modifications of the registration hunt requirement also occurred in nearby Unit 21D. Season and bag limits for the remainder of the unit were unchanged.

Hunter Harvest. Hunting seasons in the unit are diverse and reflect various moose densities and consumptive use patterns. Annual reported harvest during RY88–RY98 averaged 158 moose (123–230, Table 8). Generally, over 95% of reported harvest occurred during the September portion of the hunting season.

Illegal and unreported harvests by local residents continue to hamper department efforts to manage moose. During some years, the actual harvest was estimated to be about twice the reported harvest (Table 8). Moose taken during winter were rarely reported, even when the season is open. Hughes has never had a license vendor and that has contributed to the problem of hunters hunting without licenses or harvest tickets.

Harvest Chronology. Approximately 95% of the reported harvest occurred in the fall season (Table 9). Much of the unreported harvest likely occurred during October–March (Anderson et al. 1998).

Permit Hunts. Use of the subsistence registration permits (RM832) or the general registration permits (RM830) were required in the fall, within the Koyukuk Controlled Use Area downstream of the village of Huslia. The number of permits issued for RY99 increased by 17.6% from the previous year (Table 10). Total moose harvested in these 2 hunts increased by 7.0%. These increases raised management concerns that harvest could exceed the sustainable yield of the moose population.

Hunter Residency and Success. Based on harvest reports, there was an average of 301 moose hunters during RY88–RY98, the majority of which were Alaska residents (Table 11). Number of hunters was probably low because unit residents often do not report unsuccessful hunt information. Harvest and hunter participation by Unit 24 residents was relatively constant, according to Division of Subsistence surveys (Anderson et al. 1998). However, nonresident and nonlocal resident hunter participation has increased steadily since RY88. The increase in "nonlocals" has created tension among user groups in the area and was the impetus for creating the KWG.

The estimated annual harvest by residents of Unit 24 is about 172 moose according to Marcotte (1986) and Marcotte and Haynes (1985). They estimated 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. Data reported by Anderson et al. (1998) was similar to the earlier results. The estimated unreported harvest incorporates the recent Subsistence Division data, less the reported harvest by unit residents (Table 8).

Transportation 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 12). Highway vehicles are only used on the Dalton Highway that crosses the eastern part of the unit. Snowmachines were the main transportation method used during the winter hunt.

The Dalton Highway was closed to the public at the Yukon River Bridge after construction was completed, but was opened to public use throughout Unit 24 in 1981. Number of hunters and moose harvest for those accessing Unit 24 by the Dalton Highway during RY88–RY98 was fairly stable at 78–128 hunters, taking 27–67 moose each year (Table 13).

Other Mortality

A minimum of 400–440 wolves in 55–60 packs and a large population of black bears are found in the middle and southern portions of the unit. Grizzly bears are common throughout the montane areas. Predation on moose was thought to be high, keeping the moose population low throughout much of the central portion of the unit.

MANAGEMENT PLANNING

The KWG identified the primary issues of concern in the Koyukuk River drainage. The issues identified were the basis for developing a draft 5-year Koyukuk River Moose Management Plan (ADF&G files). The issues were also the basis for developing goals and activities for moose management in Unit 24. Although the KWG area of concern was specifically within the Koyukuk River drainage, the issues were characteristic of concerns throughout Unit 24 and nearby Unit 21D.

The primary issues of concern identified and agreed upon by the KWG were:

- The combined mortality factors of human harvest and predation may lead to a decline in Koyukuk River moose populations, particularly if combined with severe winter weather.
- There has been a great increase in the number of hunters along the Koyukuk River, particularly on the lower river, and the number of hunters may adversely impact the moose population.
- Fish and Game regulations and guiding laws are not being adequately enforced within the Koyukuk River drainage and, as a result, illegal guiding and/or transporting is increasing.
- Wanton waste of game meat is occurring on the Koyukuk River.
- Commercial guiding and transporting operations are increasing on the Koyukuk River.
- There are increasing numbers of moose hunters on the Koyukuk River and they affect traditional subsistence hunting and land use patterns.
- There are gaps in the existing biological information and harvest data concerning Koyukuk River moose.
- Environmental impacts along the river may affect moose conservation.

The management goals, objectives, and activities for the next report period will be changed to address the concerns listed above, according to KWG recommendations. The draft Koyukuk River Moose Management Plan (ADF&G files) contains details of the intent and rationale of the goals and objectives. Following is a summarization of the plan's goals and activities that will be adopted for the next reporting period.

GOAL 1: *Manage Koyukuk River drainage moose on a sustained yield basis to provide both hunting and other enjoyment of wildlife in a manner that complements the wild and remote character of the area and minimizes disruption of local resident's lifestyles.*

Objective 1: Maintain a moose population of 10,000–12,000.

Activity 1: Conduct trend count surveys annually or population estimation surveys when funding is available.

Objective 2: Provide for a harvest of moose, not to exceed 360 moose or 5% of the annual moose population estimate each regulatory year.

Activity 1: Monitor hunter use levels in the Koyukuk River drainage.

Activity 2: Monitor impacts (social and environmental) to private property and local residents by Koyukuk River moose hunters.

Activity 3: Develop programs to improve population and harvest data for moose in Unit 24.

Objective 3: Provide for moose hunting opportunity, not to exceed 500 hunters per regulatory year.

GOAL 2: *Protect and enhance moose habitat.*

Objective 1: In combination with Unit 21D, implement at least 2 habitat enhancement activities every 5 years.

GOAL 3: *Reduce meat spoilage by hunters.*

Objective 1: Reduce the amount of spoiled meat observed at Ella's Cabin and at hunting camps by 10% each regulatory year.

Activity 1: Implement a program at Ella's Cabin checkstation to monitor percentage of meat lost due to spoilage.

GOAL 4: *Maintain opportunities for wildlife viewing, photography and other nonconsumptive uses of wildlife within the Koyukuk River drainage.*

Objective 1: Increase the number of people engaging in nonconsumptive uses of wildlife by >1% each regulatory year.

Activity 1: Implement a program to monitor long-term trend and establish a baseline of the current level of nonconsumptive use, through collaboration with the Koyukuk/Nowitna and Kanuti National Wildlife Refuges, the Gates of the Arctic National Park and Preserve, and commercial operations in Unit 24.

CONCLUSIONS AND RECOMMENDATIONS

Unit 24 is an area that is larger than some states, with a wide range of habitats available to moose. Moose densities range from quite high for northern Interior Alaska to the typical low densities expected for an area at these latitudes. Hunting activity is typically concentrated in areas accessible by boat, with the potential for creating conflicts between local subsistence hunters and nonlocal hunters. Conflicts between user groups, whether real or perceived, have the potential to greatly affect future management decisions.

Habitat is excellent throughout much of the unit, with an abundance of successional willow regrowth due to either fire or riverine erosion. Availability of browse is not currently limiting the moose population.

With the exception of limited areas around Allakaket, Bettles, and Huslia, predation on moose by wolves and bears is likely the major factor limiting Unit 24 moose populations. Unit residents met their wild food requirements, but hunting opportunities cannot be expanded for people living outside the unit until moose numbers increase. Where predators have been lightly harvested for long periods, predation seems to keep moose densities low (0.1–1.0 moose/mi^2 in areas >800 mi^2, Gasaway et al. 1992).

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 should be undertaken in cooperation with National Park Service some time in the future when funding is available. Trend data should also be collected in popular hunting areas such as the South Fork Koyukuk River upstream from the Dalton Highway, the Alatna River, the John River, and the Kanuti River area.

Increased harvest reporting and licensing by unit residents is a result of efforts by the previous Galena area biologist. More emphasis needs to be placed on education, enforcement, and the recruitment of license vendors.

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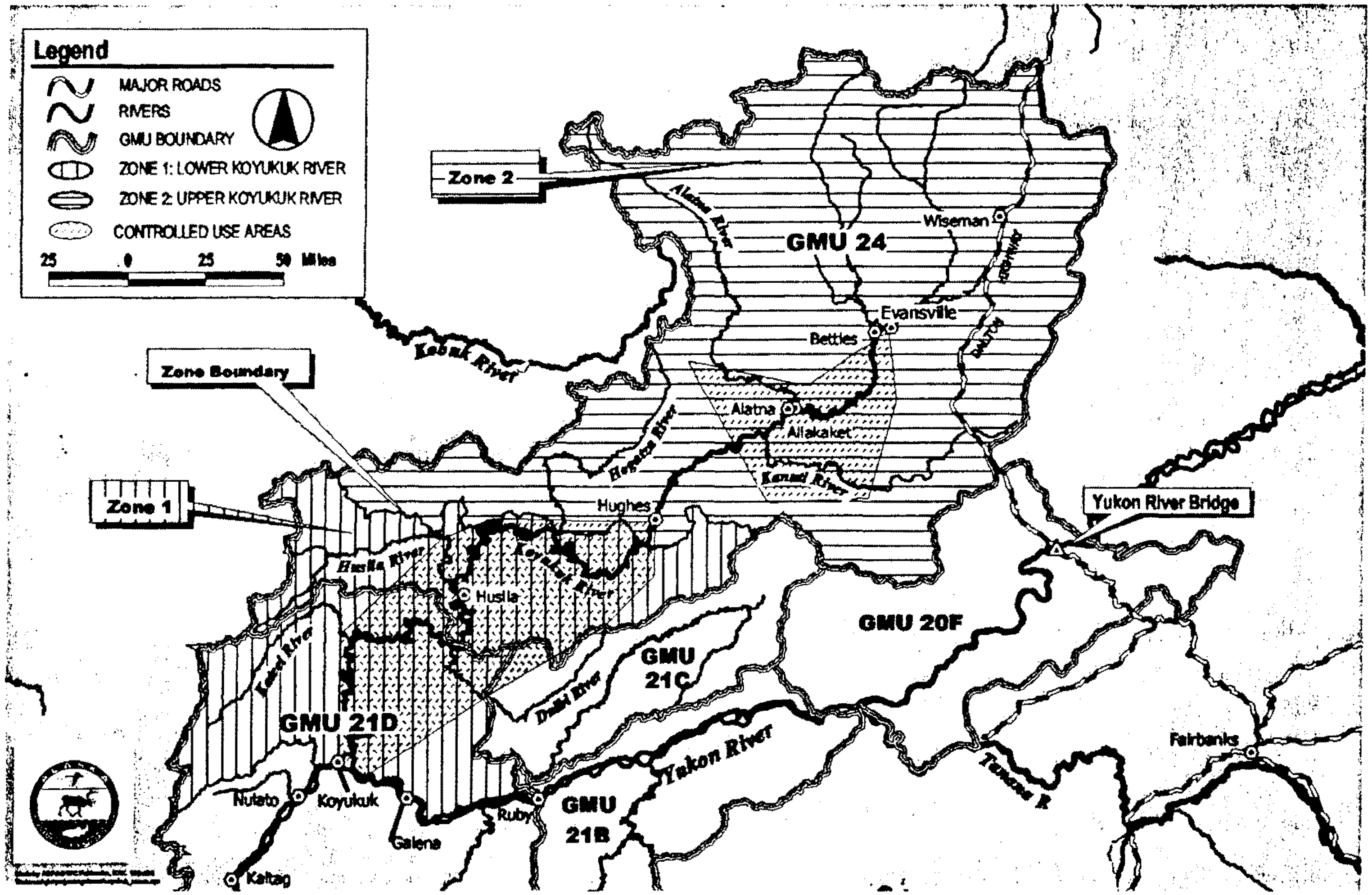

Figure 1 Units 21D and 24 management zones developed by the Koyukuk River Moose Hunters' Working Group

Table 1 Unit 24 Dulbi Slough aerial moose composition counts, regulatory years 1982–1983 through 1999–2000[a]

Regulatory year	Survey area (mi^2)	Bulls:100 Cows	Yearling bulls:100 cows	Calves:100 cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
1982–1983	35.0	45	5	7	0	4.5	111	3.2
1983–1984	39.0	17	8	33	14	22.5	113	2.9
1984–1985	48.1	19	8	20	6	14.6	130	2.7
1985–1986	54.2	19	9	10	0	7.7	170	3.1
1989–1990	48.7	53	7	23	18	13.1	298	6.1
1996–1997	86.4	24	8	37	1	23.0	443	5.1
1999–2000	89.0	11	3	22	5	16.1	411	4.6

[a] Huntington and Spindler 1997.

Table 2 Unit 24 Huslia River Flats aerial moose composition counts, regulatory years 1983–1984 through 1993–1994[a]

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins/100 cows with calves	Percent calves	Moose	Moose/mi^2
1983–1984	80.0	36	7	23	3	14.6	212	2.7
1985–1986	64.5	45	17	10	25	6.7	254	3.9
1989–1990	38.2	50	2	30	7	16.7	90	2.4
1993–1994	80.2	81	15	24	8	11.8	483	6.0

[a] Huntington and Spindler 1997.

Table 3 Unit 24 Treat Island aerial moose composition counts, regulatory years 1985–1986 through 1999–2000[a]

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins:100 cows with calves	Percent calves	Moose	Moose/mi^2
1985–1986	41.0	35	13	17	5	10.9	192	4.7
1993–1994	40.3	39	11	25	7	15.1	317	7.9
1998–1999	67.1	25	6	19	2	13.5	379	5.7
1999–2000	67.1	20	5	16	9	10.8	300	4.5

[a] Huntington and Spindler 1997.

Table 4 Unit 24 Batza Slough aerial moose composition counts, regulatory years 1986–1987 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins/100 cows with calves	Percent calves	Moose	Moose/mi^2
1986–1987	52.9	39	2	11	0	7.6	66	1.3
1997–1998	46.5	51	2	21	0	12.2	74	1.6
1998–1999	46.5	76	12	17	0	8.9	79	1.7
1999–2000	46.5	60	6	12	12	7.0	86	1.9

Table 5 Unit 24 Mathews Slough aerial moose composition counts, regulatory years 1983–1984 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins/100 cows with calves	Percent calves	Moose	Moose/mi^2
1983–1984	51.8	85	19	15	0	7.4	54	1.0
1997–1998	61.9	60	7	7	0	4.0	25	0.4
1998–1999	61.9	69	16	22	0	11.5	61	1.0
1999–2000	50.8	15	0	8	0	5.9	17	0.3

Table 6 Unit 24 Kanuti National Wildlife Refuge population estimation surveys, regulatory years 1989–1990 through 1999–2000

Regulatory year	Survey area (mi^2)	Bulls:100 cows	Yearling bulls:100 cows	Calves:100 cows	Twins/100 cows with calves	Percent calves	Moose	Moose/mi^2
1989–1990[a]	2615	64	4.1	16.5	n/a	9.2	1172 (878–1467)	0.45
1993–1994[a]	2644	61	8.0	33.0	n/a	17.0	2010 (1716–2304)	0.76
1999–2000	2714	61	4.3	27.8	n/a	14.7	1188 (879–1497)	0.39

[a] Martin and Zirkle 1996.

Table 7 Unit 24 population estimation survey summaries, regulatory years 1989–1990 through 1999–2000

Survey area	Area mi^2	Total sample units	Bulls:100 Cows	Calves:100 Cows	Population estimate
Management Zone 1 - **Subtotal**	4696				4000 ± 500
Management Zone 2					
1999 Survey block	8390	1585	65:100	28:100	3036 ± 647 (90% CI)
Moose habitat Unit 24/North[b]	4752		65:100	28:100	1720 ± 353
Remainder Unit 24/North[c]	8217		65:100	28:100	244 ± 50
Subtotal	21,359				5000 ± 1050
Unit 24 – **Total**	26,055				9000 ± 1500

[a] Martin and Zirkle 1996.

[b] The estimated area of Unit 24 that could potentially support moose year-round.

[c] The area remaining in Unit 24 with very little year-round moose habitat, primarily the high altitude mountainous portion within Gates of the Arctic National Park.

Table 8 Unit 24 moose hunter harvest, regulatory years 1988–1989 through 1998–1999

Regulatory year	Harvest by hunters Bull	Cow	Unk	Total	Unreported harvest	Total
1988–1989	132	5	0	137	131	268
1989–1990	119	8	1	128	132	260
1990–1991	141	2	1	144	129	273
1991–1992	141	2	1	144	129	273
1992–1993	118	5	0	123	124	247
1993–1994	139	12	0	151	116	267
1994–1995	134	8	0	142	135	277
1995–1996	161	8	0	169	129	299
1996–1997	176	14	0	190	117	307
1997–1998	168	10	2	180	100	280
1998–1999	213	17	0	230	100	330

Table 9 Unit 24 moose harvest chronology percent by month/day, regulatory years 1996–1997 through 1998–1999

Regulatory year	Harvest chronology percent by month/day 9/1–9/14	9/15–9/25	12/1–12/10	3/1–3/10	*n*
1996–1997	48	46	2	5	187
1997–1998	49	46	1	4	170
1998–1999	49	47	0	5	219

Table 10 Units 21D and 24 Koyukuk Controlled Use Area moose harvest by permit hunt, regulatory years 1998–1999 through 1999–2000

Hunt	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	(%)	Cows	(%)	Unk	Total harvest
RM832	1998–1999	295	0	45	55	125	77	38	23	0	163
	1999–2000	356	0	49	51	127	70	54	30	1	182
RM830	1998–1999	330	0	45	55	159	87	23	13	0	182
	1999–2000	380	0	51	49	148	79	39	21	0	187
Total	1998–1999	625	0	45	55	284	82	61	18	0	345
	1999–2000	736	0	50	50	275	75	93	25	1	369

Table 11 Unit 24 moose hunter residency and success, regulatory years 1988–1989 through 1998–1999

	Successful					Unsuccessful					
Regulatory year	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total	Total hunters
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
1995–1996	43	97	30	0	170	12	93	18	0	123	293
1996–1997	55	95	38	2	190	24	98	26	0	148	338
1997–1998	40	97	41	2	180	18	81	20	0	119	299
1998–1999	41	125	59	5	230	20	120	25	2	167	397

[a] Unit resident only

Table 12 Unit 24 moose harvest percent by transport method, regulatory years 1988–1989 through 1998–1999

Regulatory year	Harvest percent by transport method: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
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	3	12	4	142
1995–1996	13	2	59	2	6	2	15	2	170
1996–1997	12	1	62	3	6	1	13	4	190
1997–1998	19	1	51	7	6	1	11	6	178
1998–1999	17	0	62	2	4	0	10	5	230

Table 13 Unit 24 moose harvest by hunters using the Dalton Highway for access, regulatory years 1988–1989 through 1996–1997

Regulatory year	Dalton Highway hunters	
	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
1996–1997	43	55

LOCATION

GAME MANAGEMENT UNITS: 25A, 25B, and 25D (47,968 mi^2)

GEOGRAPHIC DESCRIPTION: Upper Yukon River Valley

BACKGROUND

Historically, moose have been relatively scarce in the upper Yukon River valley. Long-time residents of the area report moose were hard to find in the early 1900s, but have been more common in recent years (F Thomas, H Petersen, K Peter, personal communication). However, moose density continues to be low compared with many other areas in Interior Alaska. A few population surveys were done in the late 1970s, and more extensive surveys began in 1981 when the Alaska Department of Fish and Game (ADF&G) established a Fort Yukon area office. Estimates of population density in survey areas on the Yukon Flats have 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). Extrapolations from trend surveys and stratification efforts 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). Survey techniques have been modified to reflect advances in sampling techniques and to accommodate the area's relatively low moose density.

Unit 25D was divided into Units 25D West and 25D East during the early 1980s to allow the use of regulatory schemes that reflected the 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 north of the Yukon. Low moose density in Unit 25D West, combined with the relatively high demand for moose by local residents, resulted in the use of permit systems that limit hunting largely to residents of the area.

A registration permit hunt was established in Unit 25D West in 1983, with a bag limit of 1 bull and a 25 August–5 October open season. Sixty permits were issued to residents of the 3 communities in the area. The fall season was shortened and 2 winter hunting periods were added in 1984. A harvest quota of 35 bull moose was established in 1986. A Tier II permit hunt was established in regulatory year (RY) 1990–1991 because the harvestable surplus was deemed insufficient to support all subsistence uses, and restrictions were thought to be necessary (RY = 1 Jul–30 Jun, e.g., RY90 = 1 Jul 1990–30 Jun 1991).

In 1990 the Federal Subsistence Board promulgated regulations for subsistence use on federal lands. These regulations took effect 1 July 1991, when a federal subsistence moose permit system was established in Unit 25D West. It provided an unlimited number of permits to residents of the 3 communities in Unit 25D West 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. In 1993 there was a change in the way regulations were applied in Unit 25D West. Federal permits were required on federal land and were issued only to residents of the 3 communities in the unit. However, it appears that state Tier II permits issued to residents of Unit 25D West will again be recognized as valid on federal lands beginning in 2000.

Population surveys and observations by local residents suggest that moose numbers increased somewhat during the 1980s in Units 25D West and in 25D East. Trend counts and population estimates, as well as anecdotal information, indicate that moose numbers were stable or increasing in Unit 25D West and declining in Unit 25D East during the 1990s. Moose densities continue to be low compared to other areas in Alaska, making it difficult to simplify regulations by, for example, aligning state and federal seasons or replacing the Tier II permit system in Unit 25D West with a general season. These changes would likely result in undesirable increases in harvest and increased user conflicts.

Recent population trends in Units 25A and 25B are not well understood. Composition surveys were last conducted in Unit 25A in 1991 and in Unit 25B in 1987. Reports from experienced guides and pilots indicate moose numbers in Unit 25B declined substantially in recent years and are currently at a low level.

Based on knowledge of wolf numbers and food habits and moose mortality studies, limiting factors include predation by black bears, grizzly bears and wolves, as well as hunting. A recent moose calf mortality study showed that predation by black and grizzly bears is the major cause of calf moose mortality in Unit 25D during summer (US Fish and Wildlife Service, unpublished data). Vegetation surveys indicate that moose browse is abundant and browsing intensity is low (ADF&G, unpublished data). The area is characterized by low to moderate snowfall.

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 and the effects of cow moose harvest.

- Monitor moose population status through annual surveys.

- ➢ Work with natural resource offices in local communities to obtain and exchange information on moose populations and management issues, develop a moose management plan, and improve harvest reporting.

Objectives will be rewritten the next reporting period to clearly differentiate between objectives and activities.

METHODS

A moose population survey (Gasaway et al. 1986) was conducted in November 1992 in Unit 25D West using multiple PA-18 aircraft and a C-185 for stratification. Population surveys using similar techniques, including regression analysis (J Ver Hoef, ADF&G, personal communication), were conducted in Unit 25D West in fall 1996 and spring 1999; and in Unit 25D East in fall 1995, fall 1997, and fall 1999. Ninety percent confidence intervals were calculated for most estimates. Beginning in 1999, population surveys were conducted using a spatial analysis technique recently developed by Jay Ver Hoef (Biometrician, ADF&G, Fairbanks). Survey areas were stratified according to moose density using C-185 or C-206 aircraft prior to counting selected sample units. Sample units were counted with PA-18 or Scout aircraft flown about 500 feet above ground level at 70 miles per hour. We circled moose to determine sex, age, and antler size of bulls, and to locate other moose. Moose habitat in established count areas or sample units was searched systematically at an intensity of at least 4 minutes/mi^2. Sex and age composition observed during trend surveys is presented, as well as observed and estimated sex and age composition based on data collected during population surveys. Population sex and age composition were estimated from population survey data using statistical and spatial analyses based on bull:cow, calf:cow, and yearling bull:cow ratios observed in different density strata and the areal extent of each strata (J Ver Hoef, ADF&G, personal communication).

Mandatory harvest reports provided information on hunter effort, residency, success, transportation, and antler size. Harvest data were summarized by regulatory year. Informal visits and interviews with area residents provided insight into hunter effort and concerns about moose management issues.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Units 25A and 25B. No population estimation surveys have been completed in Units 25A and 25B. Reports from some knowledgeable observers indicate moose numbers in southern Unit 25A have declined in recent years. Reports from hunters in Unit 25B indicate that moose have declined south of the Porcupine River and in the upper Black River drainage, and are scarce north of the Porcupine River.

Unit 25D East. A population survey in Unit 25D East in 1995 resulted in an estimate of 704 moose (± 33%) in a 1534-mi^2 area (0.46 moose/mi^2) encompassing important hunting areas near Fort Yukon (Table 1). 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. A similar survey in 1997 resulted in an estimate of 625 moose (± 36%) and a density of 0.40 moose/mi^2. In fall 1999 the moose population in a 2936-mi^2 survey area was estimated at 829 (± 20%). Estimated densities in high and low strata were 0.54 and 0.13 moose/mi^2, respectively, with an overall density of 0.28 moose/mi^2. The lower density reflects a decline in numbers and inclusion of low-density habitat in the expanded survey area.

The 1999 survey area encompassed the smaller area used in 1995 and 1997. A population estimate based only on data from sample units representing the 1534-mi^2 area surveyed in 1995 and 1997 was 516 ± 21%, or 409–624 moose, with a population density of 0.33 moose/mi^2. The 1999 estimate compares to estimates of 704 ± 33% (0.46/mi^2) and 625 ± 36% (0.40/mi^2) in the 1534-mi^2 area in 1995 and 1997. Estimated average population density in 1999 was 28% lower than in 1995. It appears that calf and yearling survival was high during 1998 and 1999 and the decline in density would be somewhat greater were it not for the relatively high proportion of calves and yearlings in the population. Comparing the estimated number of bulls, cows, and total adults in the 1534-mi^2 area in 1995, 1997 and 1999 suggests the number of moose in these sex and age classes declined by about 29%, 33%, and 32% during this 5-year period (Table 2). Although the proportion of calves in the fall 1999 population was relatively high, their actual number was about 10% lower than in 1995. The total population in Unit 25D East in 1999 was probably 2000–3000 moose, assuming the population densities estimated in the 1999 survey area (0.13 moose/mi^2 in low strata and 0.28 moose/mi^2 overall) represent the upper and lower limits of moose density in the remaining 8000 mi^2 outside the survey area.

The apparent downward trend in moose numbers in Unit 25D East may be partly due to extremely low calf survival in 1997, which appears to have been caused by a flood in the Black River area. However, many local residents have observed a decline in moose numbers during the last decade. The reasons for the apparently high calf survival in 1998 and the high calf and yearling survival in 1999 are unknown, but a reduction in predation by bears and wolves is the most likely cause. It appears the population has the potential to increase, particularly if high calf and yearling survival continue and adult mortality can be reduced.

Unit 25D West. In 1992 we estimated 602 moose (± 22%) in 4544 mi^2 of Unit 25D West (Table 1). Density was 0.12 moose/mi^2. In 1996 we estimated a density of 0.44 moose/mi^2 in a 1531-mi^2 portion of the subunit. The survey area established in 1996 encompassed much of the high quality moose habitat in the subunit. Poor survey conditions in fall 1998 precluded surveys, but a survey was conducted in Unit 25D West in March 1999. This survey marked a transition to the recently developed spatial analysis survey technique, and employed a somewhat larger survey area that encompassed the previous area. The March survey resulted in an estimate of 735 ± 17%, or 0.32 moose/mi^2, in the 2269-mi^2 survey area. A fall 1999 survey in the same area resulted in a population estimate of 862 ± 19%, with a density of 0.38 moose/mi^2 (Bertram and Vivion 1999). Data gathered in the part of the area that was surveyed in 1996 were used to generate an estimate of 0.40 moose/mi^2, which compares to the 1996 estimate of 0.44 moose/mi^2.

Moose population density in both Unit 25D East and West continued to be low relative to habitat potential, but it appears that recent population trends and composition may differ between the 2 areas. Survey data suggest moose numbers have declined in Unit 25D East since 1995, but have been relatively stable in Unit 25D West. These trends may be related to differences in the level of harvest as well as other factors. Recent harvest surveys indicate that approximately 150–200 moose are harvested in Unit 25D East each year and about 60 moose are taken in Unit 25D West. These harvests indicate harvest rates of 6–8% in Unit 25D East and 3–4% in Unit 25D West, assuming prehunt populations of at least 2500 moose in the east and 1700 in the west.

Population Composition

Trend surveys in Unit 25A in 1987, 1989, and 1991 showed high bull:cow ratios (63–91:100), and moderate calf and yearling survival (Table 3). Weather precluded more recent survey attempts, but moderate to low harvests related to logistic limitations suggest that hunting is having a minor effect on bull:cow ratios. Surveys have not been conducted in northern Unit 25B in recent years. Surveys in Yukon-Charley Rivers National Preserve in the southern part of the unit resulted in estimated densities of 0.34 moose/mi^2 in 1994 and 0.23 moose/mi^2 in 1997 and 1999 (Burch 1999).

Relatively good survey conditions in Unit 25D East allowed complete trend counts in 1994 and population surveys in 1995, 1997, and 1999. Population parameters were estimated (Table 2) and observed (Table 4). Low calf survival in 1997 was most likely caused by flooding adjacent to the Black River following almost 6 inches of rainfall during 9–15 June. Calf survival appeared to be relatively high during 1999, with observed and estimated values of 45 and 59 calves:100 cows, and 22 and 27% calves in the population, respectively. The estimated proportion of calves in the population is higher than the proportion observed because there was a higher calf:cow ratio (11 calves and 9 cows, or 122:100) in low density habitat, which includes a large area compared to high density areas (36 calves and 95 cows, or 34:100). Composition data indicate a relatively high bull:cow ratio, with observed and estimated ratios of 65:100 and 57:100, respectively. Small, medium and large bulls were well represented in the population. Yearling bulls comprised 11% of the moose observed, suggesting that calf survival during 1998 was also relatively high, and that yearlings comprised 22% of the total population.

Surveys similar to those done in Unit 25D East have been completed in Unit 25D West (Tables 2 and 5). The observed adult bull:cow ratio in the fall 1999 survey was 32:100, and the estimated ratio was 31:100. However, only 6 yearling bulls:100 cows were observed. There were an estimated 31 calves:100 cows, similar to the average level observed in this area during the last several years. Estimated calf:cow and bull:cow ratios, and the proportion of yearlings, in fall 1999 were lower in Unit 25D West than in Unit 25D East (Table 2), and the proportion of large bulls was also relatively low (Bertram and Vivion 1999).

Distribution and Movements

Moose are found throughout the area, but density varies somewhat. Large areas currently support densities of 0.1–0.3 moose/mi^2. Somewhat higher densities occur in localized areas in

Unit 25D, particularly in late winter when moose tend to be concentrated in the best habitat. Moose are also concentrated in relatively small areas during early winter along the upper Sheenjek and Coleen Rivers in Unit 25A, but these concentrations are limited in extent. Telemetry studies in Units 25D East and Unit 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, the US Fish and Wildlife Service (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 once each month. 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 they began moving back into Alaska (Mauer 1998).

Mortality

Harvest

Seasons and Bag Limits.

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 Porcupine River drainage upstream from the Coleen River drainage:		
RESIDENT HUNTERS: 1 bull.	20 Sep–30 Sep	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.		20 Sep–30 Sep
Remainder of Unit 25B RESIDENT HUNTERS: 1 bull.	5 Sep–25 Sep 1 Dec–15 Dec	
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
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 18 Feb–28 Feb	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.		10 Sep–20 Sep

Board of Game Actions and Emergency Orders. A harvest quota of 35 bull moose has been in place in Unit 25D West since 1986. Moose have been hunted under a Tier II permit system since 1990. Up to 125 Tier II permits have been issued each year. In 1990 the Federal Subsistence Board was established and began promulgating 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 hunting on federal land are longer (generally 25 Aug–25 Sep and 1 Dec–20 Dec) than the state season. The state season applies to all hunters on private and state lands and to nonlocal hunters on federal lands.

In 1993 there was a change in the way regulations were applied in Unit 25D West. 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 have been issued each year. In late 1999 the requirement for federal permits to hunt on federal land was change when the Office of Federal Subsistence Management indicated that residents of Unit 25D West could hunt on federal public land under a state Tier II permit.

A number of factors have complicated moose management and harvest monitoring in Unit 25D West. The length of time needed to obtain and compile harvest reports for the 2 permit systems, as well as substantial unreported harvest, have made it difficult to effectively monitor harvests relative to the quota. Tier II reports are due within 10 days of harvesting a moose or 15 days after the close of the season (15 Mar). Local harvest reports and anecdotal information suggest the actual harvest includes about 40 bulls and up to 20 cow moose each year. In the 1980s, ADF&G's Subsistence Division estimated that a local harvest of 64 moose would be expected, based on the number of people in Unit 25D West and use levels in surrounding areas where moose were more abundant.

The cumulative effect of various annual permit application requirements, confusion over geographic boundaries, and a variety of local circumstances have resulted in poor reporting and limited participation in the management system. Discussions with local residents helped identify a number of steps that are likely to improve moose management on the western Yukon Flats. They include revising the harvest quota for moose, reducing the maximum number of Tier II permits available, and aligning state and federal hunting seasons. The Board of Game considered proposals that addressed these issues in March 2000. The board lengthened the state season to 25 August–28 February, aligning it with the season on federal public lands, and agreed with the department's recommendations to increase the harvest guideline from 35 to 60 bull moose and limit the number of Tier II permits available to 75. A proposal to include a maximum of 20 cow moose in the harvest quota was discussed, but not approved, by the board. In addition, the board approved a regulation that provides for the establishment of Community Harvest Permits, which allow individual bag limits to be pooled so that more than 1 moose can be taken by an individual hunter. The board established the Chalkyitsik Community Harvest Area and a community harvest bag limit for moose in the portion of Units 25D and 25B that are included in the community harvest area. These regulations established the opportunity for people to pool their individual bag limits so that some hunters can take more than 1 moose.

A voluntary effort by local communities to obtain moose harvest information is the most practical way to improve local harvest reporting. Local communities have expressed interest in improving harvest reporting so that moose management can be based on better information.

Hunter Harvest. The reported number of moose harvested has been relatively stable in most of Unit 25 during the past 5 years (Tables 6, 7, 8). Reported harvest for Units 25A, 25B, and Unit 25D East has ranged from 71 moose in RY97 to 101 in RY98. The reported harvest in connection with the Tier II and federal permit hunts in Unit 25D West was small (Table 9), with 12–27 moose reported taken annually in the last 5 years. The reporting rate has been low for this hunt, but has improved recently through the use of reminder letters. The actual number of moose harvested in Unit 25D West is not well documented, but reports by local governments, and preliminary results of the Council of Athabascan Tribal Governments (CATG) harvest monitoring study indicate that about 40 bulls and up to 20 cows are harvested each year.

Unreported harvest, particularly by local residents, is common in the upper Yukon River valley. The previous area biologist estimated the unreported harvest was 100–200 moose annually. Household interviews conducted by the CATG in the communities of Arctic Village, Beaver, Birch Creek, Canyon Village, Circle, Chalkyitsik, Fort Yukon, Rampart, Stevens Village, and Venetie provided relatively complete information on local moose harvest during RY93 and RY98 (CATG, unpublished data). A comparison of these data with harvest tickets returned by local residents indicates only 25–35% of the bull moose harvested by local residents in Units 25A, 25B, and 25D East are reported on harvest tickets. Combining the harvest reported by nonlocal residents with the more accurate data for local harvests obtained in the CATG study indicates the total harvest of bull moose in Units 25A, 25B, and 25D East was 152 in RY93 and 149 in RY94. Reported harvests were 98 and 84 bulls, respectively.

Current information indicates that cow moose may be taken at any time of year, especially in areas near and between communities. While the harvest of cow moose seems to have declined somewhat in recent years, it continues to be a concern to many local residents. Two educational videos were produced in 1993 in a cooperative effort between FWS and ADF&G. The adverse effects of shooting cow moose are a central message in each. These videos have been distributed in local communities and have also been used in other parts of Alaska.

Permit Hunts. Although local residents largely supported the Tier II moose permit hunt in Unit 25D West, there were a number of problems associated with it (Table 9). These included confusion about differences in applicability of federal and state permits and boundaries of federal and private lands, which are subject to different seasons and/or different permit requirements. These difficulties led to efforts to revise the harvest quota and simplify regulations.

Hunter Residency and Success. As in previous years, most hunters reporting from Units 25A, 25B, and 25D during RY94–RY98 were Alaska residents (Tables 10, 11, 12). The proportion of nonresidents was greatest in the most remote portion of Unit 25A, where guiding activity and float trips are more common. Local residents outnumbered other hunters by a wide margin in Unit 25D East. As described above, the number of local participants in moose hunting was underrepresented because of a low reporting rate. Success among reporting hunters approached 50% in Unit 25A, 30–50% in Unit 25B, and 25–30% in Unit 25D East.

Harvest Chronology. Most moose taken in Unit 25 were killed during the first 3 weeks of September, with a few reported killed before and after this period (Tables 13, 14, and 15). A number of moose were also taken in late August during the state Tier II and federal subsistence seasons in Unit 25D West. A few moose were 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 was probably greater than reported.

Transport Methods. Aircraft were the most common transport mode in Unit 25A, being used by >50% of the successful hunters. Horses and boats were used in 2–28% of the remaining hunts (Table 16). Boats were used by about 75% of successful hunters in Units 25B and 25D East, with airplanes being used in about 15% of successful hunts (Tables 17 and 18). Snowmachines were 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 probably underrepresented because relatively few harvest reports are submitted by local hunters.

HABITAT

Assessment and Enhancement

We did no systematic evaluation of habitat during this reporting period. However, previous work, empirical observations, and comparison with habitat elsewhere indicate that the upper Yukon River valley provides excellent moose habitat. Moose populations were well below densities that could be supported by the habitat. As in previous years, moose in Unit 25D appeared to be in excellent nutritional condition. Survey pilots with substantial experience in moose surveys and research projects in various parts of Interior Alaska continue to remark on the relatively large size and rounded contours of both adult and calf moose, noting that most calves were noticeably larger than those observed in other areas during winter.

A reconnaissance of browse species composition and general characteristics adjacent to the Yukon River was conducted in August 1998, in cooperation with K Kielland, Institute of Arctic Biology, University of Alaska Fairbanks. This survey indicated that moose browsing was scarce in both riparian and upland sites and that a large amount of good-to-high quality forage is available in both habitat types. Feltleaf willow (*Salix alaxensis*) provides high quality food for moose, and is the most common shrub in riparian habitats. The limited occurrence of moose browsing is reflected in growth form, with extensive stands of 6–50 foot tall feltleaf willows that show little or no evidence of branching due to browsing. Plants only 6–8 feet tall exhibited a mature growth form, also indicating the low intensity of browsing. The mature growth form is rarely observed in young feltleaf willows along the Tanana and Koyukuk Rivers, where moose are more abundant.

Other common trees and shrubs, most of which are potential forage species for moose, include sandbar willow (*S interior*), little tree willow (*S arbusculoides*), pacific willow (*S lasiandra*), blueberry willow (*S nova-anglii/monticola*), diamond leaf willow (*S pulchra*), fire willow (*S scouleriana*), bebb willow (*S bebbiana*), barren ground willow (*S brachycarpa*), red osier dogwood (*Cornus stolonifera*), balsam poplar (*Populus balsamifera*), and aspen (*P tremuloides*). Most stands of willow adjacent to upland meadows showed the effects of a leaf miner infestation, manifested in about 50% of the leaf surface being a reddish brown color. This is readily visible from the air as well, and in some years is widespread on the Yukon Flats. This condition probably affects the palatability and nutritional quality of these plants. 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

Recent population surveys indicate that moose numbers have declined in eastern Unit 25D since 1995, but have been relatively stable in western Unit 25D. This pattern may be related to differences in the level of harvest as well as other factors. Productivity and recruitment are higher than in some other areas in the Interior. However, a moderate decline in recruitment rates was evident in some areas. Moderate progress was made towards achieving management objectives in some areas. Objectives for Unit 25A were generally met, and the harvest of moose in the remainder of the unit was sufficient to satisfy local subsistence needs, as well as provide a moderate amount of hunting for other Alaskans and some nonresidents. However, declining numbers in some areas may result in lower harvests in the future.

A study of local opinions about various moose management issues was conducted in Fort Yukon during 1995–1996 (C Fleener, unpublished report). Representatives of 34 households were interviewed regarding their opinions about topics including the harvest of cow moose, enforcement of regulations, suitability of current regulations, need for further biological studies, predator control and local involvement in moose management. The results indicate there is substantial concern about the status of moose populations, opposition to the taking of cow moose, and support for increased enforcement, biological studies, predator control and local involvement in moose management. The public and various governmental agencies should address these and other political, biological, and logistical realities affecting moose management in Unit 25. An effort to develop revised moose management plans that will include revision of management objectives is underway.

Effects of increased hunting on concentrations of moose in the Sheenjek and Coleen drainages in Unit 25A are being evaluated. Based on harvest reports obtained from 1989 to 1999, antler size continues to average above 50 inches, suggesting harvest did not significantly affect the age structure of bulls during this period. However, the relatively small size of this largely migratory population indicates the situation warrants continued monitoring. Ongoing telemetry studies of moose movements and population identity will help evaluate effects of hunting in these areas.

More effort should be spent monitoring the Tier II harvest in Unit 25D West. Continued visits to local communities to discuss management issues and explain regulations before the hunting season and hunter contact by riverboat during the hunting season are recommended. Population surveys in representative areas of various subunits should be continued to monitor trends in recruitment and moose numbers. A cooperative survey by ADF&G and FWS to determine wolf numbers on the Yukon Flats was conducted in early 1992 and ADF&G completed wolf surveys in Unit 25D West in 1997 and 1999, and in Units 25B and 25D East in 2000. Knowledge of wolf numbers will help in assessing the probable effects of wolf predation on moose numbers.

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Table 1 Unit 25D moose population estimates, 1992–1999

Survey year and type	Survey area (mi^2)	Strata size (mi^2) L	Strata size (mi^2) M	Strata size (mi^2) H	Area searched (mi^2) L	Area searched (mi^2) M	Area searched (mi^2) H	Total search area	Moose estimated by strata and total, and density (moose/mi^2) L	M	H	Total estimate @ 90% CI	Average density, moose/mi^2	Sample units counted
Unit 25D East														
1995 Regression Analysis	1534							386				704 ± 33%	0.46	28
1997 Regression Analysis	1534							346				625 ± 36%	0.40	27
1999 Spatial Analysis[a]	2936	1828		1108	175		366	541	229/0.13		596/0.54	829 ± 20%	0.28	102
1999 Spatial Analysis[b]	1550											516 ± 21%	0.33	
Unit 25D West														
1992 Stratified Random	4544	3682	515	348	266	379	343	1009	77/0.02	220/0.43	228/0.66	619 ± 21%	0.14	76
1992 Stratified Random[c]	1532	1040	308	184	46	247	184	476	92/0.09	143/0.47	154/0.84	455 ± 33%	0.30	37
1996 Regression Analysis	1532	476	516	539	120	122	124	366				666 ± 21%	0.44	27
March 1999 Spatial Analysis	2369	1714		554	253		264	517	318/0.19		422/0.76	735 ± 17%	0.32	96
October 1999 Spatial Analysis	2369	1444		825	156		345	501	295/0.20		567/0.69	862 ± 19%	0.38	93
October 1999 Spatial Analysis[d]	1774											707 ± 19%	0.40	

[a] 1999 surveys used smaller sample units then those used in previous surveys, and 2 rather than 3 strata.

[b] Based on data from area surveyed in 1995 and 1997.

[c] Based on sample units counted in the 1992 survey and which later comprised the 1996 survey area.

[d] Based on data from area surveyed in 1996.

Table 2 Unit 25D estimated moose population composition based on fall population surveys, 1992–1999

Survey period and area (mi^2)	Bulls	Cows	Calves	Adults	Total (90% CI)	Bulls: 100 Cows	Yrlg Bulls: 100 Cows	Calves: 100 Cows	% Bulls	% Cows	% Calves	Moose/mi^2
Unit 25D East												
Fall 1995 (1534)	199	369	136	568	704 ± 33%	54	8	37	28	56	19	0.46
Fall 1997 (1534)	208	372	45	580	625 ± 36%	56	16	12	33	57	7	0.40
Fall 1999 (2936)	218	381	223	599	829 ± 20%	57	24	59	26	48	27	0.28
Fall 1999 (1534)	141	246	123	387	516 ± 21%	57		50	28	48	24	0.33
Unit 25D West												
Fall 1992 (4544)	224	317	78	541	619 ± 21	71	12	25	36		13	0.14
Fall 1992 (1531)	134	252	69	386	455 ± 33%	53	9	28	30	55	15	0.30
Fall 1996 (1531)	184	340	142	524	666 ± 21%	54	10	42	28	51	21	0.44
March 1999 (2296)			64	671	735 ± 17%						9	0.31
Fall 1999 (2269)	165	529	168	694	862 ± 19%	32	6	31	19	61	20	0.38

Table 3 Units 25A and 25B moose observed during early winter aerial composition counts, 1987–1992

Area/ Year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/mi^2
Unit 25A[a]								
1987[b]	63	9	33		17		149	
1989[c]	75	18	29	52	14		367	1.01
1991[d]	55		26	8	19	41	49	
1991[c]	91	13	31	44	14		314	0.87
1992[e]				8	15	44	52	
Unit 25B[f]								
1987	119	6	10	6	5	105	111	

[a] No surveys have been conducted since RY92.
[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 River drainage around Arctic Village.
[f] The only early winter composition count in this area during regulatory years 1986–2000.

Table 4 Unit 25D East moose observed during early winter aerial composition counts, 1986–1999

Year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/mi^2
1986	84	13	34	26	15	144	170	0.7
1987	81	18	27	29	13	196	225	0.9
1988[a]								
1989	63	9	41	59	20	235	294	1.0
1990[b]	64	5	32	7	16	36	43	0.7
1991[c]	66	9	26	25	13	168	193	0.7
1992[a]								
1993	38	8	40	37	22	128	165	1.0
1994	68	20	25	24	12	160	184	0.6
1995[d]	50	7	30	39	16	193	232	0.46
1996[e]	54	6	43	16	22	57	73	
1997[d]	61	18	13	14	8	169	183	0.40
1998[a]								
1999	65	24	45	47	22	172	219	0.28

[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.
[e] Based on limited composition survey in Graveyard and Mardow trend count areas.

Table 5 Unit 25D West moose observed during early winter aerial moose composition counts, 1986–1999

Year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/mi^2
1986	78	23	27	20	13	132	152	0.42
1987	71	8	25	13	13	87	100	0.57
1988	84	18	29	13	14	83	96	0.55
1989[a]								
1990[b]	44	12	29	4	15	23	27	
1991[c]	98	8	31	15	13	97	112	0.47
1991[d]	146	8	46	6	16	32	38	0.22
1991[e]	81	8	25	9	12	65	74	1.15
1992[f]	71	12	25	48	13	345	393	0.12
1992[g]	70	11	19	5	10	46	51	0.47
1993[h]	51	14	30	17	16	86	103	0.50
1994[i]	115	23	45	9	14	56	65	0.63
1995[a]								
1996[j]	54	11	42	57	17	273	330	0.44
1997[a]				26	10		248	
1998[k]								
1999[j]	32	6	35	56	21	213	269	

[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.
[j] Based on composition observed in early winter population survey.
[k] Composition observed in March 1999 population survey.

Table 6 Unit 25A reported moose harvest, regulatory years 1986–1987 through 1998–1999

Regulatory	Reported[a] harvest			
year	M	F	Unk	Total
1986–1987	47	0	0	47
1987–1988	41	0	0	41
1988–1989	39	0	0	39
1989–1990	25	0	0	25
1990–1991	56	0	0	56
1991–1992	47	0	0	47
1992–1993	17	0	0	17
1993–1994	27	0	0	27
1994–1995	24	0	0	24
1995–1996	37	0	0	37
1996–1997	39	0	0	39
1997–1998	31	0	0	31
1998–1999	47	0	0	47

[a] Source: moose harvest reports.

Table 7 Unit 25B reported moose harvest, regulatory years 1986–1987 through 1998–1999

Regulatory	Reported[a] harvest			
year	M	F	Unk	Total
1986–1987	27	0	0	27
1987–1988	26	0	0	26
1988–1999	28	0	0	28
1989–1990	24	0	0	24
1990–1991	47	0	0	47
1991–1992	32	0	0	32
1992–1993	18	0	0	18
1993–1994	43	0	0	43
1994–1995	33	0	0	33
1995–1996	32	0	0	32
1996–1997	20	0	0	20
1997–1998	21	0	0	21
1998–1999	31	0	0	31

[a] Source: moose harvest reports.

Table 8 Unit 25D East reported moose harvest, regulatory years 1986–1987 through 1998–1999

Regulatory	Reported[a]			
year	M	F	Unk	Total
1986–1987	39	0	0	39
1987–1988	47	0	0	47
1988–1999	32	0	0	32
1989–1990	38	0	0	38
1990–1991	52	0	1	53
1991–1992	29	0	0	29
1992–1993	19	0	0	19
1993–1994	27	1	0	28
1994–1995	27	0	0	27
1995–1996	23	0	0	23
1996–1997	14	0	0	14
1997–1998	19	0	0	19
1998–1999	23	0	0	23

[a] Source: moose harvest reports.

Table 9 Unit 25D West moose harvest for permit hunt 940, regulatory years 1989–1990 through 1998–1999

Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Bulls (%)	Cows (%)	Unk (%)	Harvest
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[d]	125	54 (43)	40 (32)	10 (8)	10 (100)	0 (0)	0 (0)	10
1994–1995[e]	120	63 (53)	30 (25)	10 (8)	10 (100)	0 (0)	0 (0)	10
1995–1996[f]	90	44 (49)	27 (30)	16 (18)	16 (100)	0 (0)	0 (0)	16
1996–1997[g]	91	32 (35)	31 (34)	10 (11)	10 (100)	0 (0)	0 (0)	10
1997–1998[h]	36	23 (64)	11 (82)	2 (18)	2 (100)	0 (0)	0 (0)	2
1998–1999[i]	40	22 (55)	11 (36)	7 (64)	7 (100)	0 (0)	0 (0)	7

[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.
[d] Additional harvest reported under federal permit system = 0.
[e] Additional harvest reported under federal permit system = 2.
[f] Additional harvest reported under federal permit system = 1.
[g] Additional harvest reported under federal permit system = 7.
[h] Additional harvest reported under federal permit system = 13
[i] Additional harvest reported under federal permit system = 20

Table 10 Unit 25A moose hunter residency and success, regulatory years 1986–1987 through 1998–1999[a]

Regulatory year	Successful					Unsuccessful					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
1995–1996	6	11	20	0	37 (62)	2	11	10	0	23 (38)	60
1996–1997	1	6	32	0	39 (58)	2	16	9	1	28 (42)	67
1997–1998	3	13	13	2	31 (61)	0	11	9	0	20 (39)	51
1998–1999	4	17	24	2	47 (64)	0	20	7	0	27 (36)	74

[a] Source: moose harvest reports.

[b] Resident of Unit 25A.

Table 11 Unit 25B moose hunter residency and success, regulatory years 1986–1987 through 1998–1999[a]

Regulatory year	Successful					Unsuccessful					
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Hunters
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
1995–1996	6	24	2	0	32 (40)	2	37	9	1	49 (60)	81
1996–1997	6	10	3	1	20 (29)	5	36	7	1	49 (71)	69
1997–1998	7	11	3	0	21 (34)	4	29	8	0	41 (66)	62
1998–1999	10	18	3	0	31 (53)	3	20	2	2	27 (47)	58

[a] Source: moose harvest reports.

[b] Resident of Unit 25B.

Table 12 Unit 25D East moose hunter residency and success, regulatory years 1986–1987 through 1998–1999[a]

Regulatory year	Successful					Unsuccessful					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
1993–1995	14	10	3	1	28 (36)	22	24	0	3	49 (64)	77
1994–1996	16	9	0	2	27 (30)	29	31	3	0	63 (70)	90
1995–1996	17	5	1	0	23 (29)	13	35	7	1	56 (71)	79
1996–1997	7	6	1	0	14 (23)	18	25	4	1	48 (77)	62
1997–1998	13	11	2	0	26 (27)	15	50	5	0	70 (73)	96
1998–1999	13	9	1	0	23 (31)	22	24	5	0	51 (69)	74

[a] Source: moose harvest reports.

[b] Resident of Unit 25D.

Table 13 Unit 25A reported moose harvest chronology[a] percent by month/day, regulatory years 1986–1987 through 1998–1999

Regulatory year	Harvest chronology percent by month/day						
	9/1–9/7	9/8–9/14	9/15–9/21	9/22–9/28	9/29–10/5[b]	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
1995–1996	35	38	16	8		3	37
1996–1997	33	23	35	8		0	39
1997–1998	3	23	39	26		9	31
1998–1999	28	36	30	2		4	47

[a] Source: moose harvest reports.
[b] No open season.

Table 14 Unit 25B reported moose harvest chronology[a] percent by month/day, regulatory years 1986–1987 through 1998–1999

Regulatory year	Harvest chronology percent by month/day							
	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
1995–1996	28	38	25	3	0	6	0	32
1996–1997	25	35	15	5	0	10	10	20
1997–1998	5	5	29	29	19	10	5	21
1998–1999	10	32	39	10	0	6	3	31

[a] Source: moose harvest reports.
[b] No open season.

Table 15 Unit 25D East reported moose harvest chronology[a] percent by month/day, regulatory years 1986–1987 through 1998–1999

Regulatory	Harvest chronology percent by month/day							
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
1995–1996	13	43	35	0	0	4	4	23
1996–1997	7	50	29	0	0	0	14	14
1997–1998	0	5	47	37	11	0	0	19
1998–1999	17	57	22	4	0	0	0	23

[a] Source: moose harvest reports.

[b] No open season.

Table 16 Unit 25A moose harvest percent by transport method, regulatory years 1986–1987 through 1998–1999[a]

Regulatory year	Harvest percent by transport method								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway 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
1995–1996	62	16	16	0	0	0	3	3	37
1996–1997	69	28	2	0	0	0	0	0	39
1997–1998	65	6	26	0	0	0	3	0	31
1998–1999	68	15	17	0	0	0	0	0	47

[a] Source: moose harvest reports.

Table 17 Unit 25B moose harvest percent by transport method, regulatory years 1986–1987 through 1998–1999[a]

Regulatory year	Harvest percent by transport method								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
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
1995–1996	9	3	75	3	3	0	0	6	32
1996–1997	15	5	75	0	0	0	0	5	20
1997–1998	14	5	71	0	0	0	10	0	21
1998–1999	13	3	81	3	0	0	0	0	31

[a] Source: moose harvest reports.

Table 18 Unit 25D East moose harvest percent by transport method, regulatory years 1986–1987 through 1998–1999[a]

Regulatory year	Harvest percent by transport method								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
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
1995–1996	26	0	61	0	0	0	4	9	23
1996–1997	21	0	71	0	0	0	0	7	14
1997–1998	11	0	84	5	0	0	0	0	19
1998–1999	13	0	74	4	0	4	4	0	23

[a] Source: moose harvest reports.

LOCATION

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

GEOGRAPHIC DESCRIPTION: Western North Slope

BACKGROUND

Archaeological evidence indicates moose have been present on the North Slope either sporadically or at low densities for many years. Since about 1940, moose populations have increased in size and have become well established in Unit 26A. Although moose are throughout the unit during the 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, 1991, and 1995. Throughout the period from 1970 to 1991, the population was stable and increased slowly to 1535 moose. Between 1991 and 1995 the population declined to 757 moose. Trend counts indicate the population began declining in 1992 and 1993 and continued to decline until 1996.

During summer and fall of 1995, carcasses from moose that were found dead in the study area and hunter-killed moose were examined and sampled. In addition, we captured, examined, sampled, and radiocollared 45 female and 5 male moose in 1996 and 1997. Analysis indicated that nearly all of the moose tested to be marginally deficient in copper. Several cows captured in 1996 and 1997 tested positive for antibodies to the bacteria *Brucella suis Biovar 4* (8 of 43) and *Leptospira interrogans serovar pomona* (6 of 30). Both diseases cause abortions and weak calves. The high mortality rate may have been partially due to starvation from overbrowsing when the moose population was high during the 1980s and early 1990s (Carroll 1998).

Fall surveys indicated poor production or summer calf survival during 1993 with 4% calves, 1994 with 2% calves, and in 1995 with 0% calves. Wolf and grizzly bear numbers were at relatively high levels during the time of the decline, but the predation rate was unknown. The relative importance of disease, malnourishment, or predation to low calf numbers is undetermined.

Radiotracking surveys indicated that only 6% of the instrumented animals died during 1996–1997, so the adult mortality rate was probably lower than previous years. Summer and overwinter calf survival was also much higher—22% calves during the November 1996 survey and 23% during the April 1997. The 1997 count indicated the first increase in the population in 6 years (Carroll 1998).

Hunters using aircraft as transportation to hunt moose in the subunit began in the early 1970s. North Slope hunters also travel up the Colville River by boat. The mean reported harvest from 1985 to 1993 was 59 moose per year, with a high of 67 in 1991. As the moose population declined, the harvest decreased to 40 during 1994–1995. Hunting regulations became more restrictive and the harvest declined to 14 in 1995–96 and to 0 moose harvested in 1996–1997.

MANAGEMENT DIRECTION

Management Goals

- Allow the moose population in Unit 26A to rebuild to a minimum of 1000 animals.
- Investigate reasons for the population decline.

Management Objectives:

- Conduct spring surveys to monitor short-yearling survival and population numbers.
- Conduct fall trend counts to monitor sex and age composition in the population.
- Census the population at intervals of 7 years or less.
- Capture moose and take blood, fecal and hair samples to test for pregnancy, disease, parasites, and mineral deficiencies; and attach radio collars to monitor population trends, moose movements, and help determine causes of moose mortality.
- Conduct radiotracking surveys to determine calf production and mortality among calves and adults.

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 6–7 November 1997, 1–3 April 1998, 5–6 November 1998, and 12–15 April 1999, 6–9 November 1999, and 4–6 April, 2000. 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 short yearling recruitment and total number of moose during spring surveys.

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

In1999 we made an effort to develop a correction factor for moose that were not seen by counters in the area where we censused. We logged precise locations for moose we observed during the count and then immediately tracked the radiocollared moose in the area and recorded precise locations for them. Using these locations we judged which of the collared moose were not counted during the census.

We compiled harvest data from harvest reports submitted by hunters. In addition we gathered harvest data by contacting hunters in Nuiqsut.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND:

Population Size and Trend

Census results of 1219, 1258, 1447, and 1535 in 1970, 1977, 1984, and 1991, respectively, indicate the population was stable and slowly increasing for at least 20 years. A 1995 census indicated a 51% decline in the population between 1991 and 1995 (Table 1). Trend counts indicated that the population continued to decline by up to 75% by 1996, but that, due to improved calf survival, the population began to increase in 1997 (Table 2).

The population continued to increase in 1998, 1999, and 2000 trend counts, as indicated by counts of 206, 215, and 325 moose, respectively. The population has apparently increased at an average of 20.9% per year (Table 2). The comparatively larger number counted in 2000 could be partially due to deep snow, which pushed the moose toward riparian corridors more than usual, making them easier to count. There could also have been immigration of moose to the subunit from areas to the south or east.

The increase in population is also due to low adult mortality and high calf survival. It is unclear why the adult mortality declined and calf survival suddenly improved, but some contributing factors may be recovery of vegetation after overbrowsing, less virulent bacterial diseases prevalent in the population, reduced predation, weather factors, and reduced hunting pressure.

We developed a correction factor for moose missed by observers in 1999 and found that we had failed to see between 12% and 18% of the collared moose in the original count. When we applied this correction factor to the 187 moose we saw within the standard trend count area in the Colville, Anaktuvuk, and Chandler river drainages, we calculated an estimate ranging between 209 and 221 moose with a point estimate of 215 moose.

Population Composition

The percentage of short yearlings counted in spring surveys was very low between 1994 and 1996 (3%, 2%, and <1%). However, it increased dramatically in 1997 when 23% were observed. The higher rate of calf survival continued in 1998, 1999, and 2000 when 26%, 17%, and 25% short yearlings were observed during spring counts (Table 2).

During the fall 1997 composition surveys we observed 102 moose in the following classes: 25 bulls (46 bulls:100 cows), 55 cows, and 22 calves (40 calves:100 cows). In 1998 we observed 159 moose: 51 bulls (64 bulls:100 cows), 80 cows, and 28 calves (35 calves:100 cows). In 1999 we observed 209 moose: 51 bulls (49 bulls:100 cows), 104 cows, and 54 calves (52 calves:100 cows). These counts continued the trend we saw in 1996 of marked increase in summer calf survival over the previous 3 years (Table 3).

With improved calf survival, the percentage of bulls in the younger age groups gradually increased (see below).

Estimated Antler Widths of Bulls

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

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.

We recorded GPS locations for all moose observed during radiotracking surveys and obtained distribution information. With the exception of one animal that was captured on a hillside, all moose were captured in the riparian corridors of major rivers from 22–25 April 1996.

By 13 June 1996, 25 of 35 collared moose had moved away from the river bottoms into small tributaries or hills surrounding the major rivers. Eighteen of 20 cows seen with calves had moved away from the major rivers before calving. It appeared that most pregnant cows stayed on the major rivers until a few days before parturition and then moved away from the river bottoms to give birth. Three cows moved from the Anaktuvuk River to the Tuluga River to give birth. The mean distance that moose had moved away from the river bottoms was 8 miles and ranged from less than a mile to 18 miles. Four of 5 cows with negative pregnancy test results remained on the river bottom. Three cows with positive pregnancy test results were never seen with calves and none were seen to leave the river bottoms. Three of 5 bulls moved away from the river bottoms with 12 miles being the maximum distance traveled.

By 28 July, 16 of the cows with calves had returned to the riparian corridors and 18 had dispersed away from the river bottoms. Most of the cows were within 8 miles of the rivers, but one cow and calf were 107 miles north and another cow/calf pair was 36 miles north of the Colville River. We could locate only 2 of the bulls, which were found in the foothills of the Brooks Range and we assumed the others had traveled out of the survey area.

We flew surveys on 5–8 November and found that the widely dispersed moose had moved back to within a few miles of the river bottoms. Twenty moose were sighted on the river bottoms and 14 were found on tributaries and hills around the rivers. During surveys flown in March and April, we found 28 moose in the riparian habitat of the river bottoms and 4 moose in the areas adjacent to the rivers.

MORTALITY

Harvest

Season and Bag Limit.

1997–1998 and 1998–1999 Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 26A: that portion in the Colville River drainage downstream from the Anaktuvuk River		
RESIDENT HUNTERS:		
One bull**	Harvest	1 Aug–31 Aug
NONRESIDENT HUNTERS		No open season
Remainder of Unit 26A		
ALL HUNTERS		No open season

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

Board of Game Actions and Emergency Orders. The Board of Game continued with the regulation passed in 1996 that closed Unit 26A to moose hunting, except for a portion of the Colville River downstream from the mouth of the Anaktuvuk River. The portion of Unit 26A open to hunting had a bag limit of 1 bull from 1 Aug–31 Aug, and no aircraft use was allowed for moose hunting.

Hunter Harvest. Hunter harvest reports indicate 2 bull moose were harvested during fall of 1997, 5 in 1998, and 2 in 1999 (Table 4). The low harvests were a result of restrictive regulations and low numbers of moose.

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

Hunter Residency and Success. All successful hunters and most unsuccessful hunters in 1997, 1998, and 1999 were local residents. The total number of hunters was very low because they were limited to a small section of the former hunting area and success rates were low because moose numbers were low (Table 6).

Harvest Chronology. All legal hunting took place during August due to the regulations (Table 7).

Transport Methods. All hunters used boats for transportation (Table 8).

Other Mortality

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

The mortality rate has been low for both adults and calves since 1996. Among the radiocollared moose, the mortality rate was 5.7% for 1996–1997, 2.1% for 1997–1998, 0% for 1998–1999, and 11.9% for 1999–2000 for an average of 4.5% mortality per year. Calf survival has also increased substantially. The percentage of short yearlings counted during spring surveys increased from an average of 2% from 1994 through 1996 to 23% from 1997 through 2000.

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

The fact that we have not observed dead moose that appear to have starved indicates that vegetation may have recovered from the overbrowsing that probably took place when the population was at peak numbers during the late 1980s and early 1990s.

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

CONCLUSIONS AND RECOMMENDATIONS

After several years of declining population numbers, the Unit 26A moose population began to increase in 1997. As a result of low adult mortality and high calf survival the number counted in the trend count area has increased from 152 in 1996 to 325 in the spring of 2000, an increase of 20.9 % per year. The recruitment rate for short yearlings has averaged 23% and the adult mortality rate has averaged about 4.5% for the last 4 years.

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

In response to the severe population decline, we changed the management goal in 1996 from maintaining the population to rebuilding the population. The Board of Game passed regulations that eliminated hunting pressure for most of the area in 1996. While hunting was not the major cause of the decline, it was a contributing factor and one that could be changed to help begin rebuilding the population. The population has increased consistently for 4 years, so we can now consider reinstituting a limited hunting season that will allow for some harvest but allow the continuing recovery of the population.

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Table 1 Number of adult and calf moose from Unit 26A censuses, 1970–1995

Year	Adults	Calves	Total	Percent 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 2 Unit 26A moose trend counts: Anaktuvuk River from the mouth to Sivugak Bluff, Chandler River from the mouth to Table Top Mountain, and Colville River between the mouths of Anaktuvuk and Killik rivers, 1970, 1974–1981, and 1983–2000

Year	Total	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
1996	152	151	1	<1
1997	188	145	43	23
1998	206	153	53	26
1999	210	174	36	17
2000	325	245	80	25

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

Table 3 Unit 26A fall aerial moose composition counts 1983–1999

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

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

Table 4 Unit 26A moose harvest, 1985–1999

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

Table 5 Percent antler width categories (inches) among moose harvested in Unit 26A, 1983–1999

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

Table 6 Moose hunter residency and success, Unit 26A, 1987–1999

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

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

Table 7 Percent chronology of moose harvest by month, Unit 26A, 1987–1999

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

*Season only open in August

Table 8 Percent transport methods for moose harvest in Unit 26A, 1987–1999

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

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 prior to the early 1950s, when populations expanded and reached high densities in the limited riparian habitat in major drainages (LeResche et al. 1974). Predation, as well as hunting by humans, probably contributed to the historical scarcity of moose. The reduction in wolf numbers by federal control programs during the late 1940s and early 1950s likely was important in allowing moose populations to increase and become established in most of the riparian shrub habitat on the North Slope. Aerial wolf hunting during the decade following statehood also limited wolf populations.

This area represents the northern limit of moose range in North America. Thus, habitat severely limits the potential size of moose populations, and the concentrated nature of moose distribution and open habitat creates the potential for excessive harvests in accessible areas. During the early 1990s, concentration of hunting pressure along these drainages caused concern among guides, outfitters, hunters, and Alaska Department of Fish and Game (ADF&G) and Arctic National Wildlife Refuge staff. Moose hunting regulations became increasingly restrictive during the past decade and a precipitous decline in numbers of moose led to a season closure in 1996.

Kaktovik and Nuiqsut are the only subsistence communities in the area, and residents took 2–6 moose annually prior to the season closure in 1996. Subsistence harvest was small because moose are scarce near Kaktovik and because most hunting by Nuiqsut residents occurs in the Colville River drainage in adjacent Unit 26A.

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 a least 50 bulls:100 cows.
- Determine subsistence needs and harvest levels.

METHODS

The limited and relatively open nature of winter moose habitat on the North Slope makes a total count, rather than sampling, the most effective population survey method. Moose are limited almost entirely to riparian shrub habitat during winter. Historically, surveys were conducted in Unit 26B East (east of the Dalton Highway, including the Canning River) and in Unit 26C along the Kongakut and Firth Rivers and Mancha Creek. The west bank of the Canning River is the boundary between Units 26B and 26C. However, Unit 26B East survey data includes moose counted in the Canning River portion of Unit 26C. Surveys in Unit 26B West (west of the Dalton Highway) began in 1996. Most data were combined by subunit or portion of subunit.

US Fish and Wildlife Service conducted moose composition surveys in Unit 26B East along riparian willow habitat (Martin and Garner 1984; Weiler and Liedberg 1987; Mauer and Akaran 1994; Mauer 1995, 1997). Surveys were done during the end of October, early November, April, or May using Piper PA-18 aircraft flown at 70–90 mph and/or a Cessna 185 flown at 95–120 mph at altitudes of 300–600 feet above ground level. The following drainages were surveyed as weather permitted: Accomplishment Creek, Lupine River, Saviukviayak River, Flood Creek, Ivishak River, Gilead Creek, Echooka River, Shaviovik River, Juniper/Fin Creek, Kavik River, and Canning River. Aerial observers circled each moose and, during fall surveys, classified moose as calves, cows, yearling bulls, medium bulls (≤ 50 inch antlers), or large bulls (> 50 inch antlers). Medium and large bulls were combined in this report. Spring surveys were completed in 1999 and 2000 because low snowfall and poor weather precluded fall surveys. During these surveys, moose were classified as short yearlings and adults.

We conducted spring moose surveys in Unit 26B West during April 1997, 1999, and 2000 using the methods described previously. Surveys were done along riparian willow habitat on the Sagavanirktok River from Happy Valley to Sagwon Bluffs and on the Toolik and Kuparuk Rivers starting at approximately latitude 68°52' to the White Hills. In addition, parts of the Itkillik River have been surveyed periodically since 1984 but because of incomplete surveys during 1996 and 2000, this data will not be included in this report. These data are available in ADF&G files in Fairbanks, Alaska.

We conducted habitat reconnaissance in Unit 26B East during the last week of April 1994 in cooperation with the US Fish and Wildlife Service and University of Alaska. Availability, condition, and species composition of moose browse was evaluated in parts of Accomplishment Creek, Section Creek, and the upper Lupine River.

The hunting season has been closed since fall 1996. Prior to the closure, harvest and hunting pressure were monitored using harvest reports submitted by hunters with the benefit of reminder letters. Population survey, total harvest, residency and success, chronology, and transportation data were summarized by regulatory year (RY). For example, regulatory year 1 July 1998–30 June 1999 was RY98. Informal visits and interviews with hunters and guides also provided insight into population status and moose management issues.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

A complete moose population survey has not been conducted in Units 26B and 26C, but the nature of terrain and sparse, low vegetation makes it possible for trend surveys to account for a large percentage of the moose in areas supporting major concentrations.

In Unit 26B East, the highest numbers of moose observed were 629 in fall 1988 and 600 in fall 1989 (Table 1). Beginning in fall 1990, the number of moose observed declined markedly to 381 moose and continued to decline to 145 moose by fall 1995. Since 1995, the population appears to have stabilized at around 150 moose (Table 1). The low value of 97 moose observed in fall 1997 should be viewed as an underestimate because 25% of the Canning River was not surveyed. No fall surveys were conducted in 1998 or 1999 in Unit 26B East. However, during spring surveys in April 1999 and 2000, 149 and 165 moose were observed, respectively. This slight increase in moose numbers in April 2000 may be a result of a different distribution of moose between fall and spring (G Carroll; ADF&G; personal communication) or an indication that the population is slightly increasing.

In Unit 26B West, surveys did not begin until spring 1996. Information from harvest data, hunting guides, and bush pilots indicated that the moose population in this area also declined during the early 1990s. Spring surveys conducted in 1996, 1999, and 2000 indicated a stable population of 50 moose (Table 2). This followed the same trend observed in Unit 26B East when it appeared that the population was stable during regulatory years 1995–1999. Number of moose observed in spring 2000 was slightly lower (44) than in spring 1999 (56). The difference between 1999 and 2000 is small and may be a result of differences in moose distribution. Most of the decrease in moose numbers in 2000 occurred in the Kuparuk drainage.

The decline in the number of moose observed in Unit 26B during the early 1990s appeared to be widespread on the eastern North Slope, and it also occurred in Unit 26A (G Carroll, ADF&G, personal communication). The reasons for the dramatic decline on are not well understood, but predation, weather, insect harassment, and range deterioration may all be involved.

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 suggested that wolf numbers increased during the early 1990s. Incidental observations during summer 1995 suggested an unusually high level of mortality from causes other than predation. For example, there were numerous reports of intense harassment of moose by mosquitoes, which were abundant due to an early spring and favorable moisture and temperature. This may have contributed to the demise of both calf and adult moose. Although habitat reconnaissance east of the Dalton Highway in April 1994 indicated that browsing intensity on favored vegetation was relatively heavy, forage was not in critically short supply. Species composition consisted mostly of *Salix alaxensis* and *S. pulchra* with the former predominating. Some current annual growth remained, therefore some moose browse was still available. Quality of browse was not determined, but *Salix alaxensis* is generally among the highest quality browse species.

In eastern Unit 26C, sizable concentrations of moose were surveyed during fall 1990 and 1992 in the Kongakut and Firth Rivers and Mancha Creek. However, no surveys have been completed recently and the status of these moose populations is unknown.

Population Composition

In Unit 26B East, survival of calves to fall was good from 1988–1991 (12–14%) except in 1989 (5%). No surveys were conducted during RY92 and RY93 and by fall 1994, when the number of moose observed had declined dramatically, survival of calves to fall also was very low (4%) (Table 1). This low survival also occurred in 1995 (5%).

Because no surveys were conducted during the 2 years previous to fall 1994, we do not know precisely when poor calf survival started. However, during spring surveys in 1994 in Unit 26A, a similar pattern occurred where numbers of observed moose and survival of short yearlings declined sharply (G Carroll, ADF&G, personal communication). Based on Unit 20A data, we can speculate that poor calf survival in Unit 26B started sometime between fall 1993 and spring 1994.

Survival of calves to fall began to increase in 1996 (11%) and continued in 1997 (14%, Table 1). Fall surveys were not conducted during 1998 and 1999, but we observed 13% short yearlings during spring surveys conducted in 1999 and 8% short yearlings in 2000 (Table 1).

The low values for short yearling survival in spring 2000 as compared to previous fall surveys and the 1998 spring survey may have been due to a combination of winter calf mortality and problems with survey methods. Loss of calves over winter would have depressed the percent of short yearlings observed in the spring. Also, some short yearlings may have been identified as adults during the spring 2000 surveys because observers did not circle and closely examine each moose. Survival of calves/short yearlings may have been similar to the previous 2 years. This possibility is supported by spring 2000 survey data from Units 26B West and 26A that indicated a substantial increase in the proportion of short yearlings in the population (Table 2 and Geoff Carroll, ADF&G, personal communication).

In Unit 26B East, bull:cow ratios were below the management objective of 50:100 during fall 1994; but ranged 61–69 during fall 1995–1997 (Table 1). Although bull:cow ratios were high during this time, the population was declining. This suggested that adult cow mortality was higher than adult bull mortality, at least during RY95. However, the season was closed to hunting in fall 1996 and high bull:cow ratios in fall 1996 and 1997 were probably a reflection of the closed season.

In Unit 26B West (excluding the Itkillik drainage), percent short yearlings was very low in spring 1996 (2%) and by 2000 it increased to 23% (Table 2) following the same trend that occurred in Unit 26A (G Carroll, ADF&G, personal communication).

Distribution and Movements

Moose were generally associated with narrow strips of shrub communities along drainages, except in summer when some dispersal occurred. The greatest concentrations occurred along the Canning, Kavik, Ivishak, Toolik, Kuparuk, Itkillik, and Kongakut Rivers. Moose movements have not been intensively studied, but casual observations indicated there may be seasonal movements within or between North Slope drainages. Telemetry studies show that some moose winter in the upper Kongakut River and then migrate south and east to summer on the Old Crow Flats in Canada (Mauer 1998).

MORTALITY

Harvest

Season and Bag Limit. There was no open season for moose in Units 26B and 26C during RY96–RY99.

Board of Game Actions and Emergency Orders. Following is a review of past regulations and regulatory changes. During RY90–RY94, the season for Units 26B and 26C was 5–15 September for both residents and nonresidents with a bag limit of 1 bull. A requirement of a 50-inch minimum antler size was in effect for nonresidents and also for anyone hunting within the Dalton Highway Corridor Management Area (DHCMA; see below). During RY90–RY92, the definition of a 50-inch moose was an antler width ≥ 50" or 3 or more brow tines on 1 side. In RY93, the definition was changed to 4 or more brow tines on 1 side for moose north of the Alaska Range. An additional season, 1 November–31 December with a bag limit of 1 bull, was open for residents during RY90–RY94.

In RY95, the season remained the same for Unit 26B and the Canning River drainage which is partially in Unit 26C. East of the Canning River drainage in Unit 26C, the season for residents and nonresidents was 5–15 September with a bag limit of 1 bull. The previous antler restriction for nonresidents was not required due to an error in the proposal that was submitted to the Board of Game in 1994. The winter season for residents was changed to 1–31 December.

State regulations governing moose hunting along the Dalton Highway in Unit 26B were in effect during RY90–RY95. The DHCMA extends 5 miles from each side of the Dalton Highway from the Yukon River to the Prudhoe Bay Closed Area. The DHCMA was closed to hunting with firearms. However, big game, small game, and fur animals could be taken by bow and arrow only, but hunters had to possess a valid International Bow Hunter Education card. In addition, no motorized vehicles, except aircraft, boats and licensed highway vehicles could be used to transport game or hunters.

The season was closed during RY96 because of declining moose numbers, and it has remained closed through RY00. During their March 2000 meeting, the board determined that a harvest of 60–80 moose was necessary to satisfy subsistence needs in Unit 26.

There has not been an open season on federal lands in Units 26B and 26C in federal regulations since RY96. However, federal subsistence hunting regulations existed on federal lands during RY90–RY95 (RY90 was the first year of federal implementation). During RY90, any rural resident was eligible to hunt, even if they did not live near the resource. Since then, only residents of the corridor and nearby villages (Anaktuvuk Pass, Wiseman, Nuiqsut, and Kaktovik) have been eligible. In RY92–RY93, federal regulations allowed the use of firearms for hunting on federal land within the DHCMA by qualified rural subsistence hunters.

Hunter/Trapper Harvest. The reported moose harvest in Unit 26B was relatively stable during the early 1990s. It was 24–37, except in RY92 when harvest was 45 (Table 3). In RY95, harvest declined to 16 animals. Number of hunters increased markedly from 49 in RY91 to 90 in RY92. Number of moose hunters remained high during the following 3 years (63–90), but harvest declined (range = 16–37) to previous levels. This was probably influenced by the declining moose population.

In Unit 26C the harvest was 3–6, and the number of hunters was 5–12 during RY90–RY95 (Table 4). Less hunting occurred in Unit 26C compared with Unit 26B due partially to a lack of airstrips near moose habitat in Unit 26C. Most of the hunting in Unit 26C occurred in the Canning River drainage.

Hunter Residency and Success. During RY86–RY96, Alaska residents living outside the area comprised all but a few of the resident hunters in Units 26B and 26C (Table 5). Hunter success declined to below 50% beginning in RY93, likely due to the declining moose population. Nonresidents reported a higher success rate than Alaska residents, probably because nonresidents benefited from guide/outfitter services

Harvest Chronology. During RY86–RY96 most moose harvested in Units 26B and 26C were taken during the first 2 weeks of September (Table 6). The concentration of hunting activity in early autumn was probably due to early onset of winter in the region.

Transport Methods. During RY86–RY96, aircraft was the predominant transportation method for hunters; used by over 70% of the successful moose hunters (Table 7).

Natural Mortality

No intensive studies of moose mortality have been done in the eastern arctic. Incidental observations and reports by hunters and trappers indicated predation by bears and wolves and periodic malnutrition during severe winters (deep snow) were probably the most important sources of mortality. Harassment by mosquitoes during summer 1995 may have increased vulnerability to predation and increased mortality rates. Efforts to enhance habitat do not seem feasible. Fire is not a factor in maintaining moose habitat in this area.

CONCLUSIONS AND RECOMMENDATIONS

The moose population in Units 26B and 26C declined dramatically during the early 1990s, but has stabilized since RY95. A combination of factors such as habitat quality, insect harassment, and increased predation by wolves and bears were probably responsible for the decline in numbers. Survival of calves/short yearlings was low in RY94 and RY95, but began to increase by RY96 in Unit 26B East and by RY98 in Unit 26B West. The increase continued in Unit 26B West in RY99. This followed a similar trend seen in adjacent Unit 26A (G Carroll, ADF&G, personal communication). Data collected for Unit 26B East did not show an increase in survival of short yearlings during the past 2 years; however, moose were not examined closely during aerial surveys, so some short yearlings were possibly misidentified as adults. We will make it a priority to assess the situation in Unit 26B East in spring 2001 to aid in determining whether survival is increasing or declining.

Hunting has been closed since RY96. We do not recommend opening the season until the population is clearly growing and calf survival has increased and stabilized.

We achieved our first objective of determining population distribution, composition, density, and trends by conducting fall and spring surveys. We did not accomplish our second objective to determine movements and habitat use in heavily harvested drainages. We did not radiocollar moose to determine movements and the habitat reconnaissance conducted in spring 1994 did not occur in areas where heavy hunting occurred. During most years we accomplished our third objective to maintain an annual posthunting sex ratio of 50 bulls:100 cows. Only during RY91 and RY94 in Unit 26B East did the bull:cow ratios fall below 50:100 (47 and 39; respectively). We accomplished our fourth objective of determining subsistence needs and harvest levels when the Board of Game formally adopted a minimum subsistence harvest level of 60–80 moose for Unit 26. Harvest had been determined previously from report cards and Division of Subsistence surveys. Typically, hunters from Nuiqsut and Kaktovik harvested 2–6 moose annually.

Current goals and objectives do not provide adequate direction for the management program because of changes in the moose population and in hunting regulations. Therefore, the following goals and objectives are adopted for the next reporting period.

MANAGEMENT GOALS

- Maintain viable populations of moose in their historic range throughout the region.
- Provide a sustained opportunity to harvest moose.
- Provide opportunity for viewing and photographing moose.

MANAGEMENT OBJECTIVES

- In Unit 26B East, allow the moose population to increase to ≥200 moose, including ≥15% calves in spring surveys, before opening a hunting season.
- In Unit 26B West, allow the moose population to increase to ≥75 moose, including ≥15% calves in spring surveys, before opening a hunting season.
- Once a hunting season has been reopened, maintain a posthunting sex ratio in Units 26B and 26C of 35 bulls:100 cows.

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Table 1 Unit 26B East (east of Dalton Highway, including Canning River) aerial moose composition counts, regulatory years 1988–1989 through 1999–2000[a]

Regulatory year	Season	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/mi^2
1988–1989	Fall	59	30	21	75	12	534	629	1.42
1989–1990	Fall	54	13	9	32	5	568	600	1.35
1990–1991	Fall	59	7	26	63	14	383	446	1.54
1991–1992	Fall	47	10	21	66	13	352	518	1.48
1992–1993[b]									
1993–1994[b]									
1994–1995	Fall	39	8	5	14	4	367	381	1.06
1995–1996	Fall	66	11	8	7	5	138	145	0.40
1996–1997	Fall	61	5	22	16	11	125	141	0.40
1997–1998		69	4	30	14	14	83	97	0.27
1998–1999	Spring				20	13	129	149	
1999–2000[c]	Spring				14	8	151	165	

[a] Data source for 1988–1989 through 1999–2000: F Mauer, US Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks.

[b] No survey.

[c] Moose were not circled and examined closely, so some calves may have been identified as cows.

Table 2 Unit 26B West (west of Dalton Highway excluding Itkillik River) spring aerial moose surveys, regulatory years 1995–1996 through 1999–2000

Regulatory year	Short yearlings	Percent short yearlings	Adults	Moose observed
1995–1996	1	2	52	53
1996–1997[a]				
1997–1998[a]				
1998–1999	6	11	50	56
1999–2000	10	23	34	44

[a] No survey.

Table 3 Unit 26B reported moose harvest and accidental death, regulatory years 1988–1989 through 1999–2000

Regulatory	Reported harvest				
year	M (%)	F (%)	Unk	Total	Hunters
1988–1989	33 (100)	0 (0)	0	33	49
1989–1990	24 (100)	0 (0)	1	25	47
1990–1991	24 (100)	0 (0)	0	24	45
1991–1992	28 (100)	0 (0)	0	28	49
1992–1993	45 (100)	0 (0)	0	45	90
1993–1994	30 (100)	0 (0)	0	30	84
1994–1995	37 (100)	0 (0)	0	37	85
1995–1996	16 (100)	0 (0)	0	16	63
1996–1997 through 1999–2000[a]					

[a] No open season.

Table 4 Unit 26C reported moose harvest and accidental death, regulatory years 1988–1989 through 1999–2000

Regulatory year	Reported harvest				Hunters
	M (%)	F (%)	Unk	Total	
1988–1989	10 (100)	0 (0)	0	10	18
1989–1990	1 (100)	0 (0)	0	1	11
1990–1991	3 (100)	0 (0)	0	3	8
1991–1992	6 (100)	0 (0)	0	6	11
1992–1993	4 (100)	0 (0)	0	4	5
1993–1994	4 (100)	0 (0)	0	4	7
1994–1995	6 (100)	0 (0)	0	6	12
1995–1996	4 (100)	0 (0)	0	4	8
1996–1997 through 1999–2000[a]					

[a] No open season.

Table 5 Units 26B and 26C moose hunter residency and success, regulatory years 1988–1989 through 1999–2000[a]

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	
1988–1989	0	13	26	4	43 (64)	0	14	6	4	24 (36)	67
1989–1990	0	11	15	0	26 (45)	0	24	7	1	32 (55)	58
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
1995–1996	0	3	17	0	20 (28)	2	34	17	0	51 (72)	71
1996–1997 through 1999–2000[c]											

[a] Source: moose harvest reports.
[b] Residents of Units 26B or 26C.
[c] No open season.

Table 6 Units 26B and 26C moose harvest chronology percent by month/day, regulatory years 1988–1989 through 1999–2000[a]

Regulatory year	Harvest chronology percent by month/day								
	9/1–9/7	9/8–9/14	9/15–9/21	9/22–9/28	9/29–10/5	Oct	Nov	Dec	*n*
1988–1989	42	25	22	11					36
1989–1990	27	31	31	4	4				26
1990–1991	37	52	4					2	27
1991–1992	53	41						6	34
1992–1993	63	37							49
1993–1994	50	44	3					3	34
1994–1995	54	44	3					2	41
1995–1996	37	53	10						19
1996–1997 through 1999–2000[b]									

[a] Source: moose harvest reports.

[b] No open season.

Table 7 Units 26B and 26C moose harvest percent by transport method, regulatory years 1988–1989 through 1999–2000[a]

Regulatory year	Harvest percent by transport method								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
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
1995–1996	90	0	0	0	0	0	10	0	20
1996–1997 through 1999–2000[b]									

[a] Source: moose harvest reports.
[b] No open season.

Appendix: Biological Evaluation of Spike-Fork/50" Moose Harvest in Southcentral Alaska

By

The Spike-Fork/50 Task Group

Summary

The biological effects of harvesting moose under a spike-fork/50" (SF/50) strategy is evaluated. Harvest statistics, aerial survey data, and recent research reports are used to determine if SF/50 is meeting management objectives in Game Management Units 7 and 15 (Kenai Peninsula), 14 and 16 (Matanuska-Susitna Valleys and west side of Cook Inlet), and 13 (Nelchina Basin). Units 7 and 15 have had SF/50 since 1987. An initial evaluation of the harvest system after 5 years indicated that it was successful in improving bull:cow ratios, providing more mature bulls in the population, and allowing a hunt to take place even after severe winters. SF/50 also resulted in decreased hunter participation and a somewhat decreased annual harvest, but harvest was expected to return to pre-SF/50 levels. In 1993, based partly on the Kenai experience, SF/50 was implemented throughout Southcentral Alaska and was to be evaluated after a similar period. Since 1993 in Units 7 and 15, bull:cow ratios have remained favorable, hunter participation has increased, and the level of harvest is generally equal to pre-SF/50 years. Composition of the harvest based on antler size has not changed since the first evaluation was done. No biological problems exist in these units. In Units 14 and 16, it is apparent that more moose could be harvested, particularly in subunits 14B, 16A, and 16B where objectives for bull:cow ratios are being exceeded. Subunit 14A now draws more hunters than during pre-SF/50 years and hunter success rates have declined. This increase in hunters may be linked to the addition of late-season hunts for spike-fork bulls. In subunits 14B, 16A, and 16B, hunter participation is less than it was prior to SF/50 but is increasing. Success rates are low in subunit 14B, moderate in subunit 16A, and high in subunit 16B. If hunter participation can be increased in these subunits, particularly in Unit 16, harvest levels should increase. In Unit 13, dramatic increases in hunter participation and probable decreases in calf recruitment have caused bull:cow ratios to fall below prudent levels in subunits 13E, 13B, and particularly 13A. A high proportion of yearlings are legal under spike-fork regulations, and adult moose in this area tend to produce more brow tines than moose elsewhere. This causes higher exploitation rates of yearlings and mid-sized bulls, thereby decreasing the number of bulls reaching maturity. Harvest must be decreased in subunits 13A, 13B, and 13E at a minimum to allow bull:cow ratios to reach the 20–25:100 range. Viable options for reducing the harvest in Unit 13 are: 1) reduction of hunter effort by reducing season length, or 2) reducing the number of bulls defined as legal by either a) raising the definition of a legal bull to 4 brow tines, or b) confining yearling harvest to spikes only. The impact of a reduction in season length is impossible to determine, although it is expected to result in some level of harvest decline. Of the two methods involving changes in the definition of legal animals, a computer simulation revealed little difference between the two. Based on the

assumptions of the model, both of these harvest strategies produced declines of approximately 20% in harvest and brought bull:cow ratios within the range of 20–25:100.

Purpose

This analysis of the biological ramifications of the spike-fork/50 (SF/50) moose season was prepared at the request of the Alaska Board of Game. It constitutes an evaluation of this new harvest strategy after the initial 5-year period in the Matanuska-Susitna valleys and the Nelchina Basin. Implementation of this selective harvest system in GMUs 11, 13, 14, and 16 occurred in 1993. SF/50 had been implemented in GMUs 7 and 15 in 1987.

Background

Spike-fork/50 is one of many moose management alternatives that fall under the general category of selective harvest strategies (SHS). These SHS are designed to apportion the harvest of moose among certain sex and age classes to optimize both harvest and population objectives. SHS have been implemented successfully in other jurisdictions (Timmerman and Buss 1998), and the prototype SHS incorporating antler architecture as harvest criteria was implemented in British Columbia in 1980 (Child 1983, Child and Aitken 1989).

The SF/50 program is based loosely on the British Columbia program and is intended to create a more natural age structure among males by increasing the number of mature bulls in the population. Mature bulls are necessary to ensure the timely breeding of females (i.e., the breeding of all females on their first estrus). This leads to birth synchrony and possibly to greater juvenile survival in the subsequent winter. Creating a protected class of animals, including vigorous yearlings and many animals aged 2–4, increases the prevalence of mature bulls in the population. These bulls are given the time to develop and mature so that they can be more effective breeders. SF/50 also allows mature bulls to be harvested once they reach a minimum size, which can serve to increase hunter satisfaction. The specific objectives of SF/50, delineated during its implementation on the Kenai Peninsula (Units 7 and 15) in 1987, are: 1) increase bull:cow ratios; 2) increase the number of prime bulls in the population; 3) increase the opportunity to view bull moose; 4) maintain hunter opportunity; and 5) promote hunter ethics. This analysis pertains to objectives 1, 2, and 4.

Schwartz et al (1992) conducted an analysis of the effectiveness of SF/50 on the Kenai Peninsula and determined that, after 5 years, it was partially successful in meeting its objectives (Table 1). The most striking change noted was an increase in bull:cow ratios from a mean of 16:100 before implementation to a mean of 25:100 for the first 5 years of SF/50. Proportion of the harvest composed of bulls aged 2–3 declined significantly whereas proportional harvest of yearlings increased. Proportional harvest of animals $\geq$4 years old did not change. Total harvest declined significantly as did number of hunters, whereas success rate remained stable. Anecdotal evidence from hunters revealed two trends. Some hunters refused to hunt in the area due to dissatisfaction with the program. Other hunters expressed approval of the program because they observed more bulls, particularly large bulls, while hunting.

Aside from concerns about typical harvest statistics, questions were raised about potential long-term effects of SF/50 on antler size. Would this strategy alter the size of antlers expected of mature bulls in a given population? Hundertmark et al. (1993) examined the genetic consequences involved with SHS on the Kenai Peninsula. They incorporated local antler characteristics and population parameters into a computer model that simulated genetic changes and population processes influenced by harvest for 50 years under a variety of SHS. Results of that study indicated that harvest criteria could have a profound impact on genetic and population processes after 50 years. Harvesting only spike-fork yearlings tends to alter the gene pool by favoring genes that produce larger antlers. Conversely, any kind of minimum spread component (such as 50" or 36") had the opposite effect – genes favoring larger antlers declined. By combining these two criteria, some sort of balance was achieved depending on the minimum spread chosen for the upper end. The strategy where any bull was legal yielded the highest harvest but also was characterized by the lowest ratios of all bulls:100 cows and mature bulls:100 cows. These trends have been observed in many game management units in Alaska. The strategy that had only spike-fork animals legal yielded high bull:cow ratios but low harvest. SHS utilizing both the spike-fork and 50" strategies yielded the best compromise between harvest and bull:cow ratios. Any SHS that included a component that identified legal bulls based on brow tine architecture (the 3-brow tine rule) caused a decrease in genes favoring those brow tines. There was no strategy that could be added to the season that would balance this negative effect.

The trends noted in that study were for a population that was at or close to its nutritional carrying capacity, (i.e., a high-density population). A more recent modeling effort (Hundertmark et al. 1998) examined the same population processes in moose populations that are held below carrying capacity. In these populations, the increased nutrition available due to more abundant, high-quality food would cause antlers to grow faster and achieve larger size more quickly. Also, fewer yearlings would exhibit spike-fork antlers, but would instead be expected to produce small palmated antlers. In other words, the nutritional component of antler growth would be maximized. In these populations, the same genetic and population trends were observed as in the previous exercise, but rates of change were faster.

Game Management Unit Accounts

I. Kenai Peninsula (Units 7 and 15)

The size of moose populations on the Kenai Peninsula has not been assessed routinely in a manner having known statistical precision. The general trend in subunit 15A, however, is stable or declining, and the outlook is for a general decline if significant habitat alteration does not occur (Loranger et al. 1991). Subunits 15B and 15C have stable populations due in large part to the abundance of subalpine habitat. Unit 7 has small but stable populations.

To examine bull:100 cow ratios in these units, we concentrated on large count areas that are surveyed consistently. Only years in which all count areas were surveyed and yielded reliable data were used. Thus, our results differ somewhat from those reported by

Schwartz et al (1992). Bull:cow ratios in Unit 15 (Fig. 1) from 1971 to 1986 averaged 14:100, and averaged 16:100 from 1982 to 1986. Since inception of SF/50, bull:cow ratios have averaged 20:100, with a peak of 26:100 in 1996. Mean yearling bull:cow ratios since SF/50 was implemented is 7:100. For Unit 7, bull:cow ratios were between 10–15:100 throughout the 70s. In the early 80s, these ratios increased to between 27 and 34:100 but these surveys saw few moose overall and their reliability is questionable. Subsequent to SF/50, ratios have averaged 35:100, with a mean yearling bull:cow ratio of 9:100.

For the 5 years before the institution of SF/50 on the Kenai Peninsula in 1987, hunter participation averaged approximately 3600 hunters annually and was increasing (Fig. 2). Participation declined dramatically immediately after the change in regulations and averaged approximately 2700, a 25% decrease. Nonetheless, approximately 2000 hunters participated in the 1990 hunt, which followed an extremely severe winter, whereas other units experienced closures. After SF/50 was instituted regionwide in 1993, participation in the Kenai hunt increased, indicating perhaps that hunters had fled the Kenai to hunt in other areas, but returned after SF/50 became widespread. Schwartz et al. (1992) found no evidence for this trend, but it may have been masked by other factors. Mean number of hunters participating from 1993 to 1997 was 3374, which included a year (1995) following a severe winter when participation was down. Excluding this year, the average number of hunters participating was 3540, which is nearly equivalent to pre-SF/50 levels. Percent success remained relatively constant throughout the last 16 years, with no trend apparent relative to SF/50 (Fig. 2).

Harvest followed a similar pattern to participation (Fig. 3). A mean of 635 bulls was harvested annually for the 5 years prior to SF/50. For the first 5 years following institution of SF/50, a mean of 439 bulls was harvested. During the final 6 years of this analysis (1992–1997) the mean annual harvest was 579 bulls. Excluding the poor harvest of 1995 (following a severe winter) the mean harvest for the last 5 years was 665, equivalent to pre-SF/50 levels.

The percentages of antler classes in the harvest have remained relatively constant for the last 5 years (Fig. 4). Mean prevalence of spike/fork yearlings in the harvest was 61.2%, which is not different than the prevalence (64%) observed during the first 5 years of the program (Schwartz et al. 1992). Bull with antlers greater than spike/fork but less than 50 inches (harvested because they had ≥3 brow tines and hereafter referred to as mid-sized bulls) composed 15.8% of the harvest; 15% of those had ≥4 brow tines. Bulls with spreads of ≥50" (hereafter referred to as large bulls) comprised the remaining 26%, with 20% of these having ≥4 brow tines.

Conclusion

For Units 7 and 15, there is no compelling biological reason for altering the harvest strategy of SF/50. Bull:cow ratios are stable and within reasonable levels, the proportions of bulls of different sizes in the harvest also has remained stable, indicating that harvest is not altering the antler structure of bulls, at least at a detectable rate.

II. Matanuska Valley (Units 14A, 14B, and 16)

Management objectives for subunits 14A, 14B, 16A, and 16B are listed in Table 2. Objectives have been quantified for population size, harvest level, and bull:100 cow ratio.

Since implementation of SF/50, the proportion of the harvest comprised of the 3 different antler classes (S/F, mid-sized, and large) has remained fairly constant despite an increasing trend in harvest (Fig. 5). S/F yearlings (including yearlings that were unclassified) composed a mean of 43% of the harvest, midsized bulls composed 20% (19% of which had 4 or more brow tines), and large bulls composed 37% of the harvest (32% of which had 4 or more brow tines). The proportion of S/F animals in the harvest has not increased significantly in the last 3 years even though an additional late-season harvest of S/F yearlings was permitted in subunits 14A, 14B, and 16A.

Unit 14A

The trend in population size for subunit 14A is relatively stable (Table 3). Bull:100 cow ratios declined in this subunit after the severe winter of 1989–90 (Fig. 6). Ratios have increased since 1993 and are once again within the objective range of 20-25 bulls:100 cows. [ADD 1998 DATA] The ratio of yearling bulls:100 cows has decreased since 1993. In 1988 and 1989, this ratio was approximately 10:100, but in 1996 (last survey) it was 6:100. The relative proportions of small bulls and large bulls in post-hunt surveys are an important index of the success of antler-based SHS (Hundertmark et al. 1998).

For the 5 years prior to SF/50, a mean of 2619 hunters participated annually in the general moose hunt. If 1990 (severe winter) is removed from the analysis, this mean increases to 2828. For the 5 years following implementation of SF/50, a mean of 3194 hunters participated annually (Fig. 7). Numbers participating in 1996 and 1997 were the highest in the past 10 years. Hunter success declined after SF/50. Percent success prior to SF/50 averaged 16.6%, whereas it averaged 10.8% after SF/50, although it is increasing (Fig. 8).

Harvest for Unit 14A has generally decreased since implementation of SF/50. Mean annual harvest pre-SF/50 was 486 bulls, whereas it decreased to a mean of 354 post-SF/50. The harvest has increased significantly in the past 5 years (Fig. 8) and this is due primarily to an increase in number of hunters. Harvest is significantly correlated to number of hunters both pre-SF/50 ($r = 0.96$, $P < 0.01$) and post-S/F50 ($r = 0.97$, $P < 0.01$). Harvest for both 1996 and 1997 was greater than the mean annual harvest prior to SF/50.

Unit 14B

This subunit contributes relatively few moose to the Unit 14 harvest and historically provides for limited hunter participation. Post-hunt surveys have not been conducted since 1994, and only 4 have been conducted within the last 10 years. The 1994 survey indicated an increase in population size compared with surveys from 1992 and 1990, indicating a rebound in size form the severe winter in 1989–90 (Table 3). Three surveys were conducted in the 5 years pre-SF/50, and had a mean bull:100 cow ratio of 26:100

(Fig. 9). The sole survey post-SF/50 yielded a bull:100 cow ratio of 31. The objective range for this subunit is between 20 and 25:100.

In 1988 and 1989, a mean of 955 hunters participated annually in this subunit. After the 1990 season, which was closed, hunter participation declined markedly (Fig. 10). During the 10-day seasons imposed in 1991 and 1992, a mean of 331 hunters participated. A similar number participated annually in 1993 and 1994 during 32-day SF/50 seasons. Since 1995, an additional 26 days has been added to the season for harvesting S/F bulls. For the 3 years when those regulations were active, a mean of 482 hunters participated annually. Prior to S/F50, hunter success averaged 15%. Post-SF/50, success decreased and has remained relatively constant, with a mean of 10% (Fig. 10).

As was the case with subunit 14A, harvest was related to hunter participation, both for pre-SF/50 ($r = 0.92$, $P < 0.01$) and post-SF/50 ($r = 98.5$, $P < 0.01$). Total harvest averaged 157 bulls for the 30-day seasons in 1988 and 1989 (Fig. 11). For the 10-day seasons of 1991 and 1992, the average was 43.5. Harvest has generally increased since SF/50 was implemented, but has remained much lower (mean = 43) than that of the late 80s. Proportions of the harvest comprised of the 3 antler classes have varied over the last 5 years. The one apparent trend is a slight increase in percentage of yearlings in the harvest. Mean proportions of the harvest composed of yearlings, sub-50", and ≥50" bulls are 38%, 20%, and 38% respectively (the total does not equal 100% due to a small percentage of nonclassified bulls).

Unit 16A

Population estimates indicate that this subunit lost perhaps 37% of its moose during the 1989-90 winter. Since that time, estimates have increased steadily but are still lower than the 1988 estimate (Table 3). Bull:cow ratios are high in this subunit, both before and after SF/50 (Fig. 12), and are exceeding the objective range of 20–25:100. The ratio of small bulls:100 cows has remained relatively constant, in the range of 10–12:100.

Total numbers of hunters in this subunit decreased after implementation of SF/50 (Fig. 13). Pre-SF/50 numbers averaged 1205 for the 30-day seasons held in 1988 and 1989. The season for 1990 was 10 days long and attracted 510 hunters. Fifteen-day seasons in 1991 and 1992 averaged 853 participants. Post-SF/50 seasons have averaged 650 hunters and generally have seen increases every year. Success rates decreased after the 1990 season (24% for 1988/1989 to 16% for 1991/1992) and remained low after implementation of SF/50 but generally have been increasing since 1993, approximately 20% (Fig. 13).

Harvest has followed the same trend as total hunters. Mean harvest for 1988 and 1989 was 291 (30-day season). This decreased to 153 (15-day season) for 1991 and 1992 after 37 were harvested in 1990. Post-SF/50 harvest has increased from 70 in 1993 to 141 in 1997 (Fig. 14). The dramatic jump in annual harvest seen between 1995 and 1996 is attributable only partially to the late season spike-fork harvest, but is also a result of the increase in hunters (these 2 factors are difficult to separate totally).

Unit 16B

This subunit is by far the least exploited of those considered in this study. Population estimates are few, but indicate a decrease in size due to the severe winter of 1989–90 (Table 3). No surveys have been conducted since 1994, at which time the population size was considered to be lower than at any time since 1988. Bull:cow ratios are very high, and do not seem to be affected by SF/50 (Fig. 15). Total bulls:100 cows averaged 36:100 prior to SF/50 and averaged 33 thereafter. Small bulls:100 cows averaged 10 prior to SF/50 and averaged 8 thereafter. Although this might seem like an effect of SF/50, the harvest level relative to the estimated population size is too small for this to be likely.

Total hunters averaged 1,022 annually prior to 1990 (44-day season) and 779 in 1991 and 1992 (34-day and 40-day seasons, respectively, Fig. 16). A 24-day season in 1990 saw 420 hunters. Success rates in this unit also are very high (Fig. 16), ranging from 16-30% prior to SF/50 and ranging from 23–32% thereafter. Success rates have been increasing since SF/50 was implemented. Annual harvest prior to 1990 averaged 305, and this decreased to 202 for 1991 and 1992 (Fig. 17). For the SF/50 years, harvest has been increasing but has not yet reached the levels observed prior to 1990.

Late-season spike-fork harvests

Beginning in 1995, a late season was opened in subunits 14A, 14B, and 16A to allow for additional opportunity to harvest spike/fork bulls. This season runs from 20 November through 15 December. Although this season adds another 26 days in which to harvest a spike/fork bull, the impact of this season on total harvest is not straightforward. In all subunits, the total harvest of yearlings increased after this season was added, but the chronology of harvest was unusual. Harvest of yearlings declined dramatically in all three subunits in the early season for 1995 and 1996 (Table 4). In 1997, early-season harvest in 14A and 14B returned to levels seen prior to implementation of the late season, but levels remained lower in subunit 16A. It seems, therefore, that the harvest from the late season hunt is not totally additive to total harvest.

Conclusion

For Units 14 and 16, bull:cow ratios and estimates of population size indicate that more bulls could be harvested in these units without jeopardizing population status, particularly subunits 14B, 16A, and 16B. Methods for increasing harvest in these areas include reducing the number of bulls classified as illegal by antler type (e.g., return to an any-bull season, or reduce the 50" minimum to some lower threshold), or increase hunter opportunity by extending the season. Return to an any-bull season in heavily exploited areas, such as Subunit 14A, has the potential to lead to excessive harvests that would lower bull:cow ratios below objective levels, particularly in seasons following severe winters. For unit 16, an any-bull season may not be unreasonable from a biological perspective. Reduction of the minimum spread threshold would likely cause a decrease in genetic potential for antler growth, particularly if harvest and participation continue to increase.

III. Nelchina Basin (Unit 13)

Unit 13A

Between 1985 and 1992, regulations for this subunit differed markedly from those for the remainder of the unit. Through 1989, a spike-fork season for residents and nonresidents was in place, and this was restricted to residents only from 1990-1992. One hundred drawing permits for any bull were made available in 1987. This was increased to 200 any-bull permits in 1988 as well as 25 permits for cows. Additionally, subsistence permits were first made available in 1988. In 1989, 300 any-bull permits were available and subsistence bull permits were issued as registration permits. In 1990, the 20-day spike-fork season was reduced to 5 days, and a Tier II season was instituted in December. In 1991 and 1992, the subunit was divided into two sections, with one having a SF/50 season and the other remaining spike-fork.

Before 1993, harvest in this subunit was limited, primarily by confining harvest to spike-fork animals. This resulted in a large percentage of large bulls being accumulated in the area, which is evident in bull:cow ratios. These ratios increased from about 11:100 in 1980 to about 39:100 early in this decade (Fig. 18). Of interest is the lack of increase in small bull:cow ratios, due to the harvest of these animals. In fact, these ratios show a declining trend. In 1993, after implementation of SF/50, Bull:cow ratios declined to 22:100, and declined again the next year. From 1994-1998, these ratios have averaged 13.7:100. Ratios of small bulls:100 cows continue to remain low, ranging between 1 and 6 for the last 4 years. Moose seen per hour of aerial survey time is a good index of population size in this unit. In subunit 13A, moose per hour varied generally between 60 and 80/hour throughout the 1980s and early 1990s. This declined to 55 and 52 in 1997 and 1998, respectively (Fig. 19).

Number of hunters in this subunit increased slowly but steadily throughout the 1980s, but declined in 1990 due to the effects of a severe winter, and remained low through 1992 (Fig. 20). When SF/50 was instituted, a doubling in hunter numbers was observed. This most likely can be attributed to the large number of mature bulls available in this unit due to past management practices. Hunter numbers stayed high in 1994 (above 2000) but have declined slowly since then, with 1551 hunters participating in 1997. Success varied considerably throughout the 1980s, but was usually within 15–20% (Fig. 20). Success rates increased during the years 1990–1992 when there were low levels of participation. Success remained high in 1993 when the large bulls were made legal, but dropped precipitously in 1994 to 12%, where it has remained.

Harvest of bulls in this subunit ranged from 100 to 200 annually during the 1980s and early 1990s (Fig. 21). Harvest of spike-fork yearlings in 1989 was 99, with an additional 175 bulls taken by drawing permit and subsistence permit holders. Total harvest declined during 1990–1992 due to the elimination of drawing and subsistence permit hunts as mandated by the McDowell decision. Harvest in 1993 was 500 bulls, which represented the taking of an accumulation of mature bulls built up due to prior regulations. Following that year, harvest has declined every year, with 185 moose taken in 1997.

Unit 13B

Population density, as inferred from moose/hour estimates, peaked at about 80 moose/hour in the mid to late 1980s and began to decline before implementation of SF/50

(Fig. 19). Since 1992, the moose/hour estimates have varied between 50 and 60. Bull:cow ratios followed a similar pattern, peaking in 1985 (35:100) and declining until 1994 (18:100). It rose to 20:100 in 1997 and 1998 (Fig. 22). Ratios of large bulls:cows was more highly correlated to total bulls:100 cows ($r = 0.9$) than was small bull:cow ratios ($r = 0.6$), indicating that although both components were changing, abundance of large bulls accounted for most of the change in bull:cow ratios.

Hunter numbers increased steadily in this unit in the early and mid 1980s and stabilized somewhat at about 1250 hunters in the late 1980s (Fig. 23). From 1990 to 1992, numbers declined to between 734 and 830. Since inception of SF/50, hunter numbers have varied between 1296 and 1693. The slight rise in hunter numbers seen after 1994 may be associated with a corresponding decrease seen in Subunit 13A. Success rates varied between 25 and 30% during the mid 1980s to early 1990s. In 1992 success declined to 22%, and success has remained at approximately 15% since 1993 (Fig. 23).

Harvest followed a similar pattern to hunter numbers: rising throughout the 80s to peak between 300 and 400 annually from 1986 to 1989 (Fig. 24). Harvest was down from 1990 to 1992 but increased again in 1993, the first year of SF/50, and has generally increased since then, with a maximum of 274 bulls harvested in 1996.

The decline in harvest seen in Subunit 13B halted the decline in bull:cow ratios and caused them to stabilize. This, in association with a 28% decline in moose/hour since the peak in the late 1980s, indicates a declining population. Low ratios of yearling bulls:100 cows indicate poor recruitment. Thus, any modifications in bull harvest strategy should keep harvest at the current level or decrease harvest to maintain or increase bull:cow ratios.

Unit 13C

Moose densities in subunit 13C rose from approximately 60 moose/hour in 1977 to a peak of 110 moose/hour in 1988. Densities declined to a low of 59 moose/hour in 1992, remained between 75 and 80 moose/hour from 1993 to 1997, and declined to 54/hour in 1998. Bull:100 cow ratios ranged between 25:100 and 32:100 in the late 1970s and early 1980s but have ranged from 20 to 28:100 since 1990 (Fig. 25). Changes in bull:cow ratios are closely correlated to ratios of small bulls:100 cows ($r = 0.71$), but not to ratios of large bulls:100 cows ($r = 0.24$). This indicates that changes in bull:cow ratios in this subunit are heavily dependent on yearling recruitment that varies annually.

Hunter participation and harvest correlate strongly in this subunit ($r = 0.82$), with an increase through the late 1980s, a low period from 1990 to 1992, and an increase during the SF/50 years (Fig. 26). Success has ranged generally between 30 and 45%, varying annually as the reverse of the trend in hunter numbers (Fig.26). The mean annual harvest for the years 1993–1996 (149) is exceeded only by the mean for 1986–1989 (159, Fig. 27).

Unit 13D

Moose/hour peaked in 1984 (53) and has decreased since that time, with an estimate of 20 in 1998. Such low densities tend to dissuade hunters; therefore, bull:cow ratios are very high with a maximum of 89:100 in 1993 (Fig. 28), which is a ratio expected in an unhunted population. Yearling bull:100 cow ratios have remained relatively constant, between 7 and 9:100.

Number of hunters increased from 264 in 1978 to 533 in 1986 and decreased to 244 in 1992 (Fig. 29). The first year of SF/50 saw a large increase in hunter participation (492 total hunters), that decreased to 348 in 1994 and increased to 384 in 1996. There is no clear trend in success rates, which have varied between 16 and 31% and have stayed between 18 and 25% since SF/50 was instituted (Fig. 29).

Harvest generally increased from 1978 to 1988, peaking at 125 bulls, and declined to 61 in 1992. Since SF/50, harvest has varied between 67 and 98 and has been fairly constant since 1994 with no apparent trend (Fig. 30).

Unit 13E

Moose/hour increased three-fold from 1975 to 1989 (32–94 moose/hr) and decreased to 37 moose/hour in 1998. Bull:cow ratios peaked at 33 in 1985 and have declined steadily to a low of 12 in 1998 (Fig. 31). Changes in abundance of yearlings ($r = 0.78$) and large bulls ($r = 0.76$) contribute equally to changes in overall bull:cow ratios.

Number of hunters increased through the late 1980s, peaking at 935 in 1989 (Fig. 32). From 1990 to 1992 the number of hunters averaged 532, and a great increase was noted once SF/50 was implemented. Mean annual number of hunters participating since 1993 is 1103. Success rates were fairly constant during the pre-SF/50 years, varying between 25 and 35% (Fig. 32), yielding a relatively constant harvest that averaged 204 bulls/year. From 1990 to 1992 harvest averaged 153, and since SF/50 was implemented harvest has averaged 211 annually (Fig. 33).

Unit analysis

The annual composition of the harvest under SF/50, broken down by antler size, indicates that the harvest of spike-fork yearlings increased from 1994 to 1997 (Fig. 34). Subunits 13B and 13E were the source for most of these additional yearlings, which may be the result of the increase in hunt participation in these units. Preliminary data for 1998 indicate that this increasing trend has ended. Conversely, the number of harvested midsize and large bulls peaked in 1995 and declined during the next 2 seasons. (Data from 1993 are excluded from the analysis of large bulls because of the bias introduced by the harvest of these animals Subunit 13A.) Preliminary data for 1998 indicate that harvest for these 2 size classes will exceed that for 1997 and may indicate a leveling-off. The percentage of midsize bulls has varied between 31 and 41%, with no apparent trend. Of harvested midsize bulls, a mean of 24% had 4 or more brow tines. This has varied little since 1993. Of those harvested large bulls, a mean of 43% has had 4 or more brow tines. This percentage peaked in 1994 (49%) and has declined to 31% in the preliminary 1998 data.

According to data collected from any-bull seasons held in Unit 13 from 1983 to 1985, 55% of yearlings had spike-fork antlers. In the 1998 composition count, however, 61% of bulls identified as yearlings in November were legal under spike-fork regulations. These data indicate that a proportion greater than 55% of yearlings in the pre-hunt population is legal. Preliminary harvest ticket returns compiled for 1998 indicate that 58% of harvested yearlings had at least a fork on one side. These animals represented 20% of the total harvest.

Changes in mean annual harvest between the pre-SF/50 years and those post-SF/50 indicate that harvest has decreased in all subunits except 13A (Fig. 35). To conduct this analysis we calculated the mean harvest from 1993 to 1997 and compared it to the mean from 1985 to 1989. The years 1990–1992 were not used because they represent unusually low harvests due to changes in permit systems. Additionally, data from Subunit 13A in 1993 were excluded from the analysis because of the unusually large harvest of mature bulls in that year. Subunit 13A yields a mean of 39 more moose annually since SF/50 was implemented, representing a 20% increase. Subunit 13B showed the largest decrease in mean annual harvest, 99 moose (33%). Subunits 13C and 13D showed small declines in mean annual harvest after SF/50, with slightly higher harvest of yearlings and large bulls counterbalanced by lower harvests of midsize bulls (Fig. 36). Subunit 13E showed the second largest absolute decrease in mean annual harvest (52 bulls, 20%), but 13D showed the second largest percentage decrease (26%). Yearling harvest is up in all subunits except 13D, with 13B and 13E showing the largest increases (Fig. 36). All subunits exhibited a decrease in mean annual harvest of midsize bulls, with the Subunits 13B and 13E having the largest decreases. Harvest of large bulls is up in all subunits, with the largest increase (37) in Subunit 13A.

Comparison of antler structure with other areas

Comparison of the prevalence of different antler types in the harvest indicates the differences among these units (Fig. 37). As a percentage of total harvest, Units 7 and 15 and 14 had similar levels of yearling harvest (62% vs. 63%), substantially higher than those in Unit 16 (21%) and Unit 13 (27%). Conversely, Units 7 and 15 had the fewest midsized bulls, (16%) as opposed to 36% for Unit 13. In Unit 16, 56% of the harvest is large bulls, whereas 37% of the Unit 13 harvest was large bulls. Large bulls made up less than 25% of the harvest in Units 7 and 15 and 14. For large bulls, 52% of those in Unit 13 had ≥4 brow tines, whereas those in Units 14 and 16 composed 30% with ≥4 brow tines (Table 5). Of animals in the midsize class, 23% of those in Unit 13 had ≥4 brow tines, and 19% of those in Units 14 and 16 had ≥4 brow tines. Units 7 and 15 had 17% of midsize bulls and 22% of large bulls with ≥4 brow tines.

Conclusion

For Unit 13, harvest should be reduced, at least in Subunits 13A, 13B, and 13E due to less than optimal bull:cow ratios. Methods available for reducing harvest include reducing hunter opportunity by a shortened season length, classifying fork-antlered bulls as illegal, and reducing the number of large legal bulls by raising the legal minimum number of brow tines to 4 from 3.

Reduce season length: Reduction of season length, particularly a reduction of at least 10 days, probably will reduce hunter numbers, but it is difficult to predict the extent of the decrease.

Spike-50" season: Eliminating fork-antlered bulls from the harvest will increase bull:cow ratios. Based on preliminary harvest data for 1998, 58% of harvested yearlings would become illegal. This equates to 143 animals, 20% of the total harvest. It is difficult to predict the effect of this strategy on numbers of mature bulls in the population. Surely there will be some increase, but some proportion of the conserved yearlings will become legal before reaching 50" because of brow tines.

Increase brow tines from 3 to 4: Increasing the minimum number of brow tines to 4 would be expected to decrease harvest of midsize bulls by approximately 77% (218 bulls annually, based on harvests from 1994 to 1996). Additionally, some proportion of large bulls would escape harvest. These would be animals that would not be harvested because they were too close to the 50" limit and had only 3 brow tines. After one year of such a program, the harvest of older bulls probably would increase as animals conserved in the midsize class from the prior year became legal, either with 4 or more brow tines or with spreads greater than 50".

A computer model was developed by W. Testa (ADF&G, Anchorage) to determine the effect of these additional antler restrictions on total harvest and bull:cow ratios in Unit 13. The results of this exercise are informative concerning the relative effects of the different harvest strategies, but we do not wish to place too much emphasis on absolute numbers. The first simulation compared the current regulations (SF/50/3 brow tines) to SF/50/4 brow tines. Bull:100 cow ratios for Unit 13 remained constant at 16 under the current regulations. Under SF/50/4, this ratio increased to 20 over a period of 3 years and remained stable thereafter (Fig. 38). The second simulation evaluated the effect of spike/50/3 versus spike/50/4 strategies. S/50/3 produced an increase in bull:100 cow ratio to 21 over a 4-year period, whereas S/50/4 produced an increase to 26 over the same period (Fig. 39). S/50/4 probably would be too restrictive, so further comparisons are restricted to SF/50/4 and S/50/3. These two strategies produce similar results concerning bull:100 cow ratios (Fig. 40) and harvest reduction (Fig. 41). One difference between the two is the slightly larger increase in ratio of mature ($\geq$ 4 years old) bulls:100 cows provided by SF/50/4 (Fig. 42).

The genetic ramifications of increasing the legal minimum for brow tines have not been determined, but a previous modeling effort (Hundertmark et al. 1993) determined that any SHS with a brow tine component would result in a decline in genes favorable for brow tine growth.

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Fig. 1

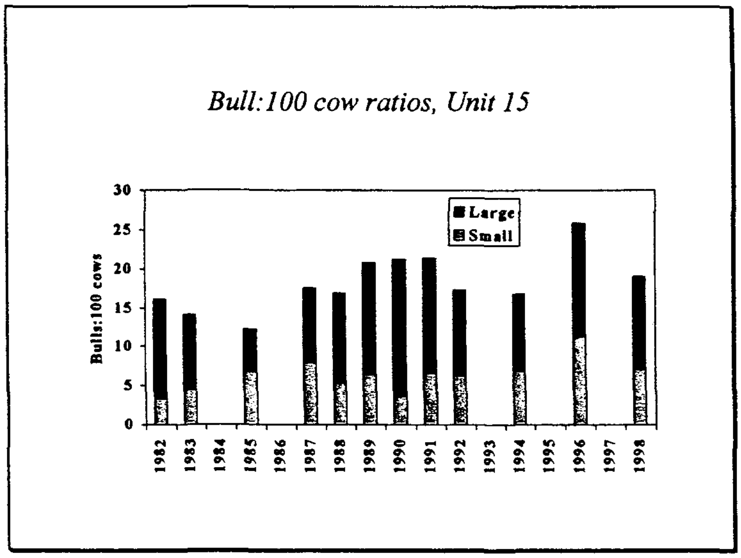

Bull:100 cow ratios, Unit 15
Large
Small
Bulls:100 cows
0
5
10
15
20
25
30
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998

Fig. 2

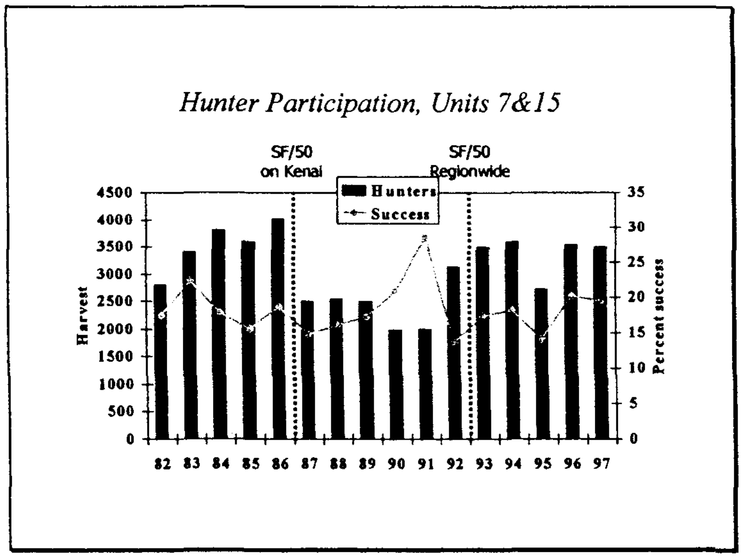

Hunter Participation, Units 7&15
SF/50
on Kenai
SF/50
Regionwide
Hunters
Success
Harvest
Percent success
0
500
1000
1500
2000
2500
3000
3500
4000
4500
0
5
10
15
20
25
30
35
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97

Fig. 3

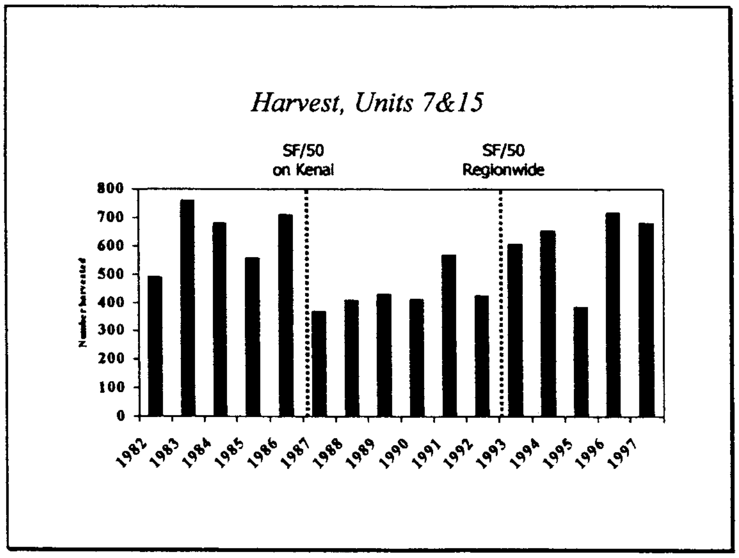

Harvest, Units 7&15
SF/50
on Kenai
SF/50
Regionwide
800
700
600
500
400
300
200
100
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997

Fig. 4

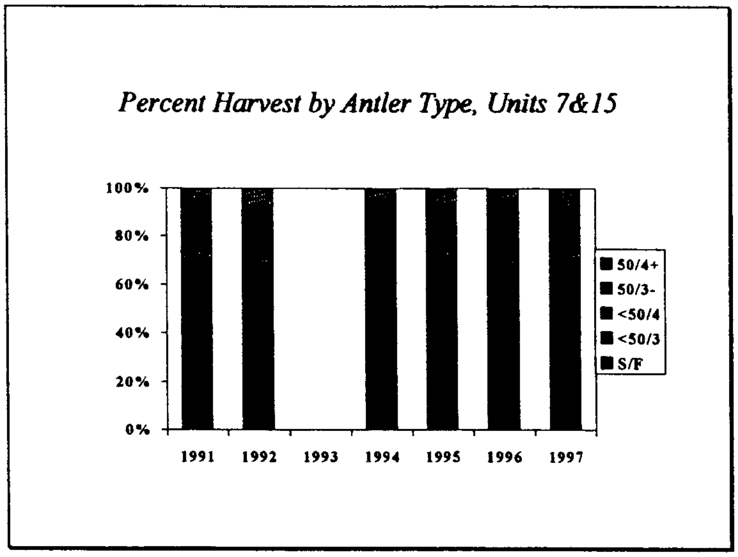

Percent Harvest by Antler Type, Units 7&15
100%
80%
60%
40%
20%
0%
1991
1992
1993
1994
1995
1996
1997
50/4+
50/3-
<50/4
<50/3
S/F

Fig. 5

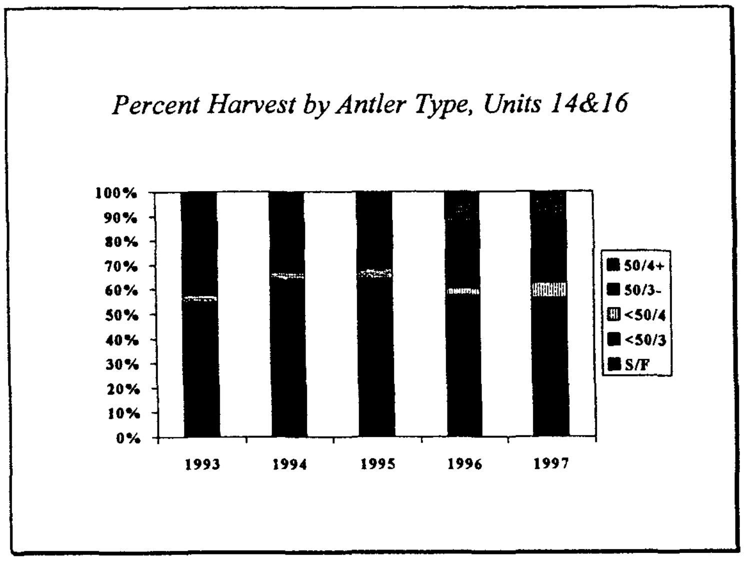

Percent Harvest by Antler Type, Units 14&16
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1993
1994
1995
1996
1997
50/4+
50/3-
<50/4
<50/3
S/F

Fig. 6

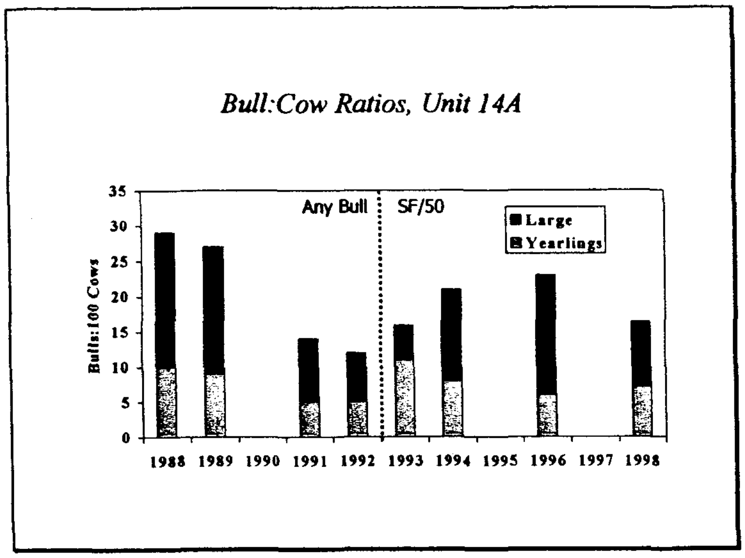

Bull:Cow Ratios, Unit 14A
Any Bull
SF/50
Large
Yearlings
Bulls:100 Cows
35
30
25
20
15
10
5
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998

Fig. 7

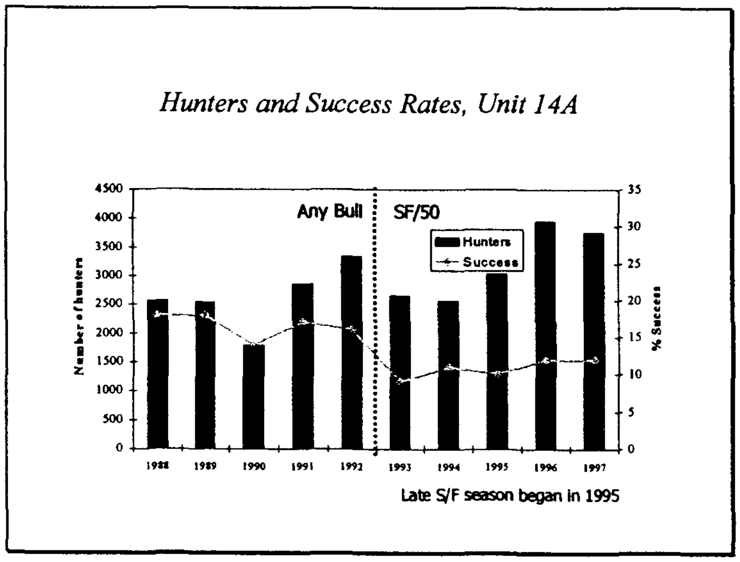

Hunters and Success Rates, Unit 14A
Any Bull
SF/50
Hunters
Success
Number of hunters
% Success
4500
4000
3500
3000
2500
2000
1500
1000
500
0
35
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
Late S/F season began in 1995

Fig. 8

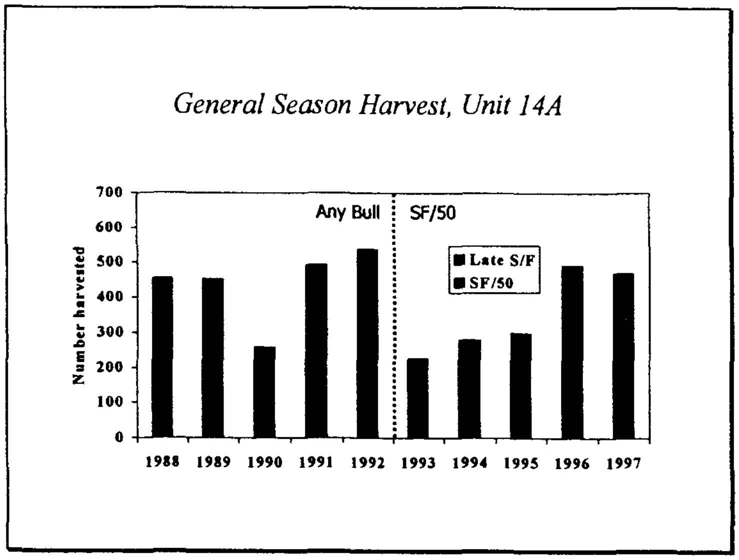

General Season Harvest, Unit 14A
Any Bull
SF/50
Late S/F
SF/50
Number harvested
700
600
500
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997

Fig. 9

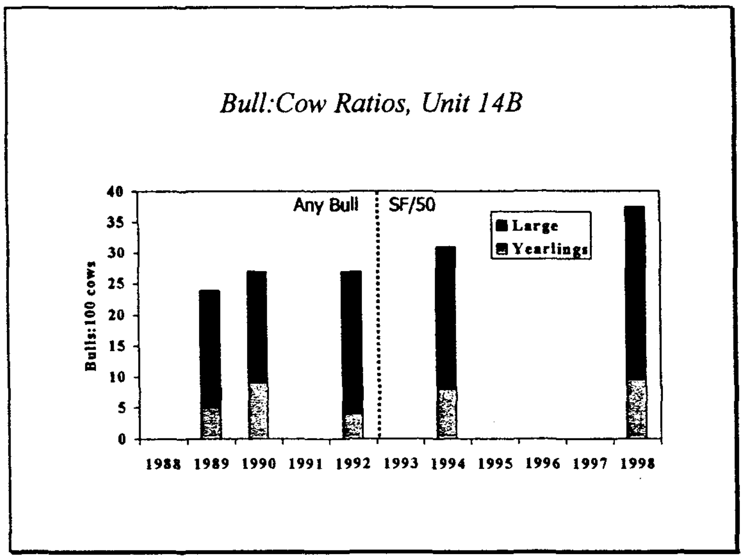

Bull:Cow Ratios, Unit 14B
Any Bull
SF/50
Large
Yearlings
Bulls:100 cows
40
35
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998

Fig. 10

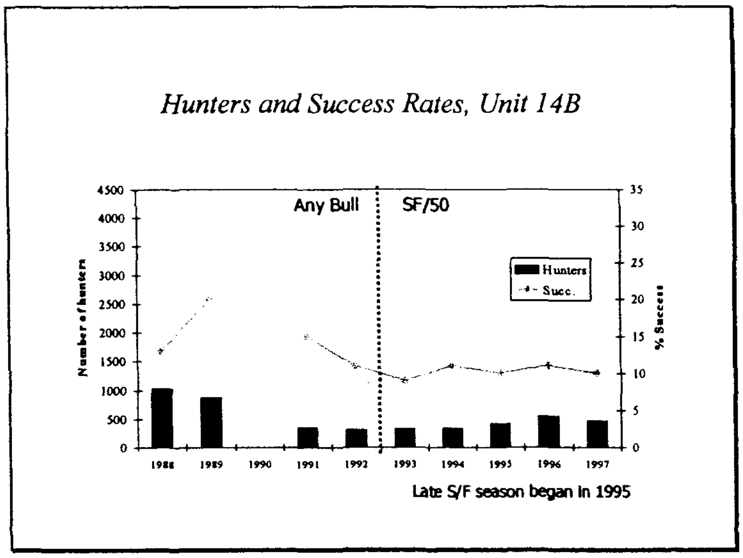

Hunters and Success Rates, Unit 14B
Any Bull
SF/50
Hunters
Succ.
Number of hunters
% Success
4500
4000
3500
3000
2500
2000
1500
1000
500
0
35
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
Late S/F season began in 1995

Fig. 11

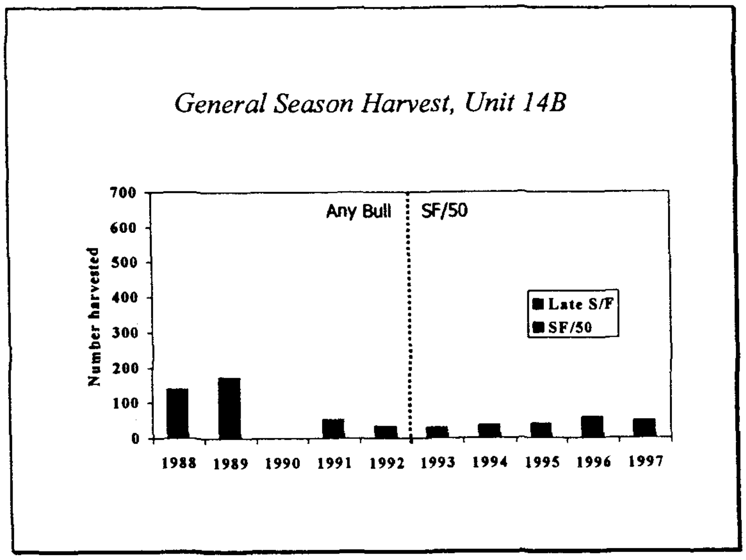

General Season Harvest, Unit 14B
Any Bull
SF/50
Late S/F
SF/50
Number harvested
700
600
500
400
300
200
100
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

Fig. 12

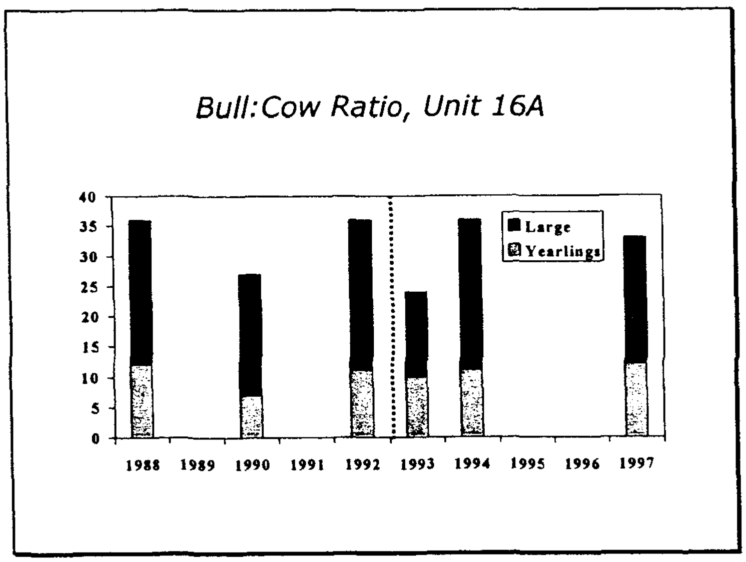

Bull:Cow Ratio, Unit 16A
Large
Yearlings
40
35
30
25
20
15
10
5
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

Fig. 13

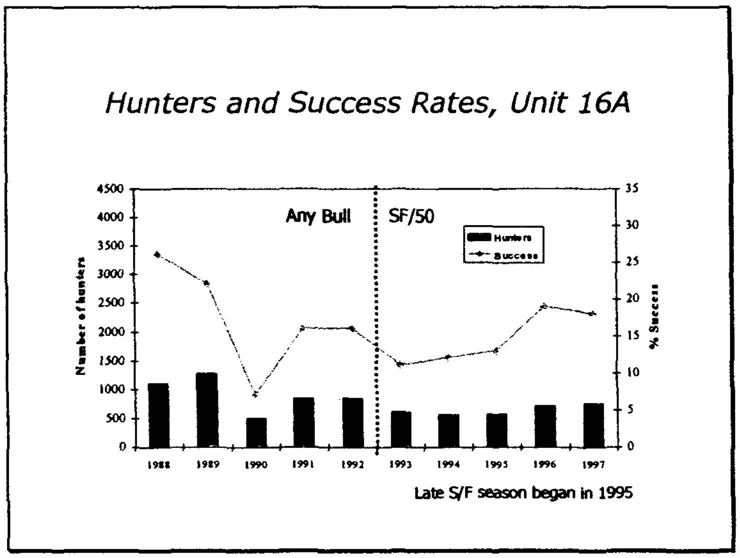

Hunters and Success Rates, Unit 16A
Any Bull
SF/50
Hunters
Success
Number of hunters
% Success
4500
4000
3500
3000
2500
2000
1500
1000
500
0
35
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
Late S/F season began in 1995

Fig. 14

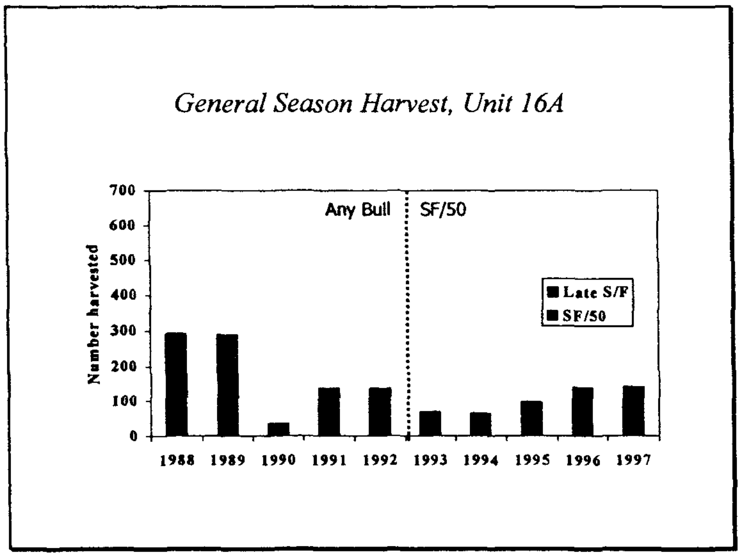

General Season Harvest, Unit 16A
Any Bull
SF/50
Late S/F
SF/50
Number harvested
700
600
500
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997

Fig. 15

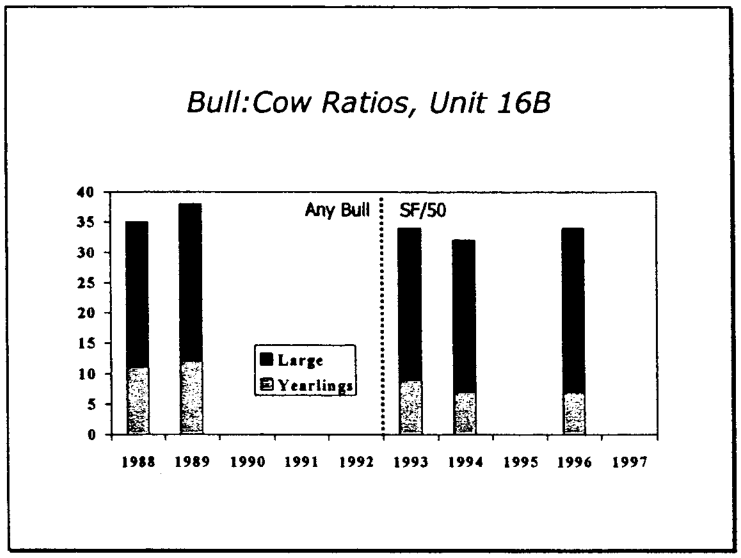

Bull:Cow Ratios, Unit 16B
Any Bull
SF/50
Large
Yearlings
40
35
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997

Fig. 16

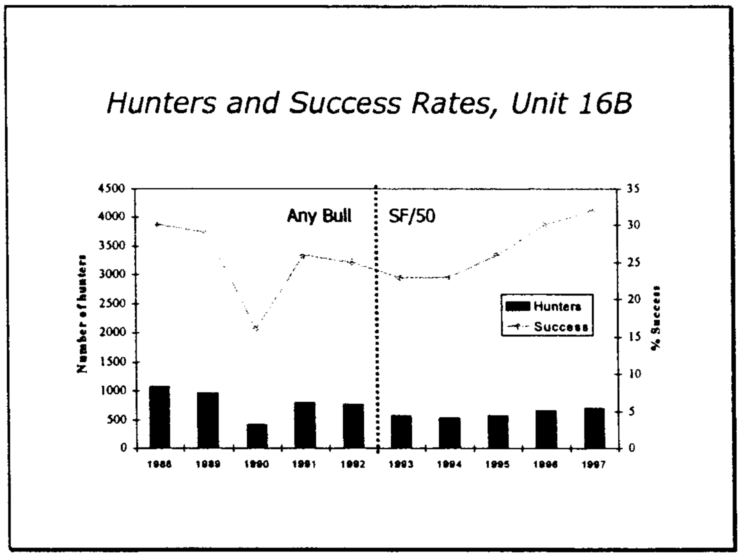

Hunters and Success Rates, Unit 16B
Any Bull
SF/50
Number of hunters
% Success
Hunters
Success
4500
4000
3500
3000
2500
2000
1500
1000
500
0
35
30
25
20
15
10
5
0

Fig. 17

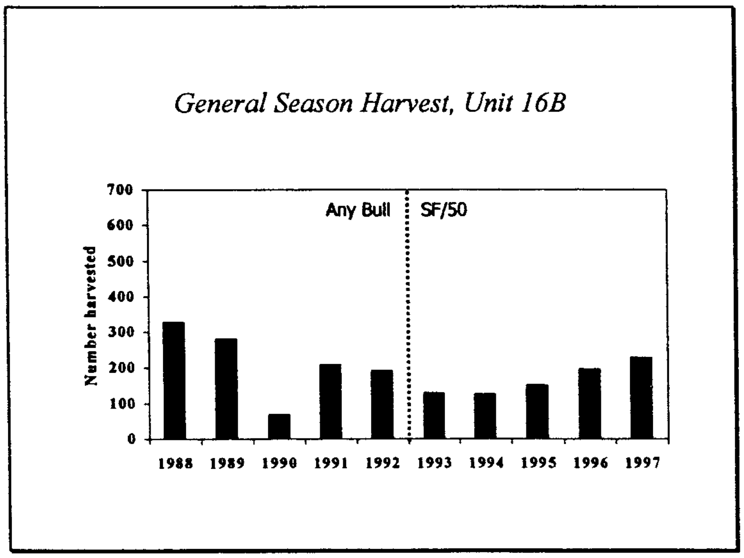

General Season Harvest, Unit 16B
Any Bull
SF/50
Number harvested
0
100
200
300
400
500
600
700
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997

Fig. 18

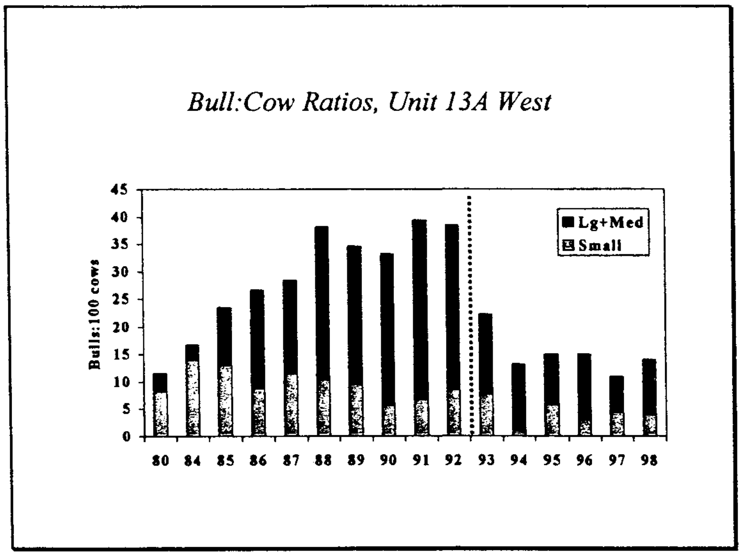

Bull:Cow Ratios, Unit 13A West
Lg+Med
Small
Bulls:100 cows
0
5
10
15
20
25
30
35
40
45
80
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98

Fig. 19

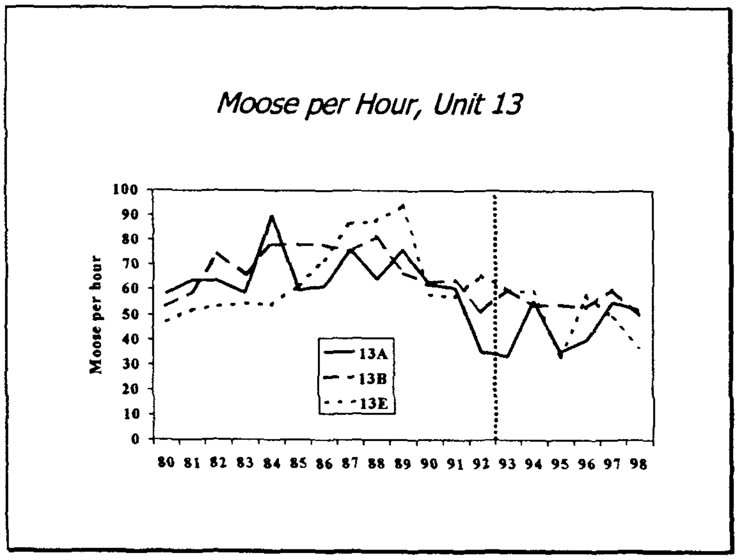

Moose per Hour, Unit 13
Moose per hour
100
90
80
70
60
50
40
30
20
10
0
13A
13B
13E
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

Fig. 20

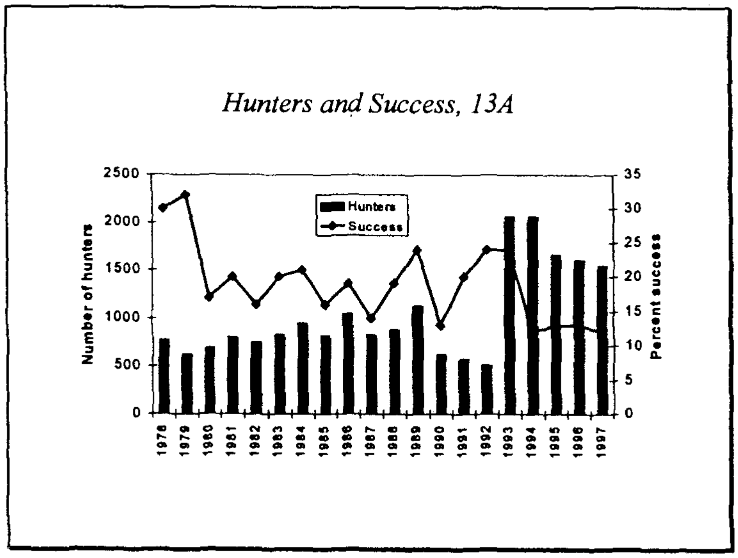

Hunters and Success, 13A
Number of hunters
2500
2000
1500
1000
500
0
Hunters
Success
Percent success
35
30
25
20
15
10
5
0
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

Fig. 21

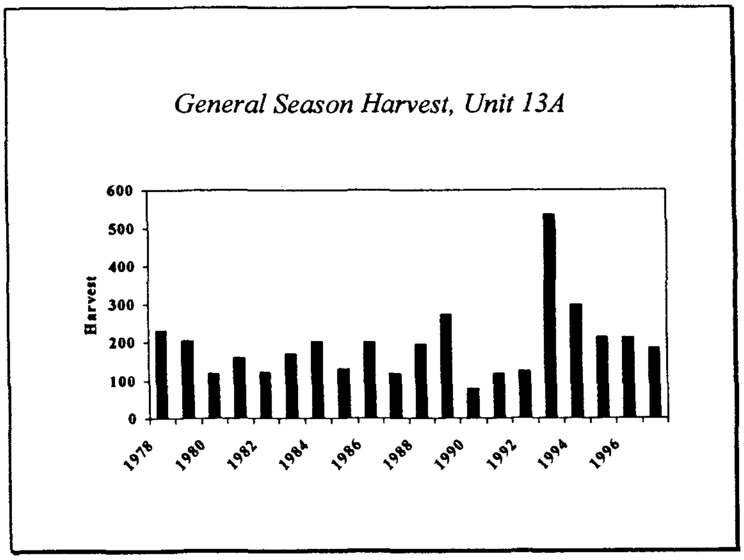

General Season Harvest, Unit 13A
Harvest
600
500
400
300
200
100
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996

Fig. 22

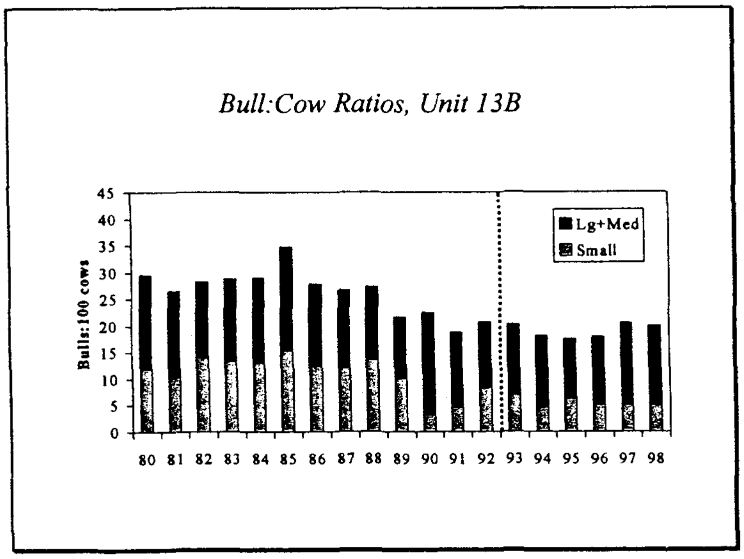

Bull:Cow Ratios, Unit 13B
Bulls:100 cows
45
40
35
30
25
20
15
10
5
0
Lg+Med
Small
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

Fig. 23

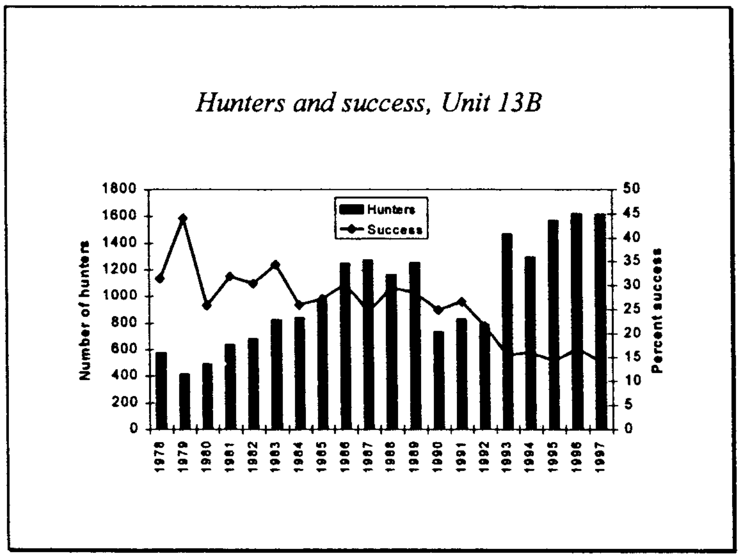

Hunters and success, Unit 13B
Hunters
Success
Number of hunters
Percent success
1800
1600
1400
1200
1000
800
600
400
200
0
50
45
40
35
30
25
20
15
10
5
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997

Fig. 24

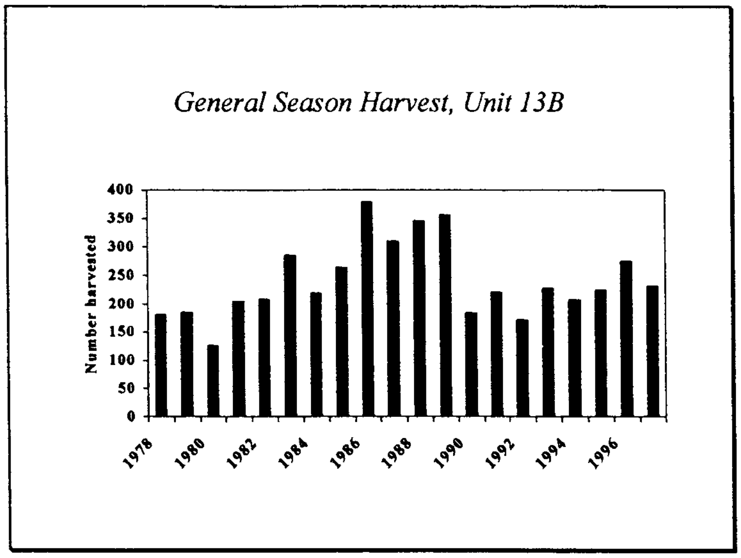

General Season Harvest, Unit 13B
Number harvested
400
350
300
250
200
150
100
50
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996

Fig. 25

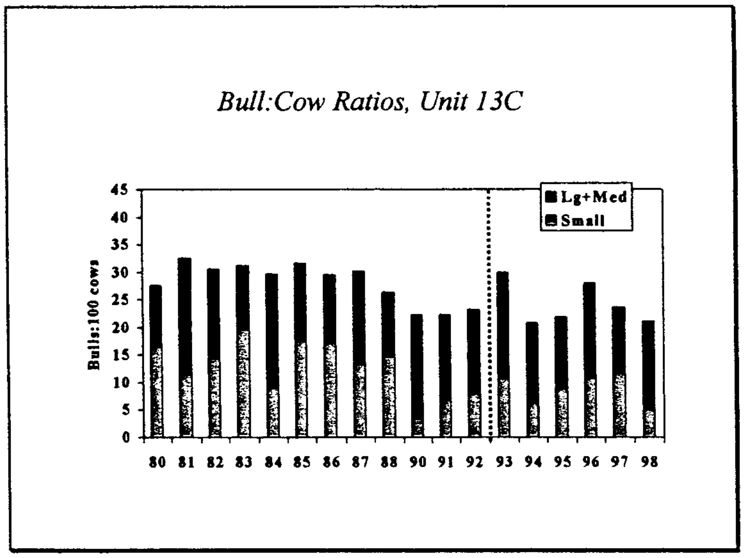

Bull:Cow Ratios, Unit 13C
Lg+Med
Small
Bulls:100 cows
45
40
35
30
25
20
15
10
5
0
80 81 82 83 84 85 86 87 88 90 91 92 93 94 95 96 97 98

Fig. 26

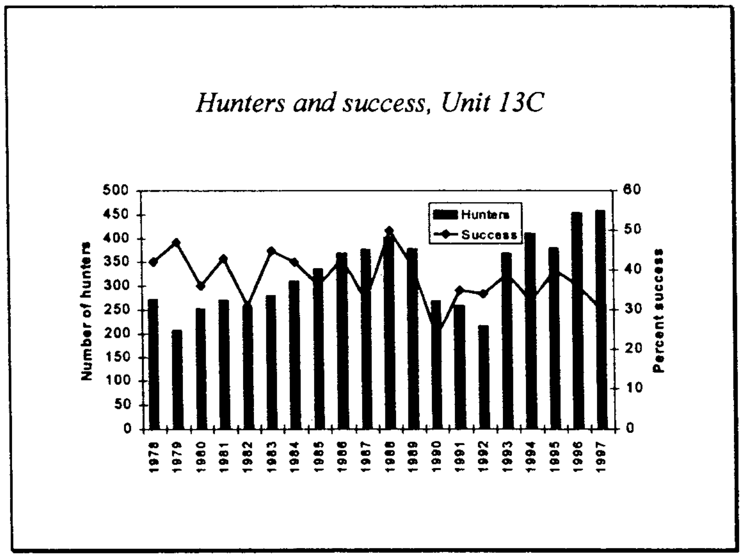

Hunters and success, Unit 13C
Hunters
Success
Number of hunters
Percent success
500
450
400
350
300
250
200
150
100
50
0
60
50
40
30
20
10
0
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

Fig. 27

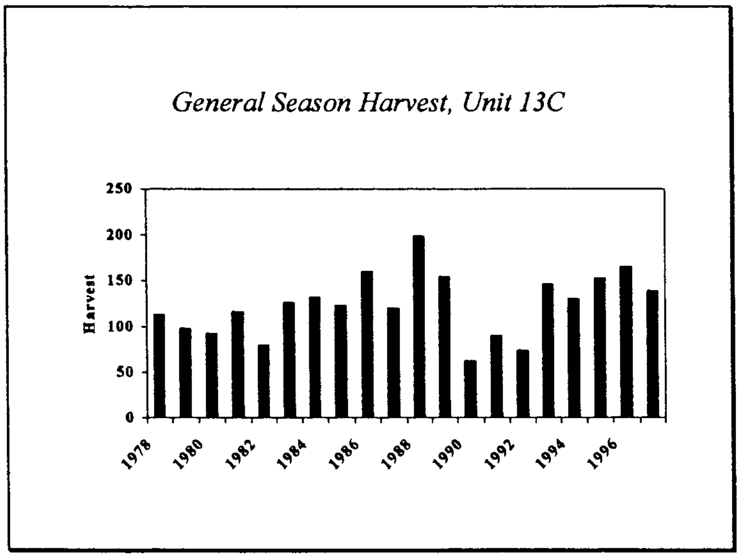

General Season Harvest, Unit 13C
Harvest
250
200
150
100
50
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996

Fig. 28

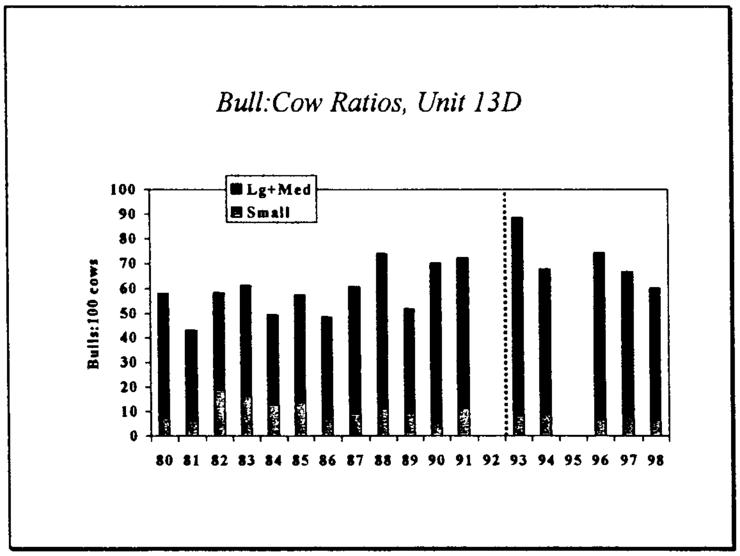

Bull:Cow Ratios, Unit 13D
Lg+Med
Small
Bulls:100 cows
100
90
80
70
60
50
40
30
20
10
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

Fig. 29

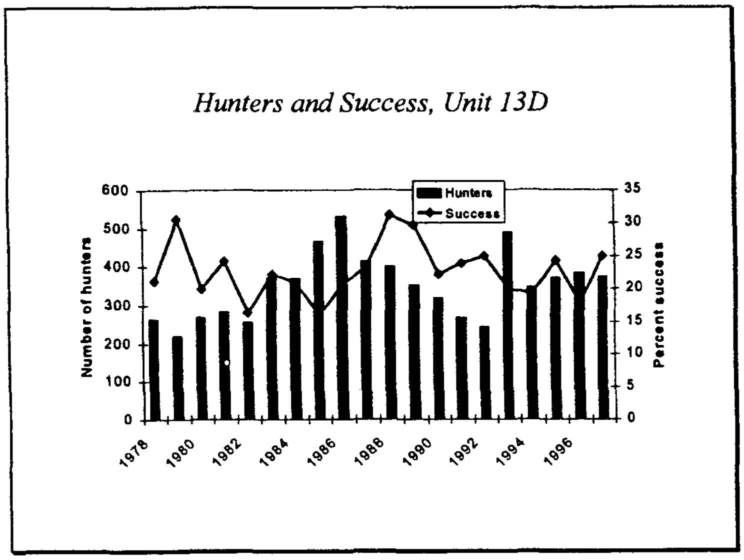

Hunters and Success, Unit 13D
Hunters
Success
Number of hunters
Percent success
600
500
400
300
200
100
0
35
30
25
20
15
10
5
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996

Fig. 30

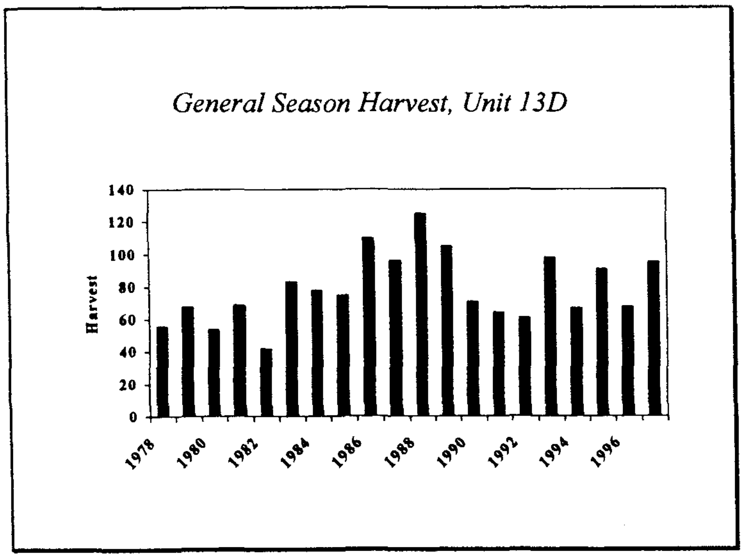

General Season Harvest, Unit 13D
Harvest
140
120
100
80
60
40
20
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996

Fig. 31

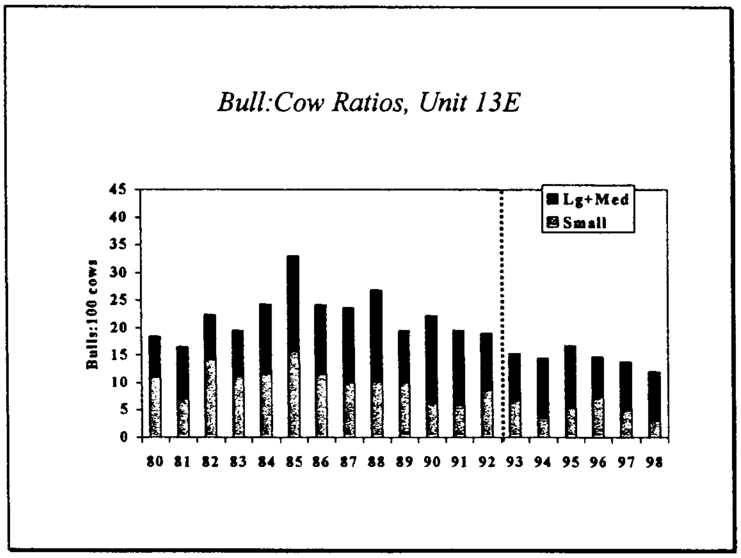

Bull:Cow Ratios, Unit 13E
Lg+Med
Small
Bulls:100 cows
45
40
35
30
25
20
15
10
5
0
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

Fig. 32

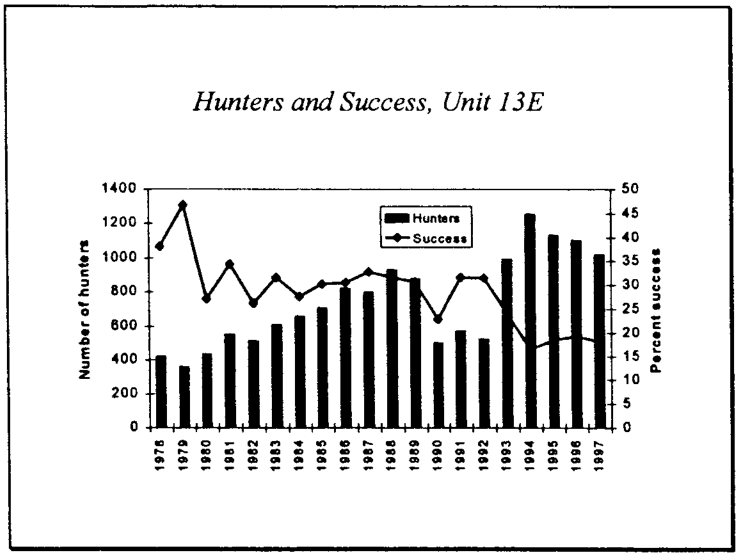

Hunters and Success, Unit 13E
Hunters
Success
Number of hunters
Percent success
1400
1200
1000
800
600
400
200
0
50
45
40
35
30
25
20
15
10
5
0
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

Fig. 33

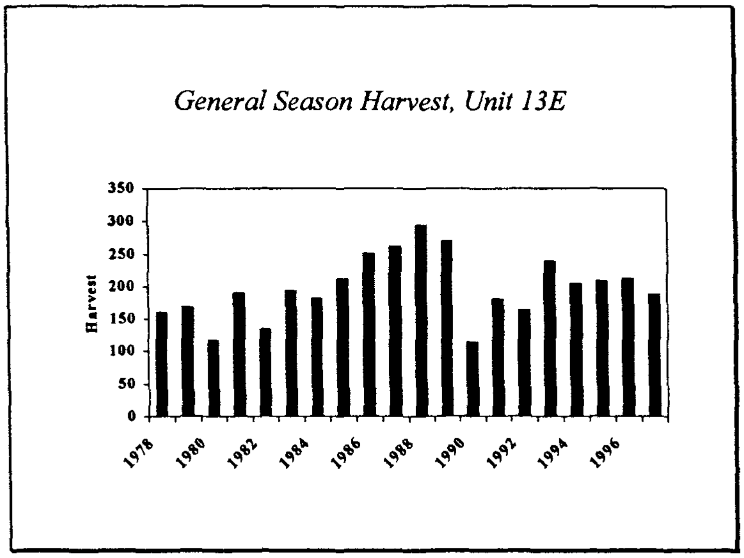

General Season Harvest, Unit 13E
Harvest
350
300
250
200
150
100
50
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996

Fig. 34

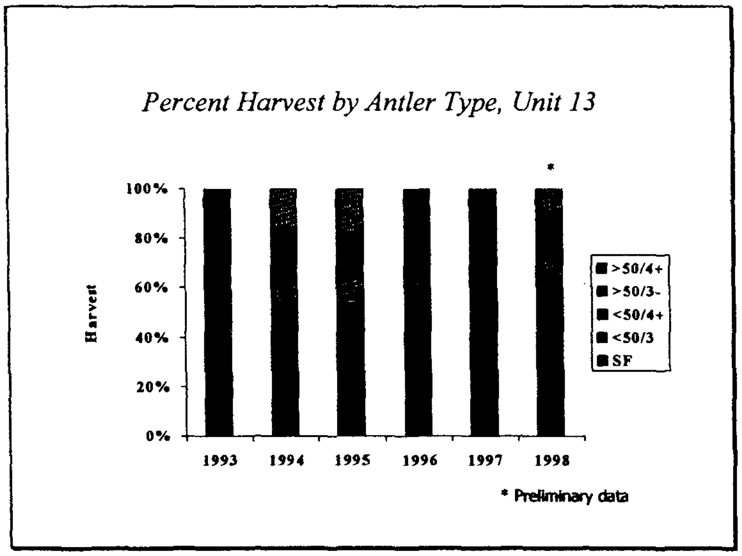

Percent Harvest by Antler Type, Unit 13
Harvest
100%
80%
60%
40%
20%
0%
1993
1994
1995
1996
1997
1998
*
>50/4+
>50/3-
<50/4+
<50/3
SF
* Preliminary data

Fig. 35

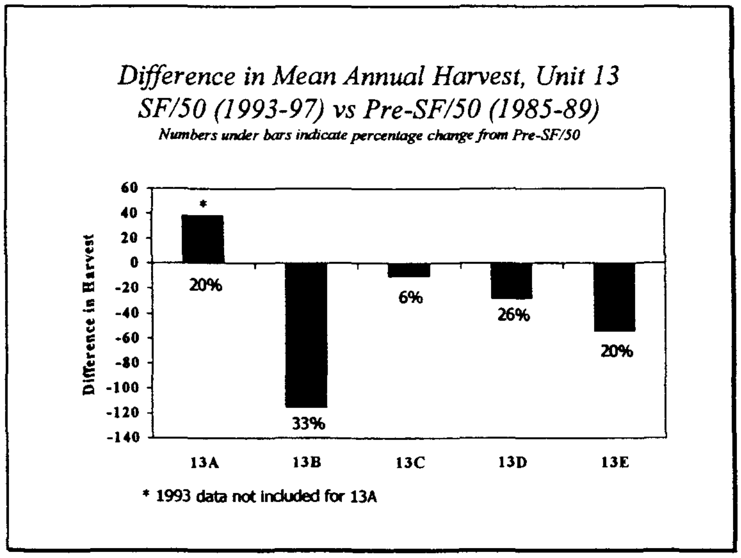

Difference in Mean Annual Harvest, Unit 13
SF/50 (1993-97) vs Pre-SF/50 (1985-89)
Numbers under bars indicate percentage change from Pre-SF/50
Difference in Harvest
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
*
20%
33%
6%
26%
20%
13A
13B
13C
13D
13E
* 1993 data not included for 13A

Fig. 36

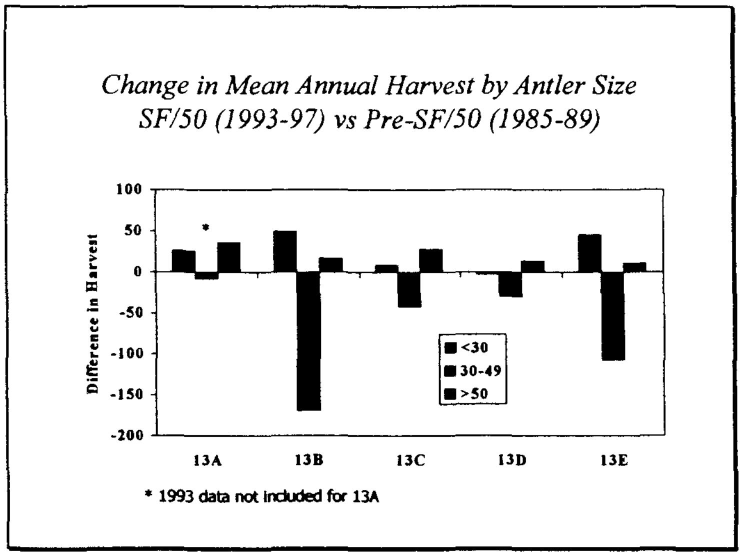

Change in Mean Annual Harvest by Antler Size
SF/50 (1993-97) vs Pre-SF/50 (1985-89)
Difference in Harvest
100
50
0
-50
-100
-150
-200
*
<30
30-49
>50
13A
13B
13C
13D
13E
* 1993 data not included for 13A

Fig. 37

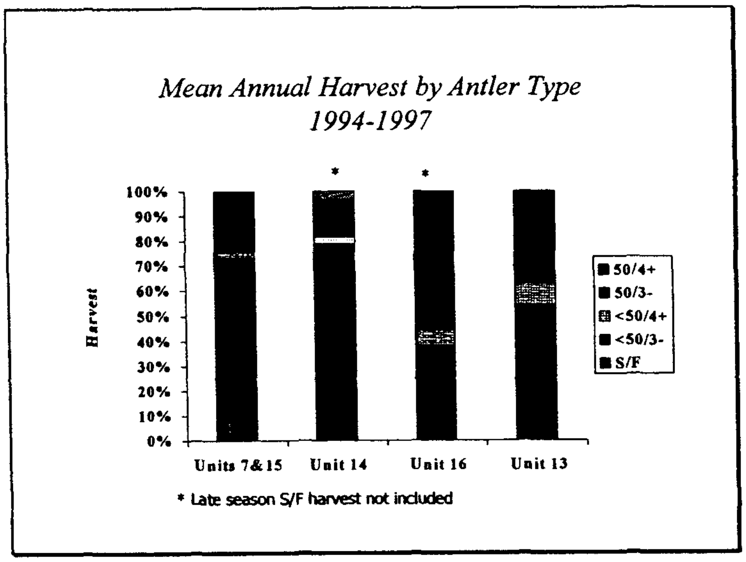

Mean Annual Harvest by Antler Type
1994-1997
Harvest
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Units 7&15
Unit 14
Unit 16
Unit 13
50/4+
50/3-
<50/4+
<50/3-
S/F
* Late season S/F harvest not included

Fig. 38

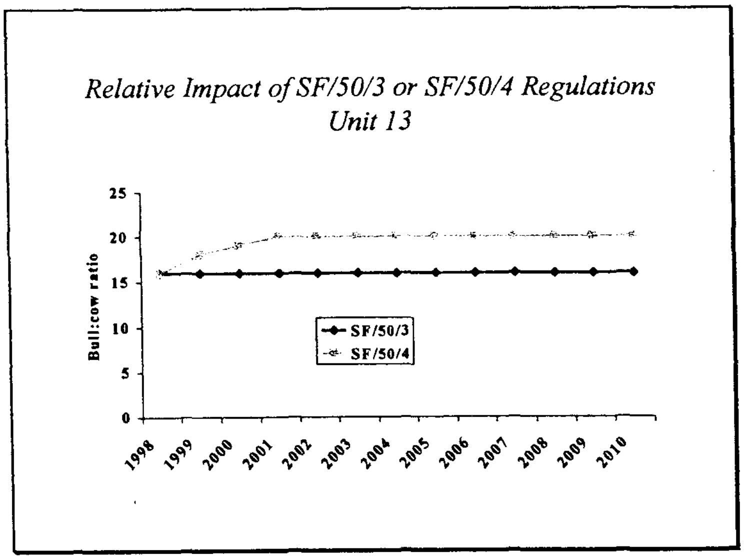

Relative Impact of SF/50/3 or SF/50/4 Regulations
Unit 13
Bull:cow ratio
25
20
15
10
5
0
SF/50/3
SF/50/4
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Fig. 39

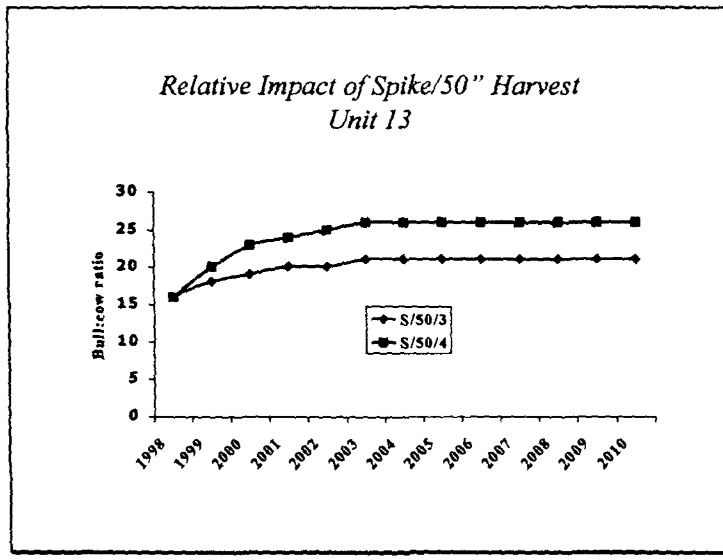

Relative Impact of Spike/50" Harvest
Unit 13
Bull:cow ratio
S/50/3
S/50/4
30
25
20
15
10
5
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Fig. 40

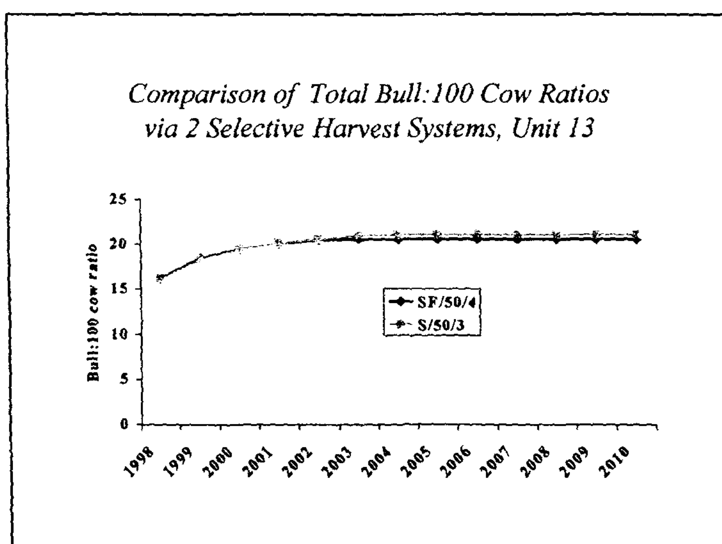

Comparison of Total Bull:100 Cow Ratios
via 2 Selective Harvest Systems, Unit 13
Bull:100 cow ratio
SF/50/4
S/50/3
25
20
15
10
5
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Fig. 41

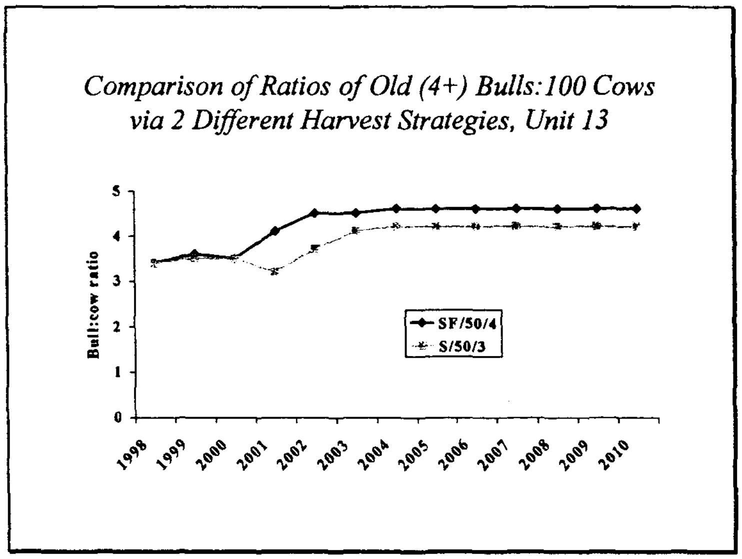

Comparison of Ratios of Old (4+) Bulls:100 Cows
via 2 Different Harvest Strategies, Unit 13
Bull:cow ratio
0
1
2
3
4
5
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
SF/50/4
S/50/3

Fig. 42

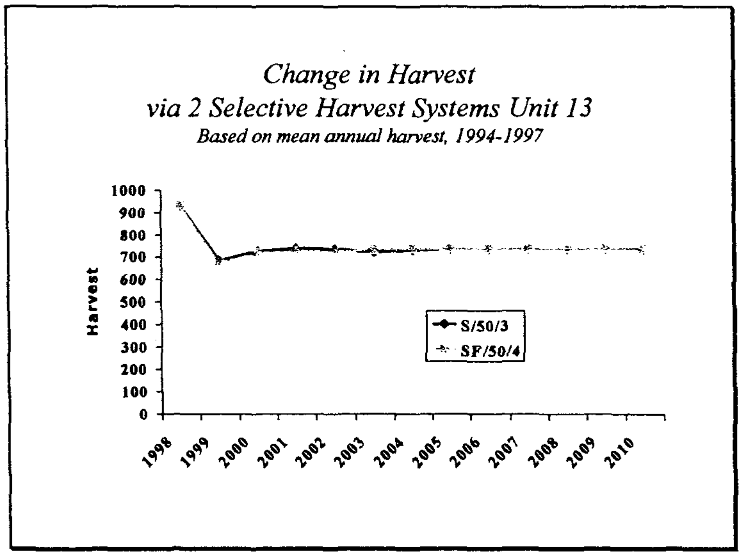

Change in Harvest
via 2 Selective Harvest Systems Unit 13
Based on mean annual harvest, 1994-1997
Harvest
0
100
200
300
400
500
600
700
800
900
1000
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
S/50/3
SF/50/4

Table 1. Characteristics of the hunt and the moose population on the Kenai Peninsula from 1982-1986 (pre-SF/50) and 1987-1992 (post-SF/50), from Schwartz et al. (1992).

Parameter	Pre-SF/50	Post-SF/50
Post-hunt bull:100 cow ratio*	16	25
Annual harvest*	636	443
Mean number of hunters*	3602	2605
Percent success	18%	16%
Percent yearlings in harvest*	46	64
Percent ages 2-3 in harvest*	38	17
Percent ages 4-5 in harvest	11	12
Percent ages $\geq$6 in harvest	5	7

*Values differ significantly ($P \leq 0.05$)

Table 2. Management objectives for Units 14A, 14B, 16A, and 16B.

Unit	Population size	Bull:100 cow ratio	Harvest (3-yr. mean)
14A	5,000 – 5,500	20 – 25	600 – 700
14B	2,500 – 2,800	20 – 25	100 – 200
16A	3,500 – 4,000	20 – 25	$\geq$ 250
16B	$\geq$ 6,500	20 - 25	$\geq$ 300*

* Additional subsistence harvest objective of 160-180 north of the Beluga River, and 39-47 south of the Beluga River

Table 3. Estimates of moose population size in Units 14 and 16 and, where applicable, the 80% confidence interval on those estimates.

Year	14A	14B	16A	16B
1988	5137 $\pm$ 895		4750 $\pm$ 750	8600
1989	5250 $\pm$ 750	2760 $\pm$ 550		8600
1990		1795 $\pm$ 247	2960 $\pm$ 256	7400 $\pm$ 100
1991	5885 $\pm$ 706			
1992	5700 $\pm$ 500	1528 $\pm$ 178	2900 $\pm$ 564	
1993	5672 $\pm$ 798		3284 $\pm$ 903	6700 $\pm$ 1600
1994	6000 $\pm$ 500	2337 $\pm$ 527	3300 $\pm$ 300	6660
1995				
1996	5750 $\pm$ 250			
1997			3636 $\pm$ 614	

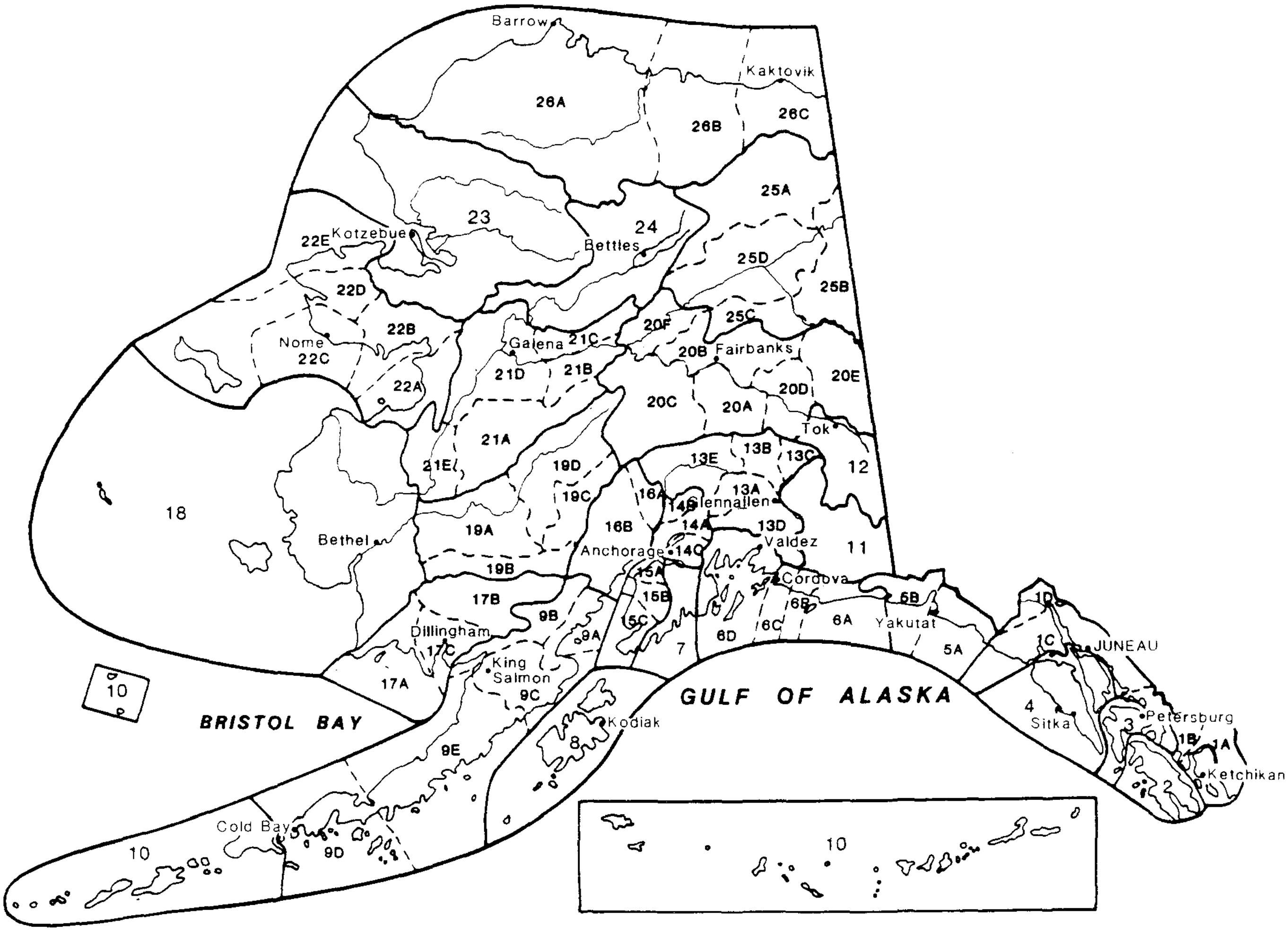
Table 4. Distribution of yearling harvest between early (SF/50) and late (SF only) seasons.

Year	14A		14B		16A	
	Early	Late	Early	Late	Early	Late
1993	160	0	9	0	24	0
1994	192	0	13	0	33	0
1995	137	75	5	11	16	10
1996	139	201	1	17	8	34
1997	186	198	12	11	16	29

Table 5. Differences in occurrence of animals with 4 or more brow tines in the SF/50 harvest.

Unit	% of bulls <50" with 4+ brow tines	% of bulls ≥50" with 4+ brow tines
7 + 15	17	22
14 + 16	19	30
13	23	52

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.

Gerhard Kraus