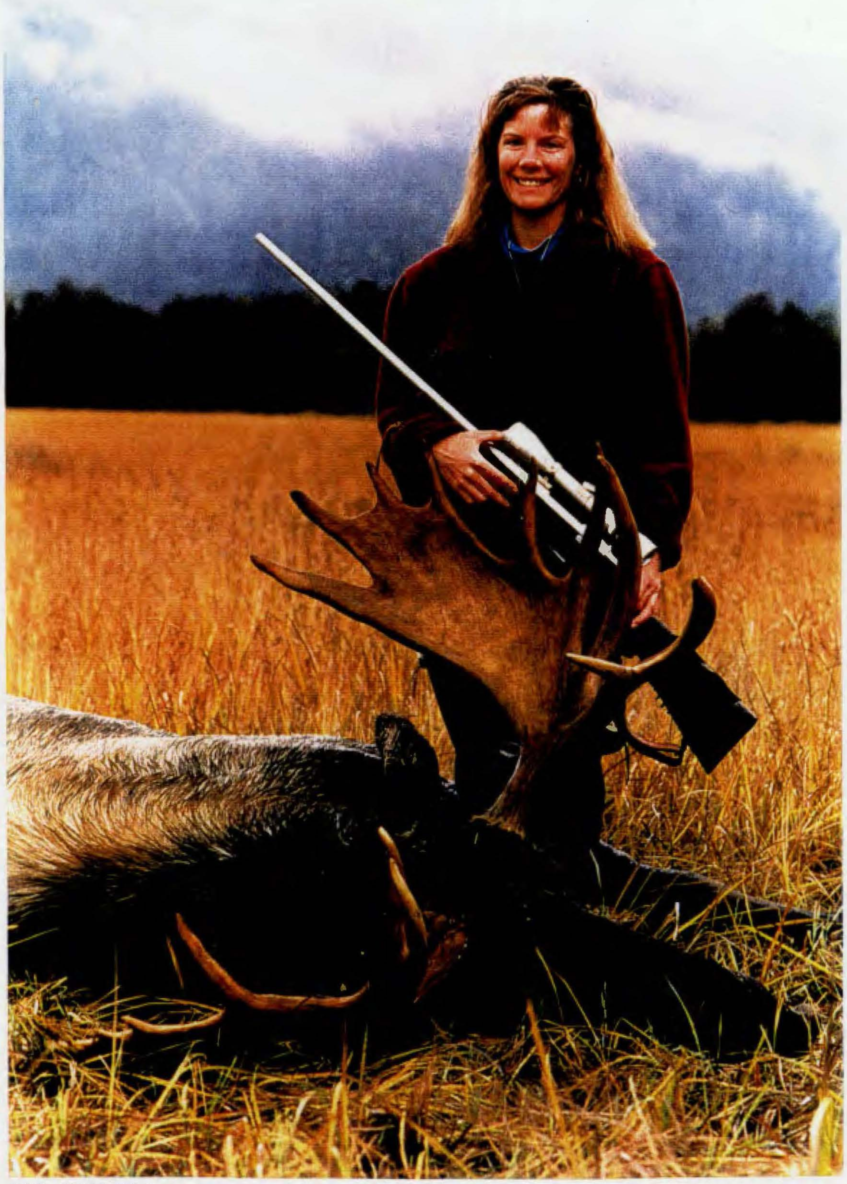
Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Survey-Inventory Management Report
1 July 1991 - 30 June 1993

MOOSE

Mary V Hicks, Editor



PAT COSTELLO

Study 1.0
Grants W-23-5,
W-24-1, W-24-2
December 1995

STATE OF ALASKA
Tony Knowles, Governor

DEPARTMENT OF FISH AND GAME
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LOCATION

GAME MANAGEMENT UNIT: SUBUNIT 1A (5,000 MI^2)
SUBUNIT 1B (3,000 MI^2)
UNIT 2 (3,900 MI^2)
UNIT 3 (3,000 MI^2)

GEOGRAPHICAL DESCRIPTION: Southeast mainland and adjacent islands from Cape Fanshaw to the Canadian border

BACKGROUND

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

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

The moose population in Thomas Bay, north and east of Leconte Bay, is isolated by the Coast Mountains from populations in mainland Canada. These moose occupy a heavily logged area. Sparse population trend information suggests that Thomas Bay moose may be more susceptible to periodic reproductive failures than other Southeast moose populations. Also, the Thomas Bay population may decline significantly as conifer regrowth in clearcut areas matures and reduces forage production. The average annual harvest of Thomas Bay moose during the decades of the 1950s, 1960s, 1970s, and 1980s was 5, 8, 10, and 18, respectively. The season was closed and no harvest occurred in 1982 and 1983.

Moose inhabiting the Alaska portion of the Stikine River drainage represent the westernmost tip of a mainland population which extends into Canada. The Alaska portion of this population was estimated at 300 animals in 1983 (Craighead *et al.* 1984). Since 1983, winters have been mild and the population, based on harvest 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.

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

Moose occur on the major islands of Unit 3. Increased sightings of moose during the 1980s suggest these populations are growing. From 1960-67, the season was open from 15 September - 15 October with a limit of one bull. Wrangell Island only was opened to hunting in 1990 and Mitkof Island was opened in 1991.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

The goals of moose management in Region I are to:

1 maintain, protect, and enhance moose habitat and other components of the ecosystem.

2 maintain viable populations of moose in their historic range throughout the region.

3 manage moose on a sustained yield basis.

4 manage moose in a manner consistent with the interests and desires of the public.

5 manage primarily for meat hunting and not trophy hunting of moose.

6 manage for the greatest hunter participation possible consistent with maintaining viable populations, sustained yield, subsistence priority, and the interests and desires of the public.

7 provide opportunities to view and photograph moose for the benefit of non-hunters (nonconsumptive users) of moose.

8 develop and maintain a database useful for making informed management decisions.

MANAGEMENT OBJECTIVES

GMU 1A:Unuk/Chickamin	Objective 1994
Posthunt numbers	35
Annual hunter kill	3
Number of hunters	20
Hunter-days of effort	90
Hunter success	15%
GMU 1B: Stikine River	
Posthunt numbers	450
Annual hunter kill	40
Number of hunters	300
Hunter-days of effort	2,100
Hunter success	13%

Thomas Bay:

Posthunt numbers	200
Annual hunter kill	20
Number of hunters	160
Hunter-days of effort	675
Hunter success	12%

GMU 2: No formally stated objective
GMU 3: No formally stated objective

These objectives were identified based on biological data and public input. They are being reviewed by other agencies and the public, and are subject to approval by the Board of Game.

METHODS

We flew one helicopter survey along the Unuk River and several winter surveys in the Stikine River valley. We checked hunters and kills in the field for the Stikine and Thomas Bay hunts. Field data was used to reconcile written hunter reports. Hunters are encouraged to report on harvest tickets and we require reporting on registration permits. We recorded moose sightings and attended public meetings in Wrangell and Petersburg where moose management was discussed.

We asked the Thomas Bay hunters to report the total number of bulls, cows, calves, wolves and bears that they saw during the season. We modified the registration permit report to provide space for this.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size: Data are insufficient to make a quantitative determination of population trends during the past five years. The moose populations appeared to be stable in Subunit 1A (low density), and increasing slightly in Thomas Bay in northern Subunit 1B (moderate to high density). The Stikine River population in central Subunit 1B(moderate density) appeared to decrease slightly. Increasing reports of moose in Unit 2 may reflect a resident population that is increasing, or may be a function of increased hunter access into once remote areas. The number of moose in Unit 3 (low to moderate density) appeared to increase.

We saw only four adults and three calves during a short survey of the Unuk River in April 1993. We made no attempt to do a complete search.

The Stikine River population was estimated at 300 moose and increasing in 1983 (Craighead, *op. cit.*). Post-1983 harvest levels and subjective impressions suggested the Stikine population slowly increased and then began to decrease in 1988. The percentage of calves surviving to late winter declined from 1980 to 1989 and remains at less than 10%. Hunters took 57 bulls in 1988 and the kill has dropped each succeeding year.

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

No population data are available for Unit 3, however a subjective estimate of the population on Mitkof Island is 200 moose. This is based on personal observations and reports from other agency biologists and the public.

No surveys were conducted in Units 2 or 3.

Population Composition: Table 1 shows the results of all surveys made in the Stikine River valley since 1988/89. Unlike moose habitat in interior Alaska, the Stikine River has tall conifer cover and little deciduous brush. The tall evergreen trees and inclement weather make it very difficult to do adequate surveys. We made no attempt to differentiate between bulls and cows but identified only adults and calves in the late winter aerial surveys. We attempted to make early winter counts to ascertain bull to cow ratios but were unsuccessful.

We asked hunters in Thomas Bay to report all predator and moose sightings during the 1992 and 1993 hunting seasons. Our premise was that the combined observations should represent the actual herd composition. We feel that these observations may provide population trend information. We urge caution in drawing conclusions from this group of observations. In 1992 hunters reported seeing 1,048 moose during the 15 day season. There were 355, 463, and 230 bulls, cows, and calves, respectively. This equates to ratios of 77:100 bulls-to-cows and 50:100 calves-to-cows. Overall, 22% of the moose seen were calves and 1.8 moose were seen per hunter-day. Similar numbers were reported in 1993, being 425, 499, and 226 bulls, cows and calves, respectively, for a total of 1,150 observations. There were 85 bulls:100 cows and 45 calves:100 cows. Hunters saw an average of 1.6 moose/day.

We asked Stikine River area hunters the same questions and the number responding was about the same as for Thomas Bay. However, the season was twice as long. One hundred forty Stikine hunters reported 586 moose observations during the 31 day season. They saw 69, 414, and 103 bulls, cows, and calves, respectively. The ratio of bulls per 100 cows in the Stikine was only 17, and 25 calves:100 cows were seen; hunters saw an average of 0.7 moose per day.

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. Radio telemetry of Stikine moose found no evidence of extensive seasonal migration (Craighead et. al.,1984). Moose appear to be well distributed in the Alaska portion of the Stikine River Valley, Thomas and Farragut Bays, and on the islands of Mitkof, Wrangell, and Kupreanof. Moose have been reported from Etolin, Zarembo, and Kuiu islands. Moose seem to be absent from the Bradfield Canal area where several river valleys appear to have suitable habitat.

MORTALITY

Harvest:

Season and Bag Limit

Unit 1A and Unit 1B south of LeConte Glacier(Stikine)	Sep. 15 - Oct. 15	One bull.
Unit 1B north of LeConte Glacier (Thomas Bay)	Oct. 1 - Oct. 15	One bull with spike/fork or 50" antlers, by registration permit only.
Unit 2	No open season	
Unit 3: Wrangell and Mitkof islands only	Oct. 1 - Oct. 15	One bull with spike/fork or 50" antlers.
Unit 3: Remainder	No open season	

Board of Game Actions and Emergency Orders. In the Stikine area the Board of Game instituted several changes for the 1993 season. Hunting in Subunits 1A and 1B (Stikine) will be by state Registration Permit only. No change was made for Stikine season dates or bag limit on the advice of the Department of Law in consideration of subsistence legislation. All of Unit 3 will be open to spike/fork or 50" or three brow tine antler restrictions by registration permit.

We closed the moose hunt at Thomas Bay and Mitkof Island by emergency order in 1991 after only nine days due to the high numbers of illegal (not meeting antler requirements) bulls being killed.

Hunter Harvest. In Subunit 1A the Unuk and Chickamin River moose populations are relatively small, isolated, difficult to hunt, and attract only a few hunters. The Unuk River population has supported a mean annual harvest of three bulls. In 1991 hunters killed three bulls and took five in 1992 (Table 2). Harvest reports indicate 40 hunters participated in 1991 and 37 in 1992.

The moose harvest continues to decline in the Stikine portion of Subunit 1B. Hunters killed 24 bulls in 1991 and 18 in 1992 (Table 3). Each year at least one cow was also killed. This decline in harvest has persisted for four years.

The harvest is more than 50% long yearlings with most of the remainder being two years old. Only occasionally will an older bull be taken (ADF&G files). This lack of older bulls in the harvest suggests that there may be few mature bulls in the herd.

In 1991 the emergency closure of the Thomas Bay hunt after only nine days restricted the kill to 15 bulls (Table 4). This included four that were illegal. The number of illegal bulls killed in 1992 was only three, perhaps due in part to the written test, while hunters took 25 legal bulls. The policy of the Division of Fish and Wildlife Protection provides hunters that personally report a violation to lose only the animal; they are not prosecuted for the violation but cannot hunt for the remainder of the moose season. Prior to 1992 no moose left in the field had been reported. One illegal bull was found and reported by several hunters in 1992.

The Unit 3 kill increased with the addition of Mitkof Island to the hunt area (Table 5). Illegal bulls are included in the totals. All illegal moose reported were surrendered to the state and donated to charity.

In 1992 we required all Thomas Bay hunters to pass a simple written test to qualify for a permit. Each hunter had to write a definition of an antler point or tine, a definition of a brow tine, and correctly identify sketches of legal and illegal antlers. We put up a display in Petersburg of typical legal and illegal antlers. It seems that the written test, the antler display, and the emergency closure all contributed to better hunter compliance with the antler requirements.

Hunter Residency and Success. Subunit 1A moose hunters are primarily Ketchikan and Metlakatla residents. Many hunters own cabins on the Unuk River.

In the Stikine hunt area we see fewer hunters in the field and fewer hunters are reporting through the harvest ticket system since 1989 (Table 6). Harvest ticket reports do not accurately represent the total hunter participation (Goodwin, 1991). Trends indicated by the hunter reports should, however, be indicative. Our field observations and harvest ticket reports agree that fewer hunters are participating and fewer moose are being killed. Petersburg and Wrangell residents continue to take most of the moose.

Petersburg residents continued to dominate the Thomas Bay hunt(Table 7). Although hunter success is relatively low, most hunters seem satisfied with the hunt. The 25% hunter success reported for 1992 includes the three illegal moose.

Harvest Chronology. Harvest chronology for Subunits 1A, 1B, and Unit 3 remains fairly consistent. Most bulls are killed in the first half of the season and the rate of kill declines throughout the season (ADF&G files). Most hunters are in the field early in the season, then fewer hunters are out except for weekends. Inclement weather does not seem to slow hunting effort early in the season.

Transport Methods. There were no apparent changes in the transportation methods used by hunters in Subunits 1A and 1B. Most hunters used boats and one to five hunters used airplanes. Hunters in Unit 3 relied on highway vehicles and used the extensive road systems to reach the field. Motorized land vehicles are prohibited for moose hunting in the Thomas Bay hunt and in the Stikine Wilderness. In Thomas Bay vehicles may be used for any purpose except the actual hunting of moose.

OTHER MORTALITY

Three species of predators inhabit the Unuk and Stikine hunt areas. Wolves, black bears, and brown bears are all known predators of moose calves. Wolves and brown bears will take adult moose. The extent of predation on these moose herds is unknown but few calves are being recruited into the Stikine herd. Anecdotal reports of extensive poaching along the Stikine River have not been verified by investigating officers. We have found very little evidence of other mortality.

HABITAT

Thomas Bay moose have used young-age clearcuts since logging began in the 1950s. Conifer regrowth in the clearcuts is progressively reducing moose habitat and canopy closure is reducing the value of the logged areas to moose. The U.S. Forest Service has cleared a 100 acre plot along the Patterson River to investigate the feasibility of improving moose habitat. A combination of treatments with lime and fertilizer to encourage willow and cottonwood growth will be tested. Pre-commercial thinning may also provide increased forage for moose but this technique is not yet proven.

The Stikine moose area lies mostly within the Stikine/LeConte Wilderness area and is generally within the Stikine River drainage. Moose habitat in this area, identified by Craighead (1984), is designated wilderness and cannot be manipulated mechanically for habitat improvement.

CONCLUSIONS AND RECOMMENDATIONS

The small Unuk and Chickamin River moose populations attract very few hunters. The change to a registration permit will provide for more accurate reporting. We recommend no other changes in regulations at this time.

The Subunit 1B Stikine herd objectives were not met. Our experience at Thomas Bay indicates that with an antler restriction hunt this decline could be stopped and in a few years the objectives should be met. The Federal Subsistence Board adopted an antler restriction for the 1993 season and restricted hunting on federal lands to federally eligible hunters only. This will mean that hunters will have two separate and conflicting sets of regulations, one for federal land and the other for non-federal land. It also means that each hunter must have both a federal and a state permit in order to hunt legally. I recommend that the Board of Game address the declining moose population (as well as hunter participation) by adopting spike-fork/50 inch-three brow tine antler restrictions for the Stikine hunt area.

In Thomas Bay the harvest objective was met in five of the last six years. The number of hunters and hunter-days of effort objectives will be re-evaluated. There is no restriction on the number of hunters and each hunter could be in the field for 15 days. Few permittees hunt more than six of the 15 days and we have no indication that regulations are unduly restricting hunter numbers. Because suitable moose habitat is limited and shrinking and all indications are of an increasing herd, I recommend a drawing permit hunt for antlerless moose. This should be conservative so a small number of permits should be issued the first year.

We recommend that Unit 2 remain closed to the taking of moose.

We have no recommendations specifically for Unit 3.

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

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Craighead, F. L., E. L. Young, and R. Boertje. 1984. Stikine River moose study, wildlife evaluation of Stikine-Iskut dams. Final Report. Alaska Dep. of Fish and Game. Juneau. 72pp.

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Prepared by: Charles R. Land, Wildlife Biologist III

Submitted by: W. Bruce Dinneford, Regional Management Coordinator

Table 1. Subunit 1B (Stikine). Moose surveys, 1988-92.

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

[a] Helicopter survey
[b] River stage high, full leaf out in lower river, moose not visible.
[c] Helicopter survey aborted due to weather.

Table 2. Subunit 1A. Moose harvest, 1986-92.

Regulatory year	Hunter Harvest							Grand total
	Reported				Estimated			
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	
1986/87	0 (0)	0 (0)	0	0	0	0	0	0
1987/88	2 (100)	0 (0)	0	2	0	0	0	2
1988/89	6 (100)	0 (0)	0	6	0	0	0	6
1989/90	1 (100)	0 (0)	0	1	0	0	0	1
1990/91	5 (100)	0 (0)	0	5	0	0	0	5
1991/92	3 (75)	1 (25)	0	4	0	0	0	4
1992/93	5 (100)	0 (0)	0	5	0	0	0	5

Table 3. Subunit 1B (Stikine). Moose harvest, 1986-92.

Regulatory year	Hunter Harvest							Grand total
	Reported				Estimated			
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	
1986/87	41 (100)	0 (0)	0	41	0	0	0	41
1987/88	47 (100)	0 (0)	0	47	0	0	0	47
1988/89	57 (100)	0 (0)	0	57	0	0	0	57
1989/90	38 (100)	0 (0)	0	38	0	0	0	38
1990/91	36 (97)	1[b] (3)	0	37	0	0	0	37
1991/92	24 (96)	1[b] (4)	0	25	0	0	0	25
1992/93	18 (95)	1[b] (5)	0	19	0	0	0	19

[a] Illegal kill.

Table 4. Subunit 1B (Thomas Bay). Moose harvest data, 1986-92.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	.... Cows (%)	Unk.	Total[a] harvest
955	1986/87	201	23	90	10	15 (100)	0 (0)	0	15
1B	1987/88	159	31	80	20	22 (100)	0 (0)	0	22
	1988/89	170	29	77	23	27 (100)	0 (0)	0	27
	1989/90	209	30	86	14	20 (100)	0 (0)	0	20
	1990/91	221	27	86	14	25 (100)	0 (0)	0	25
	1991/92	182	32	88	12	15 (100)	0 (0)	0	15
	1992/93	171	35	74	26	28 (97)	1 (3)	0	29

[a] Includes illegal kill

Table 5. Unit 3. Moose harvest, 1990-92.

	Hunter Harvest							
	Reported			Estimated				
Regulatory year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Grand total
1990/91[a]	3 (100)	0 (0)	0	3	0	0	0	3
1991/92[b]	10 (100)	0 (0)	0	10	0	0	0	10
1992/93	17 (100)	0 (0)	0	17	0	0	0	17

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

Table 6. Subunit 1B (Stikine). Moose hunter residency and success, 1986-92.

	Successful					Unsuccessful					
Regulatory year	Local[a] resident	Nonlocal resident	Nonres.	Unk.	Total (%)	Local[a] resident	Nonlocal resident	Nonres.	Unk.	Total (%)	Total hunters
1986/87	28	9	1	3	41 (17)	150	46	2	1	198 (83)	240
1987/88	37	7	1	2	47 (21)	127	49	0	5	181 (79)	228
1988/89[b]	41	16	0	0	57 (19)	167	74	4	3	248 (81)	305
1989/90[b]	23	15	0	0	38 (13)	170	106	7	0	283 (87)	321
1990/91[b]	36	0	1[c]	0	37 (12[d])	215	27	1	0	243 (88)	280
1991/92[b]	23	1	1[c]	0	25 (12[d])	146	34	5	5	190 (88)	215
1992/93	16	2	0	1	19 (8[d])	183	24	3	1	211 (92)	229

[a] Residents of Petersburg and Wrangell
[b] Unsuccessful hunter data expanded to correct for nonreporting hunters, see text.
[c] Illegal cow
[d] Legal kill only.

Table 7. Subunit 1B (Thomas Bay). Moose hunter residency and success, 1986-92.

Regulatory year	Successful: Local[a] resident	Successful: Nonlocal resident	Successful: Nonres.	Successful: Total (%)	Unsuccessful: Local[a] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Total(%)	Total hunters
1986/87	13	2	0	15 (10)	116	22	1	139 (89)	114
1987/88	21	0	1	22 (20)	79	7	2	88 (80)	110
1988/89	27	0	0	27 (23)	87	5	1	93 (77)	120
1989/90[b]	18	2	0	20 (14)	119	7	0	126 (86)	146
1990/91[b]	23	2	0	25 (15)	126	10	1	137 (85)	162
1991/92[b]	14	1	0	15 (12)	96	12	0	108 (88)	123
1992/93[b]	25	2	1	28 (25)	77	6	0	83 (75)	111

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

LOCATION

<u>Game Management Subunit</u>: 1C (7,600 mi^2)

<u>Geographical Description</u>: That portion of the Southeast Alaska mainland from Cape Fanshaw to the latitude of Eldred Rock

BACKGROUND

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

Swarth (1922) states that a moose was killed at the mouth of the Stikine River "some years" before 1919. If moose appeared at the same time on the Taku River, then presumably they first occurred in the lower part of the river near the turn of the century. In 1960, 38 moose were observed on the Taku River by ADF&G biologists, 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, or from some other source.

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

MANAGEMENT DIRECTION

<u>Management Objectives</u>

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

Taku River Area: maintain a posthunting population of 150 moose, an annual harvest of 20, and a hunter success rate of 20% by 1994.

Berners Bay: maintain a posthunting population of 90 moose, an annual harvest of eight, and a hunter success rate of 80% by 1994.

Chilkat Range: maintain a posthunting population of 150 moose, an annual harvest of ten, and a hunter success rate of 15% by 1994.

METHODS

Aerial surveys were not conducted throughout most of Subunit 1C during the reporting period because of a combination of factors, including loss of staff positions, poor weather, and commitments to mining study site flights near Juneau. Survey flights were accomplished at Berners Bay both years, in recognition of the need to reauthorize the cow hunt annually (see Table 1). An aerial survey was also conducted in February 1993 at Adams Inlet within Glacier Bay National Park in cooperation with the National Park Service, and we attempted to survey state lands at Gustavus.

Incisors were collected from moose taken from Berners Bay and elsewhere in the unit as a condition of hunt permits. Data collected from permits included the length of hunt, hunter residency, hunt location, and transport means (for all hunters), and date of kill (for successful hunters).

RESULTS AND DISCUSSION

Population Status and Trend

Moose numbers near the estimated carrying capacity for the Berners Bay area (i.e., between 100 and 150 animals) are being maintained with selective harvests to adjust the bull:cow ratio. In the Taku River area, evidence suggests the Taku River moose population may be decreasing, although the population may be supplemented by moose moving downriver from Canada. Population dynamics are not well understood for the Chilkat Range moose population, but harvest levels and anecdotal comments from hunters in the field indicate that moose numbers have probably been stable or increasing. An increased harvest in the Chilkat Range documented in 1990 probably reflected an increase in effort, but was not maintained during this period even though effort continued to rise. Effects upon the population of this harvest level and immigration of moose from Adams Inlet within Glacier Bay National Park are unknown. An influx of moose from the park is also supporting an increased level of harvest on state land at Gustavus.

Population Size: In Berners Bay the number of moose observed in fall and winter surveys has increased since 1986 (Table 1). An estimated 100-150 moose are believed to inhabit Berners Bay.

Recent survey data are not available for the Chilkat Range with the exception of a late winter survey of Adams Inlet in 1992-93 which found 79 adults and 11 calves (Table 2). As noted above, no other surveys were completed in the unit outside of Berners Bay in 1991 or 1992. The Endicott River portion of the Chilkat Range may support about 50 moose, and the entire Chilkat Range may support 150 moose. In the past, animals from this area emigrated to Adams Inlet, where willow communities have pioneered following recent glacial retreat. Moose from Adams Inlet may now be moving back to the east, supplementing the herd along the west side of Lynn Canal.

The moose population from Taku River to Cape Fanshaw numbers about 150 animals. Animals from upriver in Canada probably supplement the Taku herd, but the harvest in Canada has increased in recent years.

Population Composition: In 1991 a late winter survey in Berners Bay found 11 calves and 50 adults, for a calf percentage of 18%. In 1992 our survey indicated 23 bulls:100 cows and 13 calves:100 cows. In Adams Inlet in late winter 1992-93 we found a calf percentage of 13%. No other areas within Subunit 1C were surveyed during the report period.

Mortality

Harvest:

Season and Bag Limit.

1991-92 Regulatory Year

Subunit 1C, Berners Bay drainage	Sept. 15-Oct. 15	One moose by drawing Bay drainages permit only. Up to 10 permits will be issued.
Subunit 1C, except Berners Bay drainages.	Sept. 15-Oct. 15	One bull by registration permit only.

1992-93 Regulatory Year

Subunit 1C, Berners	Sept. 15-Oct. 15	One bull by drawing Bay drainages only. permit. Up to 10 permits will be issued.
Subunit 1C, except Berners Bay drainages.	Sept. 15-Oct. 15	One bull by registration permit only.

Hunter Harvest. The Berners Bay drawing permit hunt was managed for a harvest of 5 moose for the 5 years before 1991-92 (Table 3). The number of male and female moose to be harvested has been determined by aerial survey data. Improvements in the numbers of moose seen during surveys allowed the harvest level to be raised to 5 bulls and 5 cows in 1991. Poaching is believed to be minimal in Berners Bay because of the proximity to Juneau and the large number of people who spend time there.

The balance of Subunit 1C is managed under a registration permit with no hunt quota. The known Taku River area harvest ranged from 15 to 24 moose since 1986 and the take in the Chilkat Range ranged from 6 to 24 (Table 3). The 44 moose taken outside of Berners Bay in 1990 was the highest number since at least 1972. Harvest levels during the report period decreased to 26 (the lowest figure during the 1988-1992 period) in 1991 and 39 in 1992.

No striking changes in the contribution made by hunt areas to the total subunit harvest are evident, although the number of moose taken near Gustavus has increased as have the number taken at Berners Bay.

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

Permit Hunts. Between 247 and 1,035 applications were submitted for the Berners Bay moose drawing over the past 5 years. The proximity to Juneau and the high success rate explain the popularity of this hunt. In 1991, 974 hunters applied for 5 bull permits and 5 cow permits, for a combined success rate of 1%. In 1992, 1,035 hunters applied for 5 bull and 5 cow permits, for a success rate of 0.9%.

Since the registration permit format was initiated for Subunit 1C (except Berners Bay), more than 200 permits have been issued annually (Table 4). A record high 331 were issued in 1990, with a decline to 316 and 317 in each of the years during this report period. The number of applicants hunting ranged from 138 to 223 during the past 5 years, with a near-record number (218) of hunters participating in 1991. Reporting compliance has remained high over the years in this hunt.

Hunter Residency and Success. Most moose harvested in Subunit 1C are killed by local residents (Table 5). In 1991 and 1992, 35 of 36 moose (97%) and 42 of 48 moose (88%) were harvested by local residents. This is probably because moose habitats are not readily accessible via highway vehicle, residents from elsewhere in Alaska have better opportunities for moose hunting closer to home, and nonresident hunters focus on areas with larger moose populations. In 1991 and 1992, respectively, 14% and 18% of all hunters in Subunit 1C were successful.

Harvest Chronology. The harvest pattern first established in 1990 continued during this report period, with harvest weighted towards the beginning and end of the season, and fewer moose being taken during the middle two weeks of the season.

Transport Methods. Boats are the most common form of transportation for moose hunters in Subunit 1C. This comes as no surprise, since hunting areas are removed from highway access points, seasons are closed before the winter season, and aircraft landing sites are limited. In 1991, 59% of the successful Subunit 1C hunters used boats for access, while airplanes were used in 24% of moose hunts. In 1992, 72% of successful moose hunters used boats (Table 7).

Other Mortality: No natural mortality was documented during the report period. Neither winter during the period had deep snow for extended periods, so conditions were probably mild for moose in the subunit.

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

Board of Game Action: In 1993 the Board of Game continued the cow drawing permit hunt in Berners Bay and increased the allowable quota to 20 moose, of unspecified sex.

CONCLUSIONS AND RECOMMENDATIONS

Management objectives for hunter success and animals harvested were reached for the Taku River area in 1992 (19 animals harvested and 21% hunter success), although we have no estimate of the post-hunt population. All objectives were surpassed at Berners Bay during both years of the period; harvest exceeded the target of eight, virtually all hunters were successful, and estimates show more than 90 moose in the post-hunt population. In the Chilkat Range, hunter success exceeded 15% in both years and harvest exceeded 10 moose. Again we have no estimate of post-hunt moose numbers.

Fall and winter surveys suggest a moderately dense, stable Berners Bay population and high numbers wintering at Adams Inlet. We believe that a continuation of the drawing and registration permit systems should accommodate current population objectives. In Berners Bay, an increase in the quota seems appropriate because the herd seems to be near the area's carrying capacity. Rising effort and harvest in the Chilkat Range increase the importance of acquiring survey data for moose in that portion of the subunit.

Throughout the subunit, jaws should be collected for analysis of harvested moose ages. Areas supporting winter browse should be analyzed, even cursorily, in cooperation with land managers to determine if vegetation treatment is in order. Once population and carrying capacity estimates are made for the Taku and Endicott populations, consideration can be given to revision of management objectives.

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Table 1. Subunit 1C (Berners Bay). Moose survey data, 1986-1993.

Date	No. Bulls	No. Cows	No. Calves	Unknown Sex/Age	Total Sample	Males/ 100 FF	Calves/ 100 FF	Percent Calves	Count Time (hrs.)	Moose/ Hour
1986	15	46	7	0	68	33	15	10	1.6	41
1987	No survey									
1988[a]	3	53	12	0	68	6	23	18	2.2	31
1989	No survey									
1990	14	53	18	0	85	26	34	21	2.6	33
1991[b]	--	--	11	50	61	n/a	n/a	18	1.2	50
1992[a]	14	61	8	0	83	23	13	10	1.9	44
1993[b]	--	--	12	54	68	n/a	n/a	21	2.2	31

[a] Late winter survey, sex and age ratios unreliable. [b] Late winter survey, sex and age ratios not obtained.

Table 2. Subunit 1C (other than Berners Bay). Moose survey data, 1986-1992.

Year	No. Bulls	No. Cows	No. Calves	Unknown Sex/Age	Total Sample	Males/ 100 FF	Calves/ 100 FF	Percent Calves	Count Time	Moose/ Hour
1986[a]	3	10	6	0	19	30	60	32	1.5	13
1986[b]	2	42	1	0	45	5	2	2	1.8	25
1987	No survey									
1988[a]	No survey									
1988[bc]	2	16	4	0	22	13	25	18	1.6	14
1989	No survey									
1990	No survey									
1991	No Survey									
1992[cd]	--	--	11	79	97	n/a	n/a	13	1.3	74.6

[a] Chilkat Range [b] Taku [c] Late winter survey, sex and age ratios unreliable. [d] Adams Inlet, Glacier Bay National Park

Table 3. Subunit 1C. Harvest by hunt area, 1988-1992.

	Reported						Estimated		
Year	Berners Bay	Taku & South	St. James Bay	Endicott R.	Gustavus	Sub-Total	Unreported	Illegal	Total
1988	4	17	6	5	0	32	0	0	32
1989	5	27	3	5	2	42	0	0	42
1990	5	20	8	8	8	49	0	0	49
1991	10	14	3	3	6	36	0	0	36
1992	9	19	6	3	11	48	0	0	48

Table 4. Subunit 1C. Harvest data by permit hunt, 1988-1992.

Hunt	Year	Permits Issued	Did Not Hunt	Unsuccessful Hunters	Successful Hunters	Bulls	Cows	Total
Berners Bay	1988	5	0	1	4	4	0	4
	1989	5	0	0	5	5	0	5
	1990	5	0	0	5	5	0	5
	1991	10	0	0	10	5	5	10
	1992	10	1	0	9	5	4	9
Remainder GMU 1C	1988	215	76	110	28	28	0	28
	1989	305	109	159	37	37	0	37
	1990	331	108	179	44	44	0	44
	1991	316	133	157	26	26	0	26
	1992	317	99	179	39	38	1[a]	39
1991 Totals Both hunts		326	133	157	36	31	5	36
1992 Totals Both hunts		327	100	179	48	43	5	48

[a] Illegal kill

Table 5. Subunit 1C. Hunter residency and success, 1988-1992.

	Successful				Unsuccessful			
Year	Local Res.[a]	Nonlocal Res.	Nonres.	Total	Local Res.	Nonlocal Res.	Nonres.	Total
1988	29	2	1	32	93	14	3	110
1989	41	0	1	42	131	27	0	158
1990	44	5	0	49	155	20	1	176
1991	35	1	0	36	143	14	0	157
1992	42	4	2	48	152	26	1	179

[a] Residents of Auke Bay, Douglas, Juneau, and Gustavus.

Table 6. Subunit 1C. Harvest chronology, 1988-1992.

Year	9/15-9/21	9/22-9/28	9/29-10/5	10/6-10/15
1988	14	8	2	8
1989	22	7	5	8
1990[a]	15	6	8	15
1991	14	2	8	12
1992[b]	15	5	8	16

[a] Five kill dates unknown
[b] Four kill dates unknown

Table 7. Subunit 1C successful hunter transport methods, 1988-1992.

Year	Airplane	Boat	3- or 4-wheeler	Snow-machine	ORV	Highway Vehicle
1988	8	24	0	0	0	0
1989	8	31	0	0	0	3
1990	12	29	0	0	0	8
1991	5	26	0	0	0	5
1992	7	30	1	0	0	9

LOCATION

Game Management Subunit: 1D (2,700 mi^2)

Geographical Description: That portion of the Southeast Alaska mainland lying north of the latitude of Eldred Rock, excluding Sullivan Island and the drainages of Berners Bay

BACKGROUND

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

Moose immigrated to the Chilkat River valley from drainages in Canada sometime around 1930. Moose populations peaked in the Chilkat Valley in the mid-1960s, when as many as 700 moose may have been present. By the early 1970s the moose population had sharply declined to between 400-500 animals, possibly because of range overutilization and overharvest. Survey data collected during the mid-1980s suggested that the herd had declined further, with approximately 400 moose remaining in the Chilkat drainage. Recent surveys suggest that the moose population now numbers between 300 and 400 moose.

Residents of Subunit 1D have expressed concern over the decrease in moose numbers, the subsequent decline in hunting opportunity, and the "stampede" quality of registration permit hunts with low harvest quotas. Harvest objectives have been formulated based on survey data and harvest trends. Efforts were made to introduce measures (e.g., a spike-fork requirement) to slow the pace of the hunt, but these were pre-empted when a Tier II subsistence hunt was implemented for the area by the Board of Game 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.

MANAGEMENT DIRECTION

Management Objectives

The following objectives, presented in the Strategic Plan for Management of Moose in Region I, Southeast Alaska 1990-94 (ADF&G, 1991), were based on existing biological data and input from the public: a post-hunt population of 450; a post-hunt bull:cow ratio of 26:100; 250 hunters expending 500 hunter days; and a kill of 30 moose for a hunter success rate of 12%.

METHODS

Aerial surveys of the Chilkat River valley were conducted in December 1991, December 1992, and March 1993. Areas covered included (depending on weather conditions) the Chilkat River valley from Murphy Flats to the vicinity of Turtle Rock, and the Klehini, Tahkin, and Kelsall River valleys to the limit of moose tracks. Because moose hunts were not held during the period, no harvest data was available. A few road kills and defense of life and property incidents were reported.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: A winter survey flown in good viewing conditions in December, 1991 resulted in a population estimate of 350 moose in the Chilkat valley. This survey was better and more complete than the three previous efforts, which had been hampered by weather. However, the 1991 surveys provided lower moose numbers than the last complete surveys (1986-89) which resulted in population estimates of about 400 animals. Based on these differences, it appears that moose numbers may have declined further from the level found in the late 1980s. Both the bulls to 100 cows and the calves to 100 cows figures stood at 17. This calf ratio was within the range seen in the Chilkat valley within the previous five years. The ratio of bulls to cows was the lowest of recent complete surveys, but may have been underestimated because of antler drop.

A survey flown in mid-December 1992 resulted in an estimate of about 300 moose in the area. This was a complete survey, except the Murphy Flats area along the west bank of the lower Chilkat River was covered only cursorily as daylight faded. Although the survey total had declined some from the previous year, the number of calves (21:100 cows) and bulls (28:100 cows) relative to the total sample had improved.

In March 1993 a third survey was made of the Chilkat valley, largely in response to repeated complaints about the effects of wolves upon the moose population. Very few moose were seen despite excellent snow and light conditions. Abundant wolf tracks covered the survey area, and four moose kill sites were seen. I believe that most moose were using closed canopy coniferous forest habitat at this time of the year and were therefore virtually invisible during the survey.

Population Composition: Prior to the reporting period, two incomplete surveys produced some age and sex data. The bull:100 cow ratio in 1989 was 40, the highest recorded since 1965. In 1990, this number dropped to 27 bulls:100 cows, still above the average (21) for the previous 10 years. Antler drop may have affected the estimate of this survey. Results of both surveys may have been influenced by their lack of completeness.
The December 1991 survey produced a bull:100 cow figure of 17, the lowest of previous five year period (mean=34.3). This figure may have been influenced by antler drop and observer

inexperience. The bull:100 cow figure obtained in December 1992 (28), was within the range of values found during the five years prior to the reporting period.

In 1991, 17 calves:100 cows were seen, between the range of nine to 22 for the five years preceding the reporting period. Calves made up 11% of the sample, compared to the five-year average of 9.6%. Deep snow in the winter of 1991-92 was one of the factors leading to low calf numbers. In the deep snow of 1990 only nine calves:100 cows were present (7% calves), the lowest ratio since 1975.

The first (mid-December) survey during the winter of 1992-93 produced a calf:100 cow ratio of 21. This nearly matched the highest value found during the previous five years (22 in 1989). The calf percentage (14) matched the highest figures for the previous five years.

We were fortunate to obtain complete surveys during the reporting period. It appears that poor calf survival, due to snow, predators, or other factors may be effectively eliminating recruitment in some years.

Mortality

Harvest:

Season and Bag Limit.

1991-1992 Regulatory Years

Subunit 1D	Oct. 1-Oct. 15	One bull by Tier II permit only: 20 permit limit. Subsistence hunt only.

In 1991, we did not issue Tier II permits, because of apparent lack of recruitment and a failure to obtain complete surveys in the preceding years. The 1992 season was cancelled by emergency order prior to the Tier II permit application process based on results of the December 1991 aerial survey.

Board of Game Actions and Emergency Orders. No Tier II permits were issued in 1991. In 1992, an emergency order closing the season was issued prior to the permit application process. The 1993 Spring Board of Game implemented a Tier II, spike-fork/50 inch hunt with a limit of 200 permits for the fall 1993 hunt.

Hunter Harvest. No legal harvest took place during the reporting period.

Permit Hunts. All moose hunting within the subunit is conducted under a Tier II subsistence permit system. No permits were issued in either year because of low moose numbers in the subunit.

Hunter Residency and Success. During the reporting period, the moose hunt in Subunit 1D was limited to residents of the subunit. However, with no hunts being held, no local residents legally harvested moose during the reporting period.

Harvest Chronology. No moose were legally harvested during the reporting period.

Transport Methods. No moose hunting took place during the reporting period.

Other Mortality: Comments from area hunters suggest the brown bear population has increased in recent years, and that predation may be partly responsible for the poor recruitment rates observed. Data in support of this contention is not available. In 1992-93, wolves were more active (or more noticeable) than usual, and several reports of wolves killing moose were received, along with demands that ADF&G "do something". Deep snow conditions during both winters of the reporting period probably contributed to calf mortality, and undoubtedly affected predator success. Deteriorating range conditions (Hundertmark et al., 1983) may also play a role in low calf production and survival.

I estimate that between three and five moose are struck and killed by highway vehicles in the subunit each winter. Additionally, poaching probably occurs, but the number of moose lost to this activity is unknown. No Fish and Wildlife Protection staff were stationed in Haines for much of the 1992-93 winter.

Habitat

Nearly all of the moose habitat in this subunit lies within the Haines State Forest, managed under the multiple-use guidelines of the Haines State Forest Management Plan of 1986. The plan's goals include an annual harvest of up to 8.8 million board feet of timber on approximately 300 to 580 acres. Timber harvests occurred during the reporting period in the Chilkat River valley above Wells Bridge in areas which do not contain important moose winter range. A logging operation on a native allotment adjacent to important early winter habitat probably affected late-winter/deep snow habitat. While some benefits may accrue for moose through increased browse production in logged ares, the extent of deciduous reproduction in these areas has not been determined. The long-term usefulness of cut-over areas to moose will be reduced if a) timber harvest occurs in high value wintering areas, and b) they 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 quality 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 stimulate 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 treating vegetation in areas close to Haines.

CONCLUSIONS AND RECOMMENDATIONS

Harvest objectives contained in the strategic plan are revised downwards from previous years because of the continued low recruitment to the Subunit 1D population. The revised objectives will only be met if calf survival increases.

The effect of predation upon moose calf survival in this area is unknown. McCarthy (ADF&G, 1990) states that a program to determine the magnitude of this problem through radio-collaring calves in the spring has been rejected because of costs and practicalities, and mentions diversionary feeding as a possible way to deflect predators from calves during their early lives. Efforts to determine the extent of predation should continue to receive consideration.

McCarthy also 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, if possible, tried on a pilot basis. Volunteer efforts might be extensive enough so that browse growth and moose use could be monitored prior to engaging in a large scale habitat enhancement project. The possibility of using prescribed fire (e.g., in the Murphy Flats area) to accomplish favorable habitat changes should be investigated.

In view of the apparent slow decline in moose numbers shown by recent surveys, and recognizing the difficulties experienced in obtaining good survey information for this area in the past five years, it will continue to be important to conduct surveys to better understand the status and trend of the population.

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Table 1. Subunit 1D. Moose survey data, regulatory years 1986-1992.

Date	No. Bulls	No. Cows	No. Calves	Unknown Sex/Age	Total Sample	Males/ 100 FF	Calves/ 100 FF	Percent Calves	Moose/ Hour
1986	33	93	13	0	139	36	14	9	40
1987[a]	--	--	29	174	203	--	--	14	53
1987[a]	--	--	29	186	215	--	--	13	57
1988[a]	15	--	31	206	252	--	--	12	40
1989	18	45	10	0	73	40	22	14	48
1990	18	67	6	0	91	27	9	7	35
1990[a]	--	--	1	27	28	--	--	4	10
1991	23	137	23	0	183	17	17	11	46
1992	27	98	21	0	146	28	21	14	52
1992[a]	--	1	1	18	20	--	--	5	7

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

Table 2. Subunit 1D. Moose harvest data, regulatory years 1986-1992.

Hunt No.	Year	Permits Issued	Did Not Hunt	Unsuccessful Hunters	Successful Hunters	Bulls	Cows	Total
959	1986[a]	--	--	--	--	--	--	--
	1987	294	64	208	22	22	0	22
	1988	259	52	185	18	18	0	18
	1989	272	39	207	19	18	1	19
	1990	20	0	1	19	19	0	19
	1991[a]	--	--	--	--	--	--	--
	1992[a]	--	--	--	--	--	--	--

[a] No open season

Table 3. Subunit 1D. Harvest chronology, 1986-1992.

	September			
Year	1-7	8-15	16-23	24-30
1986[a]	--	--	--	16
1987[b]	22	--	--	--
1988[b]	18	--	--	--
1989[b]	19	--	--	--

	October														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1990[c]	4	3	2	2	2	2	0	1	0	1	1	0	0	0	1
1991[a]	No legal harvest														
1992[a]	No legal harvest														

[a] No open season [b] One day season, September 1 [c] Tier II hunt, October 1-15

Table 4. Subunit 1D. Successful hunter transport methods, 1986-1992.

Year	Airplane	Boat	ORV	Highway Vehicle	Unknown
1986[a]	--	--	--	--	(1)
1987	(14)	(55)	(5)	(27)	0
1988	0	(88)	(6)	(6)	0
1989	(5)	(67)	(5)	(22)	(3)
1990	0	(58)	0	(37)	(8)
1991[a]	--	--	--	--	--
1992[a]	--	--	--	--	--

[a] No open season

LOCATION

Game Management Unit: 5A and 5B (6,200 mi^2)

Geographical Description: Cape Fairweather to Icy Bay, eastern Gulf of Alaska coast

BACKGROUND

Moose were first documented along the lower Alsek River in eastern Subunit 5A 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. We believe that westward movement of this moose population was curtailed by the glaciers and waters of Icy Bay.

The moose population in Unit 5 grew rapidly and peaked in the early 1960s, with population estimates exceeding 2,000 animals. The population began making downward adjustments to a more realistic carrying capacity in the mid-1960s. Poor reproductive success and the severe winters of 1971-72 and 1972-73 depressed moose numbers enough that Subunit 5A hunting seasons were closed between 1974 and 1977. Since 1978, moose hunting in Unit 5 has been managed under a registration permit system.

MANAGEMENT DIRECTION

Population Objectives

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

	Objective 1994
GMU 5A Yakutat Forelands	
Posthunt moose numbers	1,000
Annual hunter kill	70
Number of hunters	250
Hunter-days of effort	1,025
Hunter success	28%
GMU 5A Nunatak Bench	
Posthunt moose numbers	50

Annual hunter kill	5
Number of hunters	10
Hunter-days of effort	60
Hunter success	50%
GMU 5B Malaspina Forelands	
Posthunt moose numbers	250
Annual hunter kill	25
Number of hunters	50
Hunter-days of effort	200
Hunter success	50%

METHODS

Fall aerial surveys were conducted in Subunit 5A in late December 1992. Moose incisors were submitted by hunters as required by the registration permit and were aged by counting cementum rings. Other data collected included the number of days hunted, hunter residency, kill date and location, and transport type.

RESULTS AND DISCUSSION

Population Status and Trend

Since the hunting closures in the mid-1970s, the Subunit 5A moose population has been slowly rebuilding to where it may now be near the habitat's carrying capacity. The Subunit 5B population is probably stable at moderate densities. The Nunatak Bench moose herd has re-established following the retreat of the Hubbard Glacier and the subsidence of the waters of Russell Fiord in 1986, but numbers are unknown.

Population Size: No aerial surveys were accomplished in the unit until just before the end of the reporting period. Based on results of a 1977 mark/recapture study in GMU 5A, it is generally assumed that the animals enumerated in a survey comprise no more than one-half of the moose present in the area surveyed.

Aerial surveys made prior to the reporting period in December 1988 located 515 moose in Subunit 5A, the highest count since before the population decline in the early 1970s. Total survey time was the lowest and the sighting rate the highest in recent years (Table 1A). A fall survey in 1990 enumerated 445 moose in Subunit 5A, at a sighting rate even higher than in 1988. Thus the population probably continues to number about 1000 animals.

A survey of part of the Yakutat Forelands was undertaken in late December 1992, covering the area from Ocean Cape to the Dangerous River, south of Forest Highway 10. A total of 196 moose were seen at a rate of 33 per hour, about half the rate of the 1990 survey. Although it was not possible to determine sex of moose reliably, the percentage of calves in the population was 19%. Half or less of the moose habitat in Subunit 5A was covered during this survey, in moderate to poor sightability conditions.

The Nunatak Bench herd was not surveyed during the report period. Before 1986 an estimated 50 moose were in this area. A survey in December 1990 found 14 moose at a sighting rate of 56 moose/hour of flight time Table 1B). Based on that survey, there are probably more than 30 moose present on Nunatak Bench.

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

Population Composition: Because weather conditions permitted aerial surveys only after antler drop began, no reliable composition counts were made in Subunit 5A. No surveys were made in other parts of Unit 5.

Mortality

Season and Bag Limit.

Regulatory Years 1991 and 1992:

Unit 5A, Nunatak Bench west of Dangerous River	Oct. 15-Nov. 15	One bull by registration except permit; 60 bulls may be taken; season will close when 30 bulls are taken in that area
Unit 5A, Nunatak Bench	No open season	
Unit 5B	Sept.1-Nov.15	One bull by registration permit; 25 bulls may be taken

Board of Game Actions and Emergency Orders

Emergency orders were issued in both years to close the area of Subunit 5A west of the Dangerous River when the quota of 30 bulls was achieved. The 1993 Spring Board of Game adopted a regulatory proposal which lengthened the Subunit 5B season to close on December 15.

Hunter Harvest. From 1991 through 1992, the Yakutat and Malaspina forelands hunts have been managed for quotas of 60 and 25 bull moose, respectively. In 1990 the hunt quota for Subunit 5A was increased to 60 bulls. The Nunatak Bench hunt had a quota of ten moose until it was closed in 1986. The total harvest for Unit 5 has been fairly constant, ranging from 57 to 71 moose between 1988 and 1992 (Table 2). The five-year high of 71 moose was taken in 1990 following the liberalization of the quota in Subunit 5A. Table 3 presents data for all three hunts within Unit 5 for the past five years.

Permit Hunts. During this period regulations provided for two registration permit hunts within Game Management Unit 5 - Hunt 961 in Subunit 5A (Yakutat Forelands) and Hunt 962 in Subunit 5B (Malaspina Forelands). The Nunatak Bench area in Subunit 5A (hunt number 960) has been closed since 1986.

Because of a federal regulation, only local residents could hunt during the first week of the 1991 and 1992 seasons in Subunit 5A. Two hundred thirty six permits were issued in 1991 and 238 were issued in 1992, compared to the five year mean of 221 (Table 3). Fifty two bull moose were taken in 1991 and 50 in 1992, eight and ten short of the quota, respectively.

Hunt 962 in Subunit 5B had 60 permits issued in 1991, close to the mean of 59 issued from 1988-1992 (Table 3); seventeen moose were killed. In 1992, 52 permits were issued, and only seven moose were taken. The quota for Hunt 962 was 25 bulls in both regulatory years.

Hunt 960, for the Nunatak Bench, has not been open since 1986.

Staff from the department's fisheries divisions and Department of Public Safety's Fish and Wildlife Protection staff continued to assist with permit issuance and monitoring of these permit hunts. A few permittees submitted harvest reports late in 1991 and 1992, partially because the area biologist is now located in Douglas.

Hunter Residency and Success. Table 4 presents data on hunter residency and success for all of Unit 5. Local residents hunt primarily in Subunit 5A on the Yakutat Forelands. Starting in 1987, local residents have been able to hunt for the first week of the season before it opened to non-local hunters. This first week traditionally accounts for a majority of the Subunit 5A harvest. In 1991, local hunters took 56% (29 of 52) of the total 5A kill during the first week of hunting. In 1992, hunt results were similar; 29 of 51 (57%) 5A moose were taken in the first week.

Nonlocal Alaskans hunting in Subunit 5A took 16 moose (31 %) in 1991 and 15 (30%) in 1992. Nonresidents took two moose in Subunit 5A in 1991 and three in 1992.
In Subunit 5B, residents took seven moose in 1991 (41% of total in subunit) and four in 1992 (57%). Nonlocal state residents killed eight moose in 1991 and three in 1992. Nonresidents took two moose in GMU 5B in 1991 and zero in 1992.

Harvest Chronology: The early season moose harvest in GMU 5 is relatively low, due in part to the fact that only Subunit 5B is open from September 1 through October 14 (Table 5). Most of the harvest comes during the first week of the Subunit 5A season, when road and river accessible moose habitats adjacent to Yakutat are first open. In 1991, 16 of 52 moose (31%) killed in Subunit 5A were taken on opening day, and 29 (56%) by the time the first week was over. In 1992, 13 moose were killed on opening day out of a total kill of 50 (26%); 29 moose (58%) were taken during the first week of the season. Although in both years the season continued for the entire time authorized, the quota was never attained. While hunting continues throughout the longer season on the Malaspina Forelands in Subunit 5B, the area is more difficult to access, and the season normally ends without the hunt quota being attained.

Transport Methods: Transport methods used during the report period were similar to recent years (Table 6). Aircraft access has been the most popular transportation during the last five years, ranging from 47 to 62%. Boat access is the second most important access means for Unit 5 hunters, averaging about one quarter of all successful hunters. Use of three- and four-wheelers for Unit 5 hunts is important and probably underrepresented in Table 5, as some hunters reporting other transport modes probably use 4-wheelers as well. Many unsuccessful hunters use these machines for access. Habitat impacts, wounding losses, animal harassment, and fair chase ethics are all concerns involving the use of three/four-wheelers. Virtually every fish camp has one or more of these machines present. 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 form of access. Rutted meadows from wheeled vehicles are now a common sight in Subunit 5A.

Other Mortality: Reports of natural mortality during the reporting period seemed similar to recent years. Anecdotal information and apparent increases in wolf populations might suggest that mortality from wolf predation has increased. However, there is no evidence that a higher percentage of moose are being taken by predators.

Habitat

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

CONCLUSIONS AND RECOMMENDATIONS

Complete fall sex and age composition counts should be done for all Unit 5 moose herds.
The department should continue to cooperate with the U.S. Forest Service in investigating various vegetation treatments for their effectiveness in stimulating browse production. Included should be treatment of willow and cottonwood stands near the coast close to Yakutat and evaluation of the spruce stand thinning near Harlequin Lake.

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Table 1A. Subunit 5A, Yakutat Forelands. Moose survey data, 1988-1992.

Year	No. bulls	No. cows	No. calves	Unknown sex/age	Total sample	MM/ 100 FF	Calves/ 100 FF	Percent calves	Count time	Moose/ hour
1988/89 F	91	339	85	0	515	27	25	17	10.1	51
1989/90 F	No survey									
1990/91 F	43	309	93	0	445	14	30	21	6.8	65
1991/92 F	No survey									
1992/93 W	--	--	37	159	196	--	--	19	5.9	33

F= fall count W = winter count

Table 1B. Subunit 5A, Nunatak Bench. Moose survey data, 1988-1992

Year	No. bulls	No. cows	No. calves	Unknown sex/age	Total sample	MM/ 100 FF	Calves/ 100FF	Percent calves	Count time	Moose/ hour
1988/89	No survey									
1989/90	No survey									
1990/91 W	2	8	4	0	14	25	50	29	0.25	56
1991/92	No survey									
1992/93	No survey									

F= fall count W = winter count

Table 1C. Subunit 5B, Malaspina Forelands. Moose survey data, 1986-1992

Year	No. bulls	No. cows	No. calves	Unk sex/ age	Total sample	MM/ 100 FF	Calves/ 100 FF	Percent calves	Count time	Moose/ hour
1986/87	No survey									
1987/88 W	--	--	14	55	69	--	--	20	2.8	25
1988/89	No survey									
1989/90	No survey									
1990/91	No survey									
1991/92	No survey									
1992/93	No survey									

Table 2. Unit 5. Annual harvest, 1988-1992.

Year	Reported Harvest	Estimated Total Harvest
1988		
Subunit 5A	47	47
5B	11	11
Total	59[a]	59
1989		
Subunit 5A	45	45
5B	12	12
Total	57	57
1990		
Subunit 5A	57	57
5B	14	14
Total	71	71
1991		
Subunit 5A	52	52
5B	17	17
Total	69	69
1992		
Subunit 5A	50	50
5B	7	7
Total	57	57

[a] one illegal kill

Table 3. Unit 5. Harvest data by permit hunt, 1988-1992.

Hunt no.	Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows
960 Nunatak Bench	1988-92	No open season					
961	1988	206	48	108	47	47	0
Yakutat	1989	213	40	128	45	45	0
Fore-	1990	213	28	122	57	57	0
lands	1991	236	45	139	52	52	0
	1992	238	39	149	50	50	0
962	1988	58	18	29	11	11	0
Malaspina	1989	65	21	32	12	12	0
Fore-	1990	60	24	21	14	14	0
lands	1991	60	15	22	17	17	0
	1992	52	27	18	7	7	0
GMU 5	1988	264	66	137	58	58	0
Totals	1989	278	61	160	57	57	0
All Hunts	1990	273	52	143	71	71	0
	1991	296	60	161	69	69	0
	1992	290	66	167	57	57	0

Table 4. Unit 5. Hunter residency and success, 1988-92.

	Successful				Unsuccessful			
Year	Local res.[a]	Nonlocal res.	Nonres.	Local Total	Nonlocal res.[a]	res.	Nonres.	Total
1988	44	12	2	58	90	45	2	137
1989	47	9	1	57	111	39	10	160
1990	49	19	3	71	99	38	5	142
1991	35	30	4	69	104	37	5	146
1992	36	18	3	57	106	52	9	167

[a] Local residents are those hunters living in Unit 5.

Table 5. Unit 5. Harvest chronology, 1988-92.

Year	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Nov. 1-15
1988	1	4	19	34	0
1989	2	7	13	35	0
1990	2	6	31	32	0
1991	2	3	23	33	8
1992	0	0	19	36	2

Table 6. Unit 5. Successful hunter transport methods, 1988-90.

Year	Airplane	Boat	3- or 4-wheeler	ORV	Highway vehicle
	N %	N %	N %	N %	N %
1988	29(50)	7 (12)	13(22)	0	9 (16)
1989	33(58)	18 (32)	2 (3)	0	4 (7)
1990	38(54)	14 (20)	7(10)	0	11 (16)
1991	43(62)	8 (12)	7(10)	1 (1)	10 (14)
1992	27(47)	10 (18)	9(16)	0	11 (19)

LOCATION

Game Management Unit	6 (10,140 mi^2)
Geographical Description	Prince William Sound and North Gulf Coast

BACKGROUND

Moose populations in most of Unit 6 originated from transplants. During 1949 through 1958, 24 calves were released on the western Copper River Delta in Subunit 6C (Burris and McKnight 1973). This small population rapidly expanded eastward, first occupying Subunit 6B and then advancing by the late-1960s into Bering River in Subunit 6A. Moose may also have reached Subunit 6A through dispersal westward from the Malaspina Glacier forelands in Subunit 5A. The introduced population may have reached a record high of approximately 1,600 in 1988 (Griese 1990). The only moose endemic to Unit 6 are small populations in Subunit 6D near Valdez and at the head of Kings Bay. These populations never expanded their ranges, and likely number about 40 animals today.

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

Harvest of the introduced population began with 25 bulls killed in 1960. Total reported take through regulatory year 1992/93 was 3,139. Total harvest of the endemic moose population in Subunit 6D during the same period was approximately 34 moose.

Population density objectives were relatively conservative in the 1970s and early 1980s in response to concerns about mortality during severe winters. The objectives were established at 0.9-1.2 moose/mi^2 after a severe winter in 1971-72 and remained conservative under management plans formulated in 1976. In 1987, density objectives were increased to 1.8-2.0 moose/mi^2. We are now considering additional revisions that incorporate new habitat information (MacCracken 1992) and use refined estimates of population size obtained during this reporting period.

MANAGEMENT DIRECTION

Management Objectives

Current Unit 6 moose management objetives are to maintain observed moose densities between 1.8 and 2.0 moose/mi^2 in the fall and maintain posthunting bull:cow ratos of 30:100.

Management objectives are being revised and will be reported during the next period.

METHODS

We conducted censuses to estimate moose distribution, density, total number and composition (Gasaway et al. 1986). A Cessna 185 aircraft was used for density stratifications. Piper Supercub (PA-18) and Bellanca Scout aircraft were used for intensive searches of sample units. Sex and age ratio estimates were obtained only from censuses conducted before mid-December because after that time significant numbers of bulls have shed antlers making results unreliable. U.S. Forest Service (USFS), Cordova Ranger District, assisted during all censuses by providing observers.

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

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

Hunters participating in drawing or registration permit hunts were required to report and were sent up to 2 reminder letters. Hunters participating in general moose hunts were sent one reminder letter if they failed to return their original hunt report.

All data were summarized by subunit, with the exception of Subunit 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 completed censuses during 1991/92 in Subunits 6B (22 January 1992) and 6C (17 December 1991). During 1992/93, censuses were done in Subunits 6A(East) (24 January 1993), 6A(West) (19 December 1992), 6B (15 December 1992), and 6C (12 December 1992). Among the 1992/93 censuses, a sightability correction factor was estimated only for Subunit 6A(West). In other subunits, sightability was assumed to be 95% because census conditions were excellent and because of high sightabilities experienced during the previous year. Also, moose density stratifications during 1992/93 in Subunits 6B and 6C were based upon prior knowledge of moose distribution (MacCracken 1992, T. Stephenson personal communication), rather than aerial observation.

Population Size: The Unit 6 moose population was approximately 1,400 during winter 1992/93. The largest concentration was 440 animals in eastern Subunit 6A (Table 1), and the smallest number was about 40 in Subunit 6D.

The population likely has declined over the past 5 years. In 1988/89, Griese (1990) estimated 1600 moose. Our estimate indicated a decline of approximately 200. Most of the reduction was in Subunit 6A, where harvest increased and recruitment declined. This decrease was desirable because moose numbers prior to 1991/92 were probably higher than could be supported by the winter food supply. Numbers in other subunits were stable.

Population Composition: Percent calves in the population was the only composition information consistently obtained. It varied from 8% to 24%, with the highest values in Subunit 6C and the lowest in 6A(East). As compared to previous years, calf survival appeared to decline in Subunits 6A and 6B and improve in Subunit 6C. Bull:cow ratios were obtained only during 1992/93 in Subunits 6A(West), 6B and 6C. They were 22:100, 18:100, and 24:100, respectively, in each subunit. These values underestimated the number of bulls in the population because classifications were done after antler shedding began.

Distribution: Density stratification flights during censuses revealed concentrations of 4.9 moose/mi^2 in Subunit 6A(East) within 6 miles of the Gulf of Alaska shoreline between the Seal and Kaliakh Rivers (Figure 1). In Subunit 6A(West), concentrations of 4.2 moose/mi^2 were found near Controller Bay and in the upper Bering River (Figure 2). Important areas in Subunit 6B with densities of 4.3 moose/mi^2, were along the Gulf of Alaska shoreline in the southeast corner of the Subunit and in the Martin River Valley (Figure 3). In Subunit 6C, concentrations of 3.9 moose/mi^2 were found between the Cordova Airport and Alaganik Slough (Figure 4). Locations of moose concentrations in Subunits 6B and 6C generally coincided with primary and secondary winter ranges delineated by MacCracken (1992).

Mortality

Harvest:

Season and Bag Limit. The season in Subunit 6A for resident and nonresident hunters was 20 August to 31 December, with a bag limit of 1 moose. Harvests in Subunits 6B and 6C were regulated by permit hunts. The season in both subunits was open for resident hunters only and was 1-30 September, with a bag limit of 1 moose. In Subunit 6B, take of up to 30 antlered moose was authorized by registration permit, and harvest of up to 30 antlerless moose was authorized by drawing permit. In Subunit 6C, issuance of up to 40 drawing permits, 20 for antlered and 20 for antlerless moose, was authorized. The season in Subunit 6D for resident and nonresident hunters was 1-30 September, and the bag limit was 1 bull.

Game Board Actions and Emergency Orders: The Board of Game took no actions in Unit 6 during this reporting period.

Emergency orders were issued in 1991 (19 September) and 1992 (3 September) to close the registration permit hunt for antlered moose in Subunit 6B. The purpose was to limit harvest to the 30 animals authorized in regulation. These were normal management actions for this hunt.

Hunter Harvest: Reported moose harvest for Unit 6 was 200 in 1991/92 and 209 in 1992/93 (Table 2). These were the highest harvests in 5 years. All of the increase was in Subunit 6A, where take was encouraged by the long either-sex season and by information provided to hunters about abundance of large-antlered bulls. Harvest was stable in the other subunits.

Composition of the kill was 65% males and 35% females during both 1991/92 and 1992/93. This was similar to previous years.

Harvest in permit hunts was as expected and administration presented no unusual problems, with the exception of the registration hunt for antlered moose in Subunit 6B. Kill objectives were met in that hunt during the past 2 years, and the season in 1992/93 was only 3 days long because increasing use of airboats for transportation improved hunter efficiency. In 1991/92 the Subunit 6B harvest objective of 30 moose was exceeded by 5. Hunters were able to take 7 moose during the 48 hour notification period between the time the emergency order closing the season was issued and when it became effective. In 1992/93, the harvest objective of 20 moose was exceeded by 8. The notification period was shortened to 12 hours, and hunters took 9 moose during that time.

The short antlered season during 1992/93 in Subunit 6B prompted numerous complaints about lack of opportunity to hunt from people who had only highway vehicles for transportation. To address those complaints, the Cordova Fish and Game Advisory Committee held a meeting of hunters who use all types of transportation. The group agreed the best solution was opening the season on 27 August and restricting transportation to highway vehicles on the maintained surface of the Copper River Highway during the first 5 days of the hunt. They also agreed that the drawing permit hunt for antlerless moose in 6B should have the same season and transportation restriction to avoid enforcement problems.

Hunter Residency and Success. Local residents were 68% and 67%, respectively, of all hunters in Unit 6 who reported residency during 1991/92 and 1992/93 (Table 4). Alaska residents from other parts of the state were 20% of total hunters during each year, while nonresidents were 12% and 13% of the total, respectively. Hunter Success during 1991/92 and 1992/93 was 44% and 55%, respectively. These proportions were similar to previous years.

Harvest Chronology. Most of the Unit 6 harvest during the past 2 years occurred during September (Table 5). During 1991/92, 62% of the moose were taken during this period, and 77% were harvested during this time in 1992/93. Opportunity to hunt was limited to September in all subunits except 6A, where the extended season allowed harvest from 20 August-31 December. The harvest pattern has not changed over the past 5 years.

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

CONCLUSIONS AND RECOMMENDATIONS

Moose numbers in Subunits 6B, 6C and 6D were stable. In Subunit 6A, management actions were taken to reduce numbers and prevent overuse of winter forage. The desired herd size was reached in 6A West, and stabilization would require reducing the harvest by 50%-60%. The season should be changed to 1 September to 5 October, with harvest of antlered moose by registration permit and harvest of antlerless moose by drawing permit. Take of up to 30 antlered and 30 antlerless animals should be authorized. In 6A East, an additional reduction in number is recommended, and, therefore, no change in the current season is recommended.

Additional opportunity for hunters using highway vehicles should be provided in Subunit 6B. I recommend the opening dates for both the antlered and antlerless permit hunts be changed from 1 September to 27 August, and transportation restricted to highway vehicles operated on the maintained surface of the Copper River Highway for the first 5 days of each season. Only 1-3 additional moose will probably be taken as a result of this change because of low moose density near the road and because travel on foot is extremely difficult.

Revision of population objectives for Unit 6 will be completed using refined population estimates obtained during the this reporting period and using results of habitat studies recently completed by USFS (MacCracken 1992). Public participation in this effort will be solicited by requesting comment from the Cordova and Valdez Fish and Game Advisory Committees and by conducting at least one workshop open to the public.

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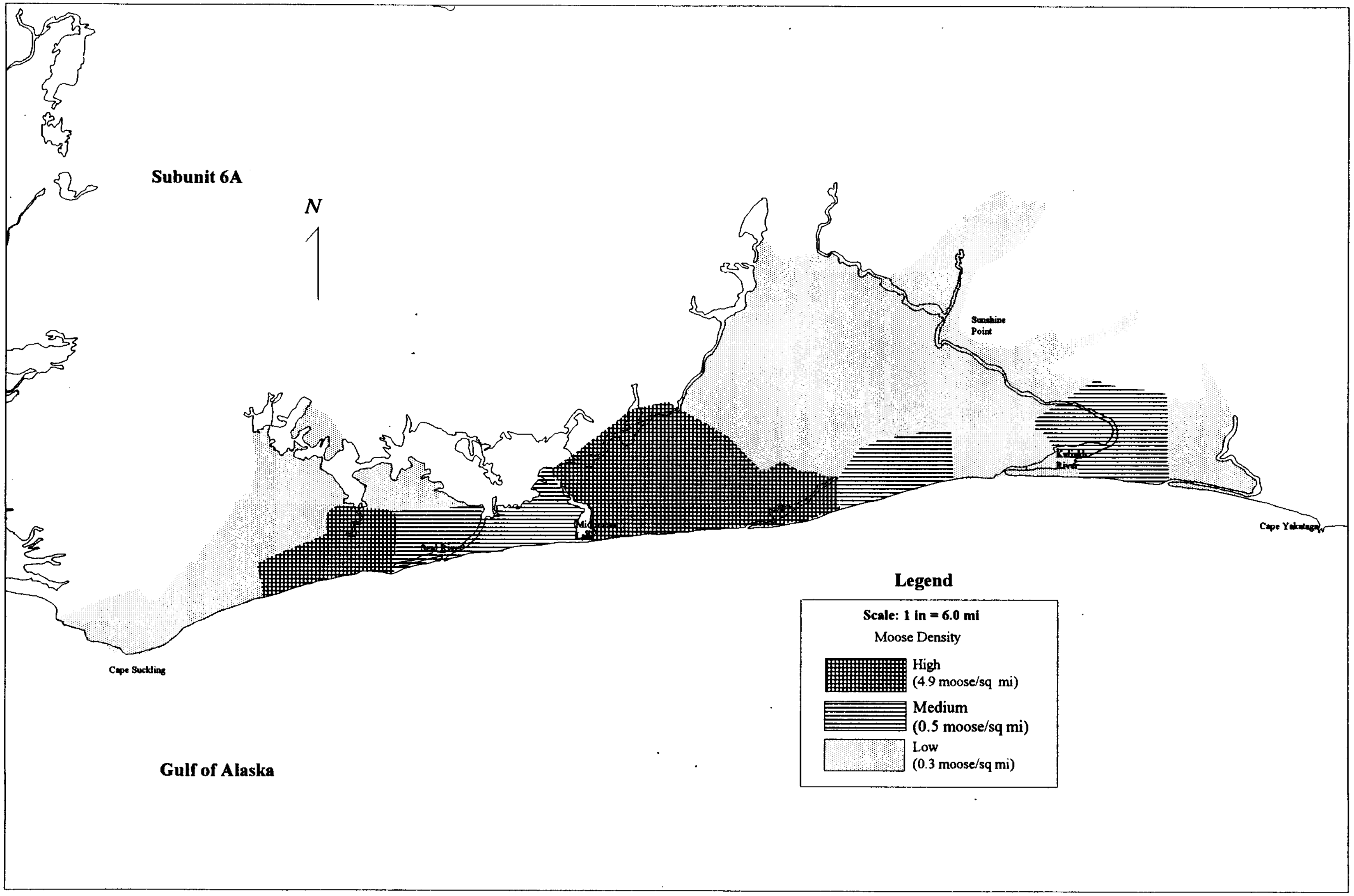

Figure 1. Subunit 6A(East) moose distribution, 24 January 1993.

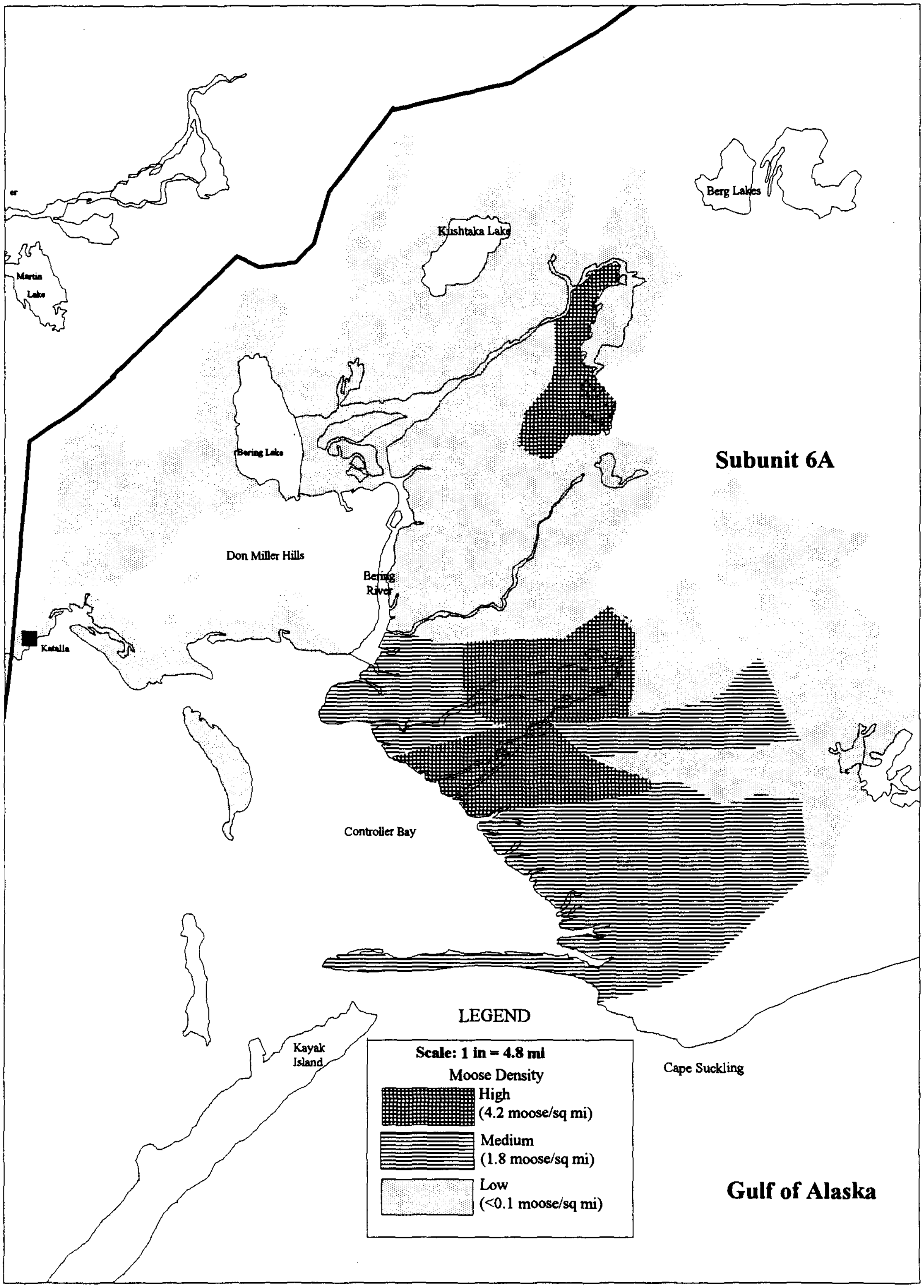

Figure 2. Subunit 6A (West) moose distribution, 19 December 1993.

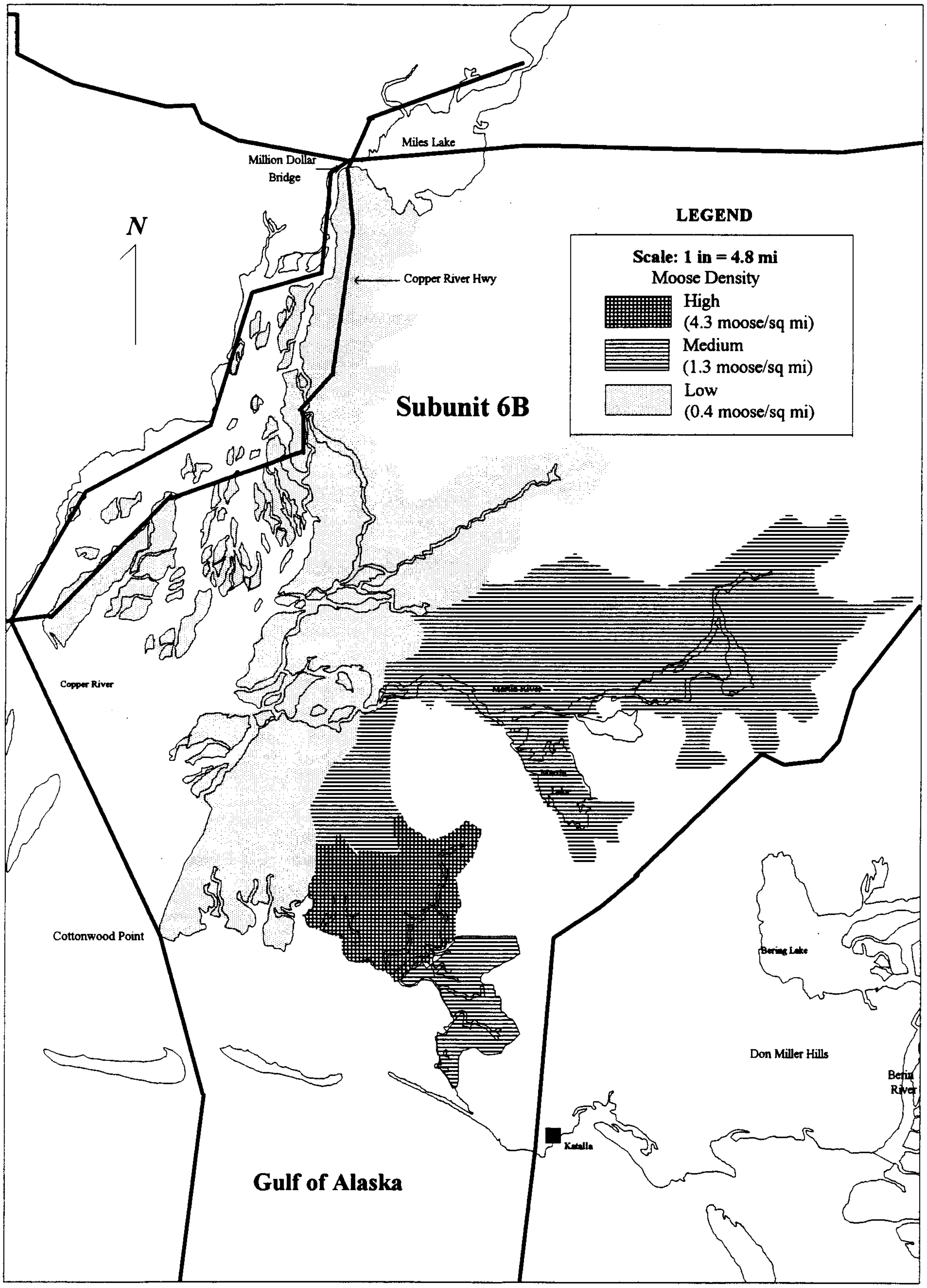

Figure 3. Subunit 6B moose distribution, 22 January 1992.

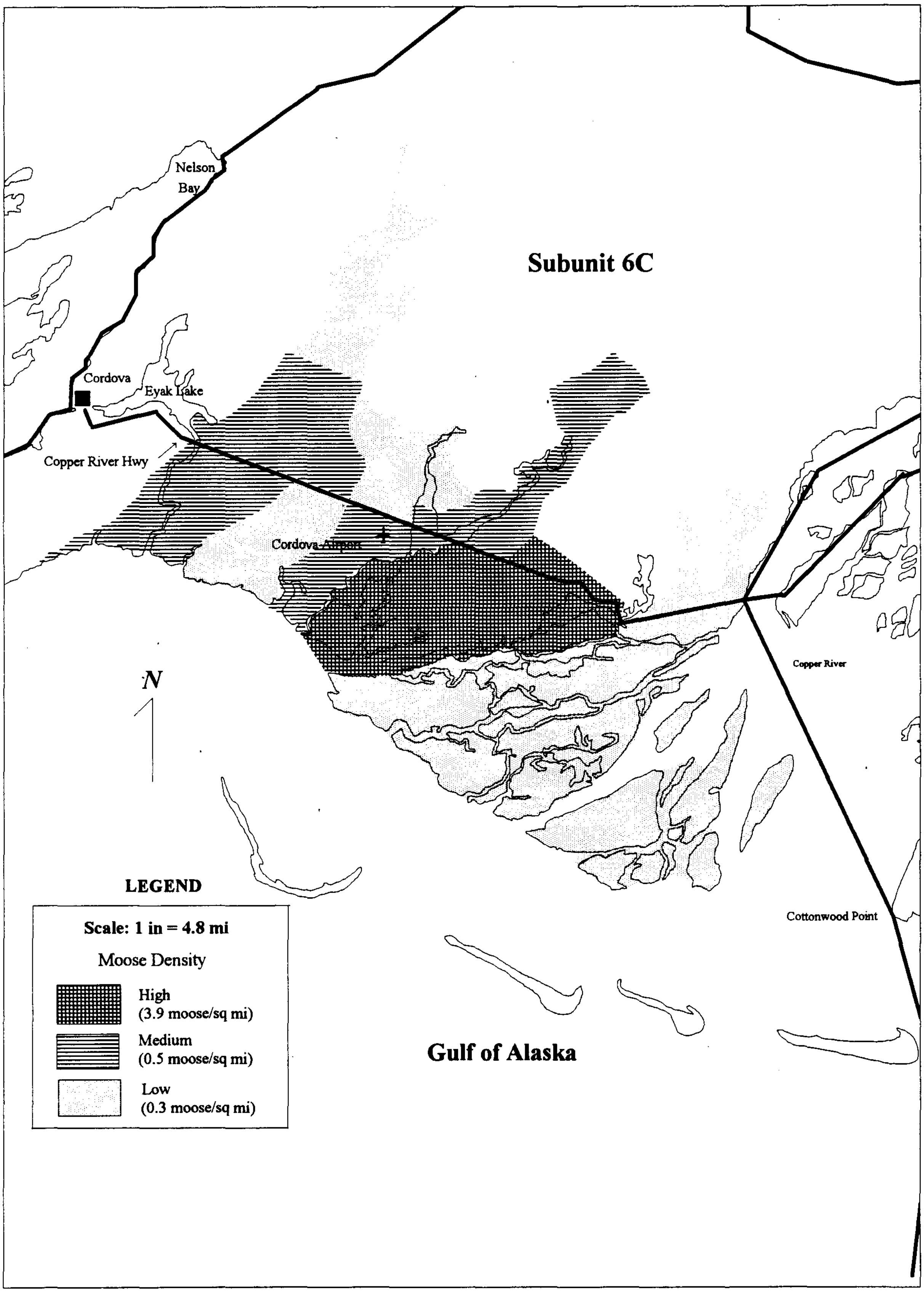

Figure 4. Subunit 6C moose distribution, 17 December 1991.

Table 1. Unit 6 fall/winter moose counts and estimated population size, 1988-93

Subunit	Regulatory year	Count type	Bulls: 100 Cows	Calves (%)	Adults	Total moose observed	Estimated population size
6A East	1988/89	Survey	-	20	294	369	490
	1989/90	None	-	-	-	-	-
	1990/91	None	-	-	-	-	-
	1991/92	None	-	-	-	-	-
	1992/93	Census	-	8	346	378	440
6A West	1988/89	Survey	36	22	293	375	460
	1989/90	None	-	-	-	-	-
	1990/91	Survey	-	17	236	286	370
	1991/92	None	-	-	-	-	-
	1992/93	Census	22	12	240	273	294[a]
6B	1988/89	Survey	-	23	229	296	330
	1989/90	Survey	-	13	245	282	330
	1990/91	Survey	31	18	249	304	350
	1991/92	Census	-	12	197	224	311[b]
	1992/93	Census	18	14	174	203	340
6C	1988/89	Survey	24	20	184	231	330
	1989/90	Survey	-	12	226	258	330
	1990/91	Survey	28	15	156	183	350
	1991/92	Census	-	21	158	199	233[c]
	1992/93	Census	24	24	156	204	310

[a] 90% CI 255-334.
[b] 90% CI 279-343.
[c] 90% CI 206-260.

Table 2. Unit 6 moose harvest and accidental death, 1988-93.

Subunit	Regulatory year	Hunter harvest: Reported M (%)	F (%)	Total[a]	Estimated Unreported	Illegal	Total	Accidental death	Total
6A East	1988/89	18 (69)	8 (31)	26	10	4	14	0	40
	1989/90	18 (82)	4 (18)	22	5	3	8	0	30
	1990/91	21 (84)	4 (16)	25	5	2	7	0	32
	1991/92	25 (76)	8 (24)	33	6	1	7	0	40
	1992/93	35 (69)	16 (31)	52	4	2	6	0	58
6A West	1988/89	20 (50)	20 (50)	40	3	1	4	0	44
	1989/90	19 (90)	2 (10)	21	2	1	3	0	24
	1990/91	36 (67)	18 (33)	55	4	2	6	0	61
	1991/92	51 (59)	36 (41)	89	5	3	8	0	97
	1992/93	50 (61)	32 (39)	82	4	1	5	0	87
6A Total	1988/89	38 (58)	28 (42)	66	13	5	18	0	84
	1989/90	37 (86)	6 (14)	43	7	4	11	0	54
	1990/91	57 (72)	22 (28)	80	9	4	13	0	93
	1991/92	76 (63)	44 (37)	122	11	4	15	0	137
	1992/93	85 (64)	48 (36)	134	8	3	11	0	145
6B	1988/89	22 (73)	8 (27)	30	0	1	1	0	31
	1989/90	31 (76)	10 (24)	41	0	1	1	0	42
	1990/91	30 (64)	17 (36)	47	0	1	1	0	48
	1991/92	36 (75)	12 (25)	48	0	2	2	0	50
	1992/93	29 (71)	12 (29)	41	0	1	1	0	42
6C	1988/89	9 (100)	0 (0)	9	0	2	2	2	13
	1989/90	16 (50)	16 (50)	32	0	1	1	1	34
	1990/91	18 (58)	13 (42)	31	0	2	2	0	33
	1991/92	15 (54)	13 (46)	28	1	4	5	0	33
	1992/93	19 (59)	13 (41)	32	1	3	4	1	37

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

Table 2. (Cont'd.)

Subunit	Regulatory year	Hunter Harvest: Reported M (%)	F (%)	Total[a]	Estimated: Unreported	Illegal	Total	Accidental death	Total
6D	1988/89	3 (100)	0 (0)	3	1	1	2	0	5
	1989/90	2 (100)	0 (0)	2	0	0	0	0	2
	1990/91	0 (0)	0 (0)	0	0	0	0	0	0
	1991/92	1 (100)	0 (0)	1	0	0	0	0	1
	1992/93	2 (100)	0 (0)	2	0	0	0	0	2
Unit 6 Total	1988/89	72 (67)	36 (33)	108	14	9	23	2	133
	1989/90	86 (73)	32 (27)	118	7	6	13	1	132
	1990/91	105 (67)	52 (33)	158	9	7	16	0	174
	1991/92	128 (65)	70 (35)	200	12	10	22	0	222
	1992/93	135 (65)	73 (35)	209	9	7	16	1	226

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

Table 3. Unit 6 moose harvest data by permit hunt, 1988-93.

Subunit/ hunt no.	Regulatory year	Legal moose	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Total harvest
6B/R964[a]	1988/89	Antlered	163	37	78	21	21 (100)	0 (0)	21
	1989/90	Antlered	211	27	77	20	31 (100)	0 (0)	31
	1990/91	Bull	179	25	78	22	30 (100)	0 (0)	30
	1991/92	Antlered	245	24	80	19	35 (100)	0 (0)	35
	1992/93	Antlered	186	40	75	25	28 (100)	0 (0)	28
6B/D966[b]	1988/89	Antlered	10	0	10	90	1 (11)	8 (89)	9
	1989/90	Antlered	30	7	61	36	0 (0)	10 (100)	10
	1990/91	Antlered	30	3	41	59	0 (0)	17 (100)	17
	1991/92	Antlered	30	17	48	52	1 (8)	12 (92)	13
	1992/93	Antlered	20	15	24	76	1 (8)	12 (92)	13
6C/D967	1988/89	Bull	10	10	0	100	9 (100)	0 (0)	9
	1989/90	Antlered	20	10	11	89	16 (100)	0 (0)	16
	1990/91	Antlered	20	10	0	100	18 (100)	0 (0)	18
	1991/92	Antlered	20	5	21	79	15 (100)	0 (0)	15
	1992/93	Antlered	20	0	5	95	19 (100)	0 (0)	19
6C/D968	1988/89	Cow	0	-	-	-	- (-)	- (-)	-
	1989/90	Antlerless	20	10	0	89	0 (0)	16 (100)	16
	1990/91	Antlerless	20	10	28	72	0 (0)	13 (100)	13
	1991/92	Antlerless	20	10	28	72	0 (0)	13 (100)	13
	1992/93	Antlerless	15	0	13	87	0 (0)	13 (100)	13

[a] R=Registration permit hunt.
[b] D=Drawing permit hunt.

Table 4. Unit 6 moose hunter residency and success, 1988-93.

		Successful				Unsuccessful				
Subunit	Regulatory year	Local resident[a]	Nonlocal resident	Non-resident	Total (%)[b]	Local resident	Nonlocal resident	Non-resident	Total (%)	Total hunters
6A East	1988/89	4	8	13	26 (47)	4	13	12	29 (53)	55
	1989/90	1	8	3	22 (59)	1	10	4	15 (41)	37
	1990/91	1	5	19	25 (61)	3	11	2	16 (39)	41
	1991/92	3	10	20	33 (56)	3	14	9	26 (44)	59
	1992/93	7	18	27	52 (69)	5	10	8	23 (31)	75
6A West	1988/89	27	6	7	40 (61)	12	9	5	26 (39)	66
	1989/90	6	0	11	21 (66)	5	5	1	11 (34)	32
	1990/91	31	11	13	55 (65)	13	10	7	30 (35)	85
	1991/92	54	16	16	89 (68)	17	17	6	41 (32)	130
	1992/93	64	12	6	82 (65)	22	15	7	45 (35)	127
6A Total	1988/89	31	14	20	66 (55)	16	22	17	55 (45)	121
	1989/90	7	8	14	43 (62)	6	15	5	26 (38)	69
	1990/91	32	16	32	80 (63)	16	21	9	46 (37)	126
	1991/92	57	26	36	122 (65)	20	31	15	67 (35)	189
	1992/93	71	30	33	134 (66)	27	25	15	68 (34)	202
6B	1988/89	28	2	-[c]	30 (27)	74	7	-[c]	81 (73)	111
	1989/90	39	2	-[c]	41 (23)	123	14	-[c]	137 (77)	178
	1990/91	42	5	-[c]	47 (29)	102	15	-[c]	117 (71)	164
	1991/92	43	5	-[c]	48 (23)	144	17	-[c]	161 (77)	209
	1992/93	38	3	-[c]	41 (32)	78	10	-[c]	88 (68)	129

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

Table 4. (Cont'd.)

Subunit	Regulatory year	Successful: Local resident[a]	Successful: Nonlocal resident	Successful: Non-resident	Successful: Total (%)[b]	Unsuccessful: Local resident	Unsuccessful: Nonlocal resident	Unsuccessful: Non-resident	Unsuccessful: Total (%)	Total hunters
6C	1988/89	8	1	-[c]	9 (100)	0	0	-[c]	0 (0)	9
	1989/90	29	3	-[c]	32 (94)	2	0	-[c]	2 (6)	34
	1990/91	30	1	-[c]	31 (86)	4	1	-[c]	5 (14)	36
	1991/92	28	0	-[c]	28 (76)	8	1	-[c]	9 (24)	37
	1992/93	28	4	-[c]	32 (91)	2	1	-[c]	3 (9)	35
6D	1988/89	3	0	0	3 (8)	10	6	1	34 (92)	37
	1989/90	1	1	0	2 (6)	9	6	1	32 (94)	34
	1990/91	0	0	0	0 (0)	7	1	0	16 (100)	16
	1991/92	0	1	0	1 (5)	9	8	1	18 (95)	19
	1992/93	2	0	0	2 (17)	8	2	0	10 (83)	12
Unit 6 Total	1988/89	70	17	20	108 (39)	101	36	18	172 (61)	280
	1989/90	76	14	14	118 (37)	140	35	6	197 (63)	315
	1990/91	104	22	32	158 (46)	129	38	11	186 (54)	344
	1991/92	128	32	37	200 (44)	181	59	16	257 (56)	457
	1992/93	139	37	33	209 (55)	115	38	15	169 (45)	378

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

Table 5. Unit 6 moose harvest percent by time period, 1988-93.

Subunit	Regulatory year	Harvest periods 8/20-8/31	9/1-9/15	9/16-9/30	10/1-10/15	10/16-10/31	11/1-11/30	12/1-12-31	n
6A East	1988/89	12	16	0	4	48	12	8	25
	1989/90	0	19	38	10	14	19	0	21
	1990/91	0	16	40	16	20	8	0	25
	1991/92	13	13	28	19	13	13	3	32
	1992/93	0	23	25	23	21	2	6	52
6A West	1988/89	0	3	78	14	0	5	0	37
	1989/90	0	43	24	29	5	0	0	21
	1990/91	0	33	29	25	6	4	4	52
	1991/92	13	13	24	34	8	5	3	87
	1992/93	4	10	64	10	5	3	4	77
6A Total	1988/89	5	8	47	10	19	8	3	62
	1989/90	0	31	31	19	10	10	0	42
	1990/91	0	27	32	22	10	5	3	77
	1991/92	13	13	25	30	9	7	3	119
	1992/93	2	16	48	16	12	2	5	129
6B	1988/89	0	80	20	0	0	0	0	30
	1989/90	0	98	2	0	0	0	0	41
	1990/91	0	77	23	0	0	0	0	47
	1991/92	0	66	34	0	0	0	0	47
	1992/93	0	80	20	0	0	0	0	41
6C	1988/89	0	67	33	0	0	0	0	9
	1989/90	0	63	38	0	0	0	0	32
	1990/91	0	52	48	0	0	0	0	31
	1991/92	0	43	57	0	0	0	0	28
	1992/93	0	69	31	0	0	0	0	32

Table 5. (Cont'd.)

Subunit	Regulatory year	Harvest periods 8/20-8/31	9/1-9/15	9/16-9/30	10/1-10/15	10/16-10/31	11/1-11/30	12/1-12-31	n
6D	1988/89	0	33	67	0	0	0	0	3
	1989/90	0	0	100	0	0	0	0	2
	1990/91	0	0	0	0	0	0	0	0
	1991/92	0	0	100	0	0	0	0	1
	1992/93	0	50	50	0	0	0	0	2
Unit 6 Total	1988/89	3	35	38	6	12	5	2	104
	1989/90	0	62	24	7	3	3	0	117
	1990/91	0	47	33	11	5	3	1	155
	1991/92	8	30	32	18	6	4	2	195
	1992/93	1	37	40	10	7	1	3	204

Table 6. Unit 6 moose harvest percent by transport method, 1988-93.

Subunit	Regulatory year	Airplane	Boat	3- or 4-wheeler	ORV	Highway vehicle	n
6A East	1988/89	79	8	8	0	4	24
	1989/90	72	11	17	0	0	18
	1990/91	92	0	8	0	0	24
	1991/92	64	18	18	0	0	28
	1992/93	78	8	12	0	2	51
6A West	1988/89	58	31	12	0	0	26
	1989/90	62	29	0	10	0	21
	1990/91	55	45	0	0	0	53
	1991/92	53	47	0	0	0	88
	1992/93	32	67	0	1	0	81
6A Total	1988/89	68	20	10	0	2	50
	1989/90	67	21	8	5	0	39
	1990/91	66	31	3	0	0	77
	1991/92	56	40	4	0	0	116
	1992/93	50	44	5	1	1	132
6B	1988/89	3	80	0	0	17	30
	1989/90	10	76	0	0	15	41
	1990/91	11	76	0	0	13	45
	1991/92	11	74	0	0	15	47
	1992/93	20	70	0	8	3	40
6C	1988/89	0	44	0	0	56	9
	1989/90	0	53	0	0	47	32
	1990/91	0	39	0	3	58	31
	1991/92	0	38	4	0	58	26
	1992/93	0	28	0	0	72	32

Table 6. (Cont'd.)

Subunit	Regulatory year	Airplane	Boat	3- or 4-wheeler	ORV	Highway vehicle	n
6D	1988/89	33	33	0	0	33	3
	1989/90	50	0	50	0	0	2
	1990/91	0	0	0	0	0	0
	1991/92	0	100	0	0	0	1
	1992/93	0	0	0	0	100	2
Unit 6 Total	1988/89	39	42	5	0	13	92
	1989/90	27	49	4	2	18	114
	1990/91	37	46	1	1	16	153
	1991/92	37	48	3	0	12	190
	1992/93	36	46	3	2	13	206

LOCATION

Game Management Unit 7 (3,520 mi^2)

Geographical Description Eastern Kenai Peninsula

BACKGROUND

The Unit 7 moose population irrupted most recently during the 1960s after wildfires in adjacent Subunit 15A created large areas of early seral vegetation. Wolf numbers were simultaneously reduced to low levels. A rapid population decline followed in the early 1970s after 3 severe winters in 4 years. The population has fluctuated at low levels since then as predator densities increased and habitat quality deteriorated. Since 1980, bark beetles have infested in many old-growth spruce stands in Unit 7. In 1993, an aerial survey showed 26,000 acres of land were infested with spruce bark beetles and much of the mature overstory had died (Jim Peterson ADNR pers. comm.). Logging has been initiated in response to the bark beetle damage. Reduction of old-growth forests may be beneficial to the moose population by enhancing nutritional quality and availability of winter food plants.

MANAGEMENT DIRECTION

Management Objective

The management objective for Unit 7 is to maintain a healthy population of moose with a minimum bull to cow ratio of 15:100.

METHODS

Aerial sex and age composition surveys were conducted in November and December of both years in selected trend count areas. Annual moose harvest data were collected through the statewide harvest reporting system and reported through the Wildlife Information Data Base (WIDB) software.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Terrain features and extensive mature spruce forest prevented application of the moose census technique described by Gasaway et al. (1986). Results from aerial surveys and harvest reports suggests that the moose population has remained stable since the mid 1980s. The 1991-92 winter was considered moderately severe in most of the region. Documented winter mortality was predominantly calves-of-the-year. The 1992-93 winter was considered normal with very little winter mortality. We believe the moose population has remained stable at approximately 1,000 animals.

Population Composition:

Two of 32 count areas, excluding Portage and Placer River drainages, were surveyed during 1991 fall sex and age composition surveys. One hundred fifteen moose were classified with ratios of 26 calves:100 cows and 27 bulls:100 cows. Five count areas were surveyed in 1992, resulting in 18 calves:100 cows and 34 bulls:100 cows. Yearling bulls:100 cows dropped from 18 in 1991 to 7 in 1992 reflecting the severity of the previous winter even though there were 17% calves in 1991. There were only 12% calves in 1992 following the moderately severe winter (Table 1).

Mortality

Harvest:

Season and Bag Limit. A moose hunting season occurred in the Placer River drainage, and that portion of Placer Creek drainage (Bear Valley) outside the Portage Glacier Closed Area and that portion of Unit 14C within the 20-Mile River drainage. The bag limit was 1 moose by drawing permit only with up to 40 permits for antlered moose and up to 60 permits for antlerless moose. The season was 20 August to 30 September for hunt 910 (Bulls only) and 20 August to 10 October for hunt 911 (antlerless). The remainder of Unit 7 moose season was from 1-20 September for 1 bull with spike-fork or 50-inch antlers.

Game Board Action and Emergency Orders. During the fall 1991 Board of Game Meeting the Board amended and renamed the Exit Glacier Closed Area to conform with the Kenai Fjords National Park boundary. The area is now called the Seward Closed Area.

Hunter Harvest. In 1991, 60 moose were harvested by 476 hunters during the general season (Table 2). Twenty-seven (45%) hunters reported taking spike/fork bulls (less than 35 in) compared to 26 (43%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Seven reports (12%) indicated either unknown size or illegal classification.

In 1992, 54 moose were harvested by 433 hunters during the general season (Table 2). Twenty-one (39%) hunters reported taking spike/fork bulls (less than 35 in) compared to 31 (57%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Two reports (4%) indicated either unknown size or illegal classification. Successful hunters averaged 5.1 and 5.0 days hunting in 1991 and 1992, respectively.

Permit Hunts. Permit hunt results for Unit 7 (hunts 910 and 911) were included in the management report for Subunit 14C.

Hunter Residency and Success. Hunter success in 1991 was 12.6%. Twenty-four (40%) successful hunters were unit residents, 32 (53%) were nonunit residents and 4 (7%) were nonresidents (Table 3). Residency reported for unsuccessful hunters was: unit residents 186, nonunit residents 222, nonresidents 5, and unspecified residency 3.

Hunter success in 1992 was 12.5%. Twenty-four (40%) successful hunters were unit residents, 26 (53%) were nonunit residents and 4 (7%) were nonresidents (Table 3). Residency reported for unsuccessful hunters was: unit residents 166, nonunit residents 205, nonresidents 6, and unspecified residency 2.

Harvest Chronology. The 1-20 September season has been in place since 1987 in the general hunt portion of Unit 7. Reported chronology of harvest suggests the highest percentage of hunting occurred during the first 5 days of the season in all years except 1992 when the highest percentage occurred in the last week of the season (Table 4).

Transport Methods. In 1991, 48% of successful hunters reported highway vehicles as their means of transportation (Table 5). The second commonly used transportation means for successful hunters was horses (21%). Hunters using aircraft, ATVs, or boats accounted for 13%, 7%, or 7%, respectively, of the reported harvest.

In 1992, 51% of successful hunters reported highway vehicles as their means of transportation (Table 5). The second commonly used transportation means for successful hunters was aircraft (16%). Hunters using horses, boats, or ATVs accounted for 13%, 13%, or 4%, respectively, of the reported harvest by transportation means.

Other Mortality:

In addition to reported harvest, a minimum of 36 moose were killed in Unit 7 by trains (7) or motor vehicles (29) during the 1991-92 winter. There were no reported train kills for the 1992-93 winter. At least 31 moose were killed in Unit 7 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.

Impact of predation by wolves and bears is unknown. The unit supports an estimated 50 wolves or ratio of 1 wolf per 20 moose. At this ratio, impact of wolf predation alone should prevent the moose population from increasing. Black bears are abundant throughout the unit and brown bears are common in all drainages supporting salmon which exert additional pressure on Unit 7 moose.

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 regrowth. However, if site preparation is not adequate, grass (*Calamagrostis spp.*) will compete with spruce and hardwood seedlings.

CONCLUSIONS AND RECOMMENDATIONS

Winter conditions in Unit 7 during 1991-92 were moderately severe and many calves were lost regionwide. Calf production in 1992 appeared lower than normal due to the nutritional stresses on adult cows during winter. The 1992-93 winter was considered normal with little documented mortality. Human-caused moose mortality, including road or train kills and harvest, represented 9-10% of the estimated moose population of 1,000.

The harvest of moose under spike-fork/50-inch regulations appeared to fluctuate in response to the 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. A thorough review of the selective harvest system was reported by Schwartz et al. (1992).

The bull to cow ratio exceeded the management objective during all 5 years since the selective harvest program was initiated. Under the current selective harvest system a longer season may be warranted. However, to avoid shifts in hunting pressure, Unit 7 season length or bag limit should not be altered until similar changes are recommended for Unit 15.

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Table 1. Unit 7 fall aerial moose composition counts and estimated population size, 1988-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1988/89	46	14	42	22	376	484	65	1,000
1989/90	39	13	28	17	191	299	31	1,000
1990/91	39	13	22	14	305	355	35	1,000
1991/92	27	18	26	17	94	115	43	1,000
1992/93	34	7	18	12	218	248	24	1,000

Table 2. Unit 7 moose harvest[a] and accidental death, 1988-92.

Regulatory year	Hunter Harvest							Accidental death			
	Reported				Estimated						
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1988/89	49	0	1	50[b]			20	7	--	7	77
1989/90	59	0	0	59			20	11	--	11	90
1990/91	69	0	0	69			20	8	7	15	104
1991/92	60	0	0	60[b]			20	29	7	36[c]	116
1992/93	54	0	0	54[b]			20	31	0	31[c]	105

[a] Excludes permit hunt harvest.
[b] Total includes unreported sex.
[c] Prior to 1991, accidental deaths were estimated.

Table 3. Unit 7 moose hunter[a] residency and success, 1988-92.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total[c] (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	
1988/89	17	25	7	50	139	106	7	258	308
1989/90	18	32	8	59	135	126	6	270	329
1990/91	23	40	6	69	175	194	8	385	454
1991/92	24	32	4	60	186	222	5	416	476
1992/93	24	26	4	54	166	205	6	379	433

[a] Excludes hunters in permit hunts.
[b] Local means resident of Unit 7.
[c] Total includes unreported sex.

Table 4. Unit 7 moose harvest[a] chronology percent by time period, 1988-92.

Regulatory year	Harvest periods					n
	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	
1988/89	42	12	24	20	2	50
1989/90	39	12	15	29	5	59
1990/91	33	13	29	19	6	69
1991/92	40	12	22	25	2	60
1992/93	26	11	26	30	7	54

[a] Excludes permit hunt harvest.

Table 5. Unit 7 moose harvest[a] percent by transport method, 1988-1992.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1988/89	22	16	18	0	0	2	38	4	50
1989/90	15	24	19	2	0	2	37	2	59
1990/91	19	23	9	4	0	0	41	4	69
1991/92	13	21	7	5	0	2	48	5	61
1992/93	16	13	13	4	0	0	51	4	55

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit 9 ($33,600 \text{ mi}^2$)

Geographical Description Alaska Peninsula

BACKGROUND

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

MANAGEMENT DIRECTION

Management Objectives

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

METHODS

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

RESULTS AND DISCUSSION

Population Status and Trend

Results of fall sex and age composition surveys in Subunits 9B, 9C, and the central portion of 9E suggested populations in most of Unit 9 have stabilized or declined at a much slower rate than had occurred earlier (i.e., 20 years ago). Very low moose densities and unreliable snow conditions in Subunit 9A precluded efficient surveys for monitoring trends in population size or composition. Although recent surveys have not been specifically directed toward moose in Subunit 9D, incidental observations south of Port Moller did not show noticeable expansion of moose into that area.

Population Size:

A 1983 census in the central portion of Subunit 9E resulted in an estimate of 1,148 moose (90% C.I. = $\pm$16%) in the 1,314-mi^2 study area. Extrapolation of this census to the remainder of Subunit 9E provided an estimate of approximately 2,500 moose. The diferences in the number of moose counted and to some extent differences in ratios reflect which of the 3 trend areas were surveyed. Survey data from Subunit 9C and the limited data from other subunits show that bull:cow ratios have stabilized at acceptable levels. Calf:cow ratios remained low.

Mortality

Harvest:

Seasons and Bag Limit. During 1991 in Subunit 9A, resident hunters could hunt from 1-15 September, and the season for nonresidents was 5-15 September. The bag limit was 1 bull for all hunters. In Subunit 9B nonresidents could hunt from 5-15 September and the bag limit was 1 bull with 50-inch antlers, and resident hunters could hunt from 1-15 September and 1-31 December, with a bag limit of 1 bull. The season dates and bag limits in Subunit 9C were the same as for Subunit 9B, except that resident hunters could take any moose during December, however within the Naknek drainage a registraton permit was required. There was not an open season in Subunit 9D. The season for resident hunters in Subunit 9E was 10-20 September and 1-31 December; the season for resident and nonresident hunters was 10-20 September. The bag limit in Subunit 9E was 1 bull; however, moose taken from 10-20 September must have an antler spread of at least 50 inches or at least 3 brow tines on at least 1 antler.

The Unit 9 federal subsistence seasons and bag limits were the same as the state's regulations for residents except for the September portion of the Subunit 9E season which ran from 1-15 September with a bag limit of 1 bull.

The 1992 state regulations were the same as in 1991, except within the Naknek drainage portion of Subunit 9C where the December registration permit requirement was dropped and the bag limit was 1 bull. The 1992 federal subsistence regulations in Subunits 9A, 9B, and the portion of Subunit 9C outside the Naknek drainage were the same as the state's resident seasons and bag limits. Within that portion of Subunit 9C draining into the Naknek River from the north, qualified subsistence users could take 1 bull from 1-15 September and 1-31 December, however a federal registration permit was required during December. Within that portion of Subunit 9C draining into the Naknek River from the south, only qualified subsistence hunters were allowed to hunt on federal lands during 1-31 December; and antlerless moose were legal under a federal registration permit with a quota of 5 antlerless moose. In Subunit 9E, federally qualified subsistence hunters could hunt from 1-20 September and 1-31 December with a bag limit of 1 bull.

Game Board Actions and Emergency Orders. In 1991, the Board expanded the nonresident bag limit of 1 bull with 50" antlers or 3 brow tines to Subunits 9B and 9C. The department recommended uniform fall season dates of 1-15 September for residents and 5-15 September for nonresidents for all subunits, except 9D where there was not an open season. The Board adopted these dates for Subunits 9A, 9B and 9C, but retained the 10-20 September season in Subunit 9E.

In November 1990, we issued an emmergency order closing the northern portion of the Naknek drainage to the taking of antlerless moose. We surveyed the King Salmon Creek trend area in November 1991 and found that moose numbers were still less than half of the average counted during 1984-88. Consequently we issued and emergency order closing the entire Naknek drainage to the taking of anterless moose. In 1992, the registration permit requirement was droped for the December hunt and the bag limit was 1 bull.

Hunter Harvest. During 1991, hunters reported killing 222 moose, including 214 bulls and 6 cows. In 1992, the reported harvest was 207 moose, including 205 bulls and 1 cow. Harvests from 1988 to 1992 averaged 228 (Table 2). The Unit 9 harvest over the past 10 years has also averaged 228 (range 173-300), and showed a steady increase through 1987, followed by a decline.

Permit Hunts. The 1991 state registration hunt #972 was restricted by emergency order to antlered moose only. A total of 97 permits was isssued. Of the 85 permittess who reported hunting, 42 were Unit 9 residents, 36 were from outside Unit 9, and the remainder of unknown residency (Table 3). Local residents killed 13 bulls; other Alaskans killed 3 bulls and 1 illegal cow.

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. South of the Naknek River, nonlocal state residents were excluded from hunting on federal lands. Subsistences hunters could kill 1 moose, and a quota of 5 antlerless moose was set. The Becharof National Wildlife Refuge offfice issued 3 permits in 1992 and 1 antlerless bull was reported.

Hunter Residency and Success. The number of moose hunters using Unit 9 increased during 1981-87 and peaked at 645. Since then the number has droped to a mean of 567 for the period 1988-92 (Table 4). While there have been fluctuations in the proportion of the 3 residency categories, there was not a clear trend. Most subsistence hunters did not get moose harvest tickets and consequently were not represented in the local resident category. Since 1988, the success rates have been stable, with nonresidents having higher success (51%, range 47-59%) than either residents of Unit 9 (34%, range 28-41%) or other Alaska residents (30%, range 19-34%). Nonresidents had a higher success rate because virtually all of them flew out to hunt, and many of them employed guides.

Harvest Chronology. Several adjustments to season dates since 1989 have shifted the chronology of the harvest in Unit 9 to earlier in September (Table 5). Local hunters favor hunting before the rut, and like to have their season open before the nonresident hunt. Harvest levels in December have remained low (Table 5), but some subsistence harvests were not reported.

Transportation Methods. Aircraft continued as the most common method of transportation in Unit 9, followed by boats (Table 6). No major change in transportation type occurred in the past 5 years.

Other Mortality:

Given the continued low calf production, bear predation of neonatal moose remained the apparent primary cause of natural mortality. Bear:moose ratios in Unit 9 ranged from >1:1 to 1:10, and they were much higher than anywhere else within the indigenous range of moose. Winter conditions during 1991-92 and 1992-93 were relatively mild and winter mortality appeared to be insignificant.

CONCLUSIONS AND RECOMMENDATIONS

Hunting regulations have been restricted in all subunits, 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 subunits to maintain bull:cow ratios at prescribed levels. Harvests declined in 1991 and 1992, but before liberalization of season lenght is recommended, we need to evaluate the effect on Unit 9 of changes in season dates and antler restrictions imposed in southcentral Alaska in 1993.

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. Subunit 9C aerial moose composition counts and estimated population size, 1988-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1988/89	38	6	32	19	555	684	66	1,000
1989/90	35	8	13	9	721	792	68	1,000
1990/91	37	5	25	17	232	274	39	1,000
1991/92	48	9	16	18	118	131	27	1,000
1992/93	38	7	26	21	550	635	40	1,000

Table 2. Unit 9 moose harvest[a] and accidental death, 1988-92.

Regulatory year	Hunter Harvest							Accidental death			Grand total
	Reported				Estimated						
	M	F	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	
1988/89	217	16	0	233	--	--	100	--	--	--	333
1989/90	226	10	3	239	--	--	100	--	--	--	339
1990/91	248	6	0	254	--	--	100	--	--	--	354
1991/92	214	6	2	222	--	--	100	--	--	--	322
1992/93	205	1	1	207	--	--	100	--	--	--	307

[a]Includes permit hunt harvest.

Table 3. Subunit 9C moose harvest data by permit hunt, 1988-92.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
972	1988/89	47	21	59	41	47	53	0	15
	1989/90	63	27	74	26	41	59	0	12
	1990/91	85	32	67	33	89	11	0	19
	1991/92	97	13	81	19	94	6[a]	0	17
	1992/93	No hunt							

[a] Includes 1 illegal cow.

Table 4. Unit 9 moose hunter[a] residency and success, 1988-92.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	
1988/89	41	80	111	237 (44)	60	164	114	305 (56)	542
1989/90	37	50	135	228 (41)	79	108	132	327 (59)	555
1990/91	45	57	125	242 (42)	70	113	128	338 (58)	580
1991/92	62	41	114	222 (37)	115	172	78	378 (63)	600
1992/93	45	59	97	207 (37)	114	115	111	352 (63)	559

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

Table 5. Unit 9 moose harvest[a] chronology percent by time period, 1988-92.

Regulatory year	Harvest periods 9/1-9/4	9/5-9/9	9/10-9/14	9/15-9/20	9/21-9/25	12/1-12/15	12/16-12/31	n
1988/89	0	6	45	36	5	3	4	233
1989/90	0	3	43	43	<1	5	4	239
1990/91	6	28	39	10	0	11	7	254
1991/92	9	15	42	18	0	6	10	222
1992/93	7	20	47	16	<1	5	4	207

[a]Excludes permit hunt harvest.

Table 6. Unit 9 moose harvest[a] percent by transport method, 1988-1992.

Regulatory year	Percent of harvest Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	n
1988/89	64	--	22	4	6	2	2	233
1989/90	69	--	17	5	4	2	3	239
1990/91	65	--	19	5	7	2	3	254
1991/92	56	--	20	8	11	1	3	236
1992/93	62	--	25	5	4	1	1	206

[a]Excludes permit hunt harvest.

LOCATION

Game Management Unit 11 ($13,300\ mi^2$)

Geographical Description Chitina Valley and the Copper River Basin

BACKGROUND

Moose numbers in Unit 11 were generally considered low from the early 1900s until the 1940s. Moose numbers increased during the 1950s and reached a peak in the early 1960s. When moose were most abundant, between 85 and 120 moose per hour were observed 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. Moose numbers were probably the highest in 1987 when 55 moose per hour were observed.

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

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

MANAGEMENT DIRECTION

Management Objectives

The Unit 11 management objective is to allow the population to fluctuate as dictated by available habitat and predation rates and to maintain a population with a minimum of 30 bulls:100 cows with 10-15 adult bulls:100 cows.

METHODS

An aerial survey was conducted during the late fall in 1992 to determine sex and age composition and population trends on a count area located along the western slopes of Mount Drum. Harvests and hunting pressures were monitored through a harvest ticket reporting system; the average reported antler length in the harvest was also monitored. Predation and overwinter mortalities were monitored in the field whenever possible and by reports from hunters and trappers.

Large portions of Unit 11 are classified as limited suppression zones, where wildfire would be allowed to burn. One wildfire in a limited area was allowed to burn without suppression. Unfortunately burn conditions were unfavorable and only 150 acres were impacted by the fire.

Other methods of addressing moose habitat issues included attending meetings on a proposed logging operation and commenting on reforestation alternatives to improve moose habitat. Meetings were also held regarding damage to timber resources by the spruce bark beetle. Again, the interest was in improving moose habitat after logging attempts to salvage spruce beetle infected logs.

RESULTS AND DISCUSSION

Population Status and Trend

The number of moose observed during fall sex and age composition counts in Count Area (CA) 11 along the western slopes of Mount Drum increased between 1979 and 1987, then remained relatively stable for 3 years. Between 1990 and 1992 the number of moose counted in this area declined dramatically as reflected by the 75% decline in the number of moose counted per hour between 1990 and 1992 (Table 1). An additional count was conducted in northern Unit 11 by National Park Service (NPS) biologists in 1992. A decline of 41% was observed in the moose per hour figure between 1991 to 1992. Observed declines in the number of moose counted on trend count areas were assumed to indicate fewer moose were present in the count area and vicinity. This could be due to an actual decrease in moose present in the population or changes in movement and migration patterns of moose that year or a combination of both.

Population Size:

An accurate population estimate was not available for Unit 11 because moose have never been censused there. Moose numbers observed during fall composition counts in CA 11 resulted in a density estimate between 0.1 and 0.7 moose/mi^2. The density estimate from NPS count areas was 0.5 moose/mi^2. During late-winter stratification surveys in 1986, 20% of the estimated 5,200 mi^2 of moose habitat in the unit was surveyed. Density estimates between 0.1 and 0.4 moose/mi^2 were obtained. The lowest moose densities were south of the Chitina

River valley, the highest were in CA 11 near Mt. Drum. If actual moose densities approached the estimates obtained during fall composition counts and the 1986 stratification flights, the overall unit population could number as high as 2,500 animals.

Population Composition:

A bull:cow ratio of 64:100 was observed in CA 11 in 1992, down from the previous year's ratio of 91 bulls:100 cows but similar to ratios observed during prior years. The 1991 ratio was unusually high for this count area, probably because of atypical movement patterns that fall. In 1992 all the bulls observed were adults, suggesting little or no bull recruitment in the count area that year. The adult bull:cow ratio greatly exceeds the current management goal of maintaining no less than 15 adult bulls:100 cows. The bull:cow ratio in northern GMU 11 observed by NPS biologists in 1992 was 37 bulls:100 cows, of which 4:100 were yearlings. In this area the only change in bull numbers from the prior year's survey was a 50% decline in the yearling bull ratio, also suggesting lower recruitment.

The observed calf:cow ratio in CA-11 was only 4:100 in 1992, appreciably lower (78%) than the 1991 figure of 18:100. Calf production has declined in CA-11 from an average of 19 calves:100 cows observed between 1986 and 1989 to an average of 10:100 since. Calf production or survival was higher in northern Unit 11 where 20 calves:100 cows were observed by NPS biologists.

Distribution and Movement:

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

Fall rutting and postrutting concentrations normally occur in upland habitats as high as elevations of 4,000 feet. Migrations to lower elevations are initiated by snowfall, but usually don't occur until late November or early December after fall counts. Record cold temperatures with deep snowfall in September and October 1992 could have disrupted normal migratory behavior patterns. 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. The moose hunting season in Unit 11 was 1-15 September and the bag limit was 1 bull. The federal subsistence season was from 25 August to 20 September and the bag limit was 1 bull.

Game Board Actions and Emergency Orders. The hunting regulations for moose in Unit 11 remained unchanged between 1975 and 1989. In 1990 a separate federal subsistence season was established because the state subsistence law with a rural preference was determined to be illegal by the state supreme court. The federal season coincided with the prior state season of 1-20 September. Also in 1990 the board of game reduced the state season from 20 to only 5 days with the season running from 5-9 September. to align Unit 11 with the Unit 13 season. In 1991 the state season was lengthened to 15 days with season dates of 1-15 September and the federal subsistence season was lengthened 5 days to 25 August. to 20 September. During the spring 1993 Board of Game meeting, the Unit 11 season was increased by 15 days with season dates of 20 August to 20 September, and the bag limit was changed to 1 bull with spike or forked antlers or antlers with a minimum 50-inch width or 3 brow tines. These changes were effective for the 1993 season. The eruption of Mt. Spurr in early September 1992, resulting in heavy ash fall in portions of Unit 11, reduced hunting effort.

The mean antler spread reported for bulls harvested during 1992 was 44 inches, the same as the 5-year (1985-89) mean of 44 inches observed before the severe winter. Approximately 55% of the harvest in 1992 was composed of bulls with antler spreads of 40 inches or more. These data indicate that hunting pressure in Unit 11 was not heavy enough to crop bulls before they reach maturity and that there were enough mature bulls available for breeding purposes.

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. Recent poaching activity has been greatest in the northern portion of Unit 11 along the Nabesna Road. A tremendous increase in the human population around Slana in the early to mid-1980s has led to increased poaching, and enforcement efforts in the area have increased.

Hunter Residency and Success. Local residents accounted for 39% (n = 9) of the moose harvest in 1992, nonlocal Alaska residents took 48% (n = 11), while nonresidents took only 13% (n = 3) (Table 3). The federal subsistence season for local rural residents was 10 days longer than the general state season for nonlocals and nonresidents. In addition to a longer season, hunter success rates are influenced by NPS regulations that 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.

The overall hunter success rate in 1992 was only 14%, substantially lower than in 1991 (23%) and the 5-year (1987-91) mean of 27%. Successful hunters spent an average of 6.2 days to kill a moose in 1992, while unsuccessful hunters averaged 7.1 days in the field. From 1987 through 1991, successful hunters averaged 5.9 days hunting and unsuccessful hunters 6.5 days. Contributing to the decline in success rate were record cold temperatures, early deep snowfall, and volcanic ash fall. Hunter effort increased because of the increased length of the general season.

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

Transportation Methods. Transportation methods utilized by successful hunters are listed in Table 5. Aircraft, highway vehicles, and 3 or 4-wheelers were the most popular methods reported. Transportation methods that may be used by hunters in Unit 11 are limited by NPS regulations. Aircraft cannot be used in portions of the unit designated as park, and all vehicle use is restricted to existing trails unless a permit is obtained. These rules limit hunting opportunity in the more remote portions of the unit.

Preliminary 1993 Harvest. Preliminary moose harvest figures were obtained for the 1993 hunting season by hand tabulating harvest report forms and only represents a minimum estimate of the kill. To date 31 bulls have been reported from Unit 11. This is a 35% increase from the 1992 take of 23 but well below harvests reported in prior years (Table 2).

Other Mortality:

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

Habitat

Assessment and Enhancement:

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

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

Data from CA-11 and CA-2 along the western slopes of Mt. Drum and Mt. Sanford suggest a decline in moose numbers in 1992. Moose numbers were thought to be relatively stable in these areas between 1987 and 1990. The reason for the decline is not known, but I believe increased winter mortality during the last 3 severe winters and predation have limited recruitment. Low calf ratios suggest calf production and survival to fall have been poor. However, over-winter loss of calves has also been occurring, based on a reduction in yearling bull ratios. Harvest records show a decline in yearling bulls cannot be attributed to hunting mortality. A decline in the number of cows counted during the fall surveys also supports yearling loss to weather and predation.

Hunting pressures and annual harvests increased when the hunting season was liberalized in 1991. The observed decline in the 1992 moose kill was partially attributed to severe weather and volcanic ash fall which restricted hunting during the last half of the season. Maintenance of high bull:cow ratios suggests hunting has little effect on overall bull numbers, except in a few areas where access is readily available. In addition, the mean antler spread of bulls in the harvest was relatively wide, indicating a large proportion of the bull population was made up of adult animals. Cow hunts should be avoided as long as low moose densities persist.

The Board of Game lengthened the moose season and changed the bag limit for moose starting with the 1993 season. Initial harvests under this new harvest strategy have not increased. Since 1993 results are preliminary, additional analysis of hunt results will be needed once the harvest data becomes available. The bag limit, however, under this spike-fork or 50-inch regulation is very conservative. Because of this, I do not believe the overall harvest will increase, even if hunting pressure does.

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 moose population consistent with NPS regulations.

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Table 1. Moose composition counts in Count Area 11 of GMU 11, 1988-92.

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour	Density moose/mi^2
1988	56	6	22	12	170	194	52	0.7
1989	No data - fall count not completed.							
1990	63	4	8	5	199	209	51	0.7
1991	91	5	18	9	105	115	29	0.4
1992	64	0	4	2	41	42	13	0.1

Table 2. Annual moose harvest in Unit 11, 1988-92.

Year	Reported			Estimated			Total
	M	F	Total[a]	Unreported	Illegal	Total	
1988	48	0	48	5	5	10	58
1989	52	0	52	5	5	10	62
1990	31	0	32	5	5	10	42
1991	42	0	42	5	5	10	52
1992	23	0	23	5	5	10	33

[a] Includes unknown sex.

Table 3. Moose hunter residency and success in Unit 11, 1988-92.

Year	Successful				Unsuccessful			
	Local resident	Nonlocal resident	Non resident	Total[a]	Local resident	Nonlocal resident	Non resident	Total[a]
1988	17	23	4	48	46	54	5	109
1989	22	27	2	52	51	65	4	122
1990	16	12	2	32	63	47	4	115
1991	24	14	3	42	81	58	4	145
1992	9	11	3	23	59	73	4	139

[a] Includes unspecified residency.

Table 4. Moose harvest chronology percent by time period in Unit 11, 1988-92.

Year	Season dates	Week of Season 1st	2nd	3rd	4th
1988	1-20 Sept.	7	16	44	33
1989	1-20 Sept.	17	37	46	
1990	5-9 Sept.[a] 1-20 Sept.[b]	7	48	16	29
1991	1-15 Sept. [a] 1-20 Sept. [b]	17	19	43	21
1992	1-15 Sept. [a] Aug. 25-Sept. 20[b]	5	30	45	20

[a] State hunt.
[b] Federal subsistence hunt

Table 5. Successful moose hunter transport methods (%) in Unit 11, 1988-92.

Year	Airplane	Horse	boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown
1988	17	2	2	10	0	29	27	13
1989	33	4	2	19	0	11	27	4
1990	28	0	3	22	0	13	28	6
1991	36	0	2	31	0	5	19	7
1992	35	4	9	22	0	0	30	0

LOCATION

<u>Game Management Unit</u>: 12 (10,000 mi^2)

<u>Geographical Description</u>: Upper Tanana and White River drainages

BACKGROUND

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

In response to the declining moose populations, wolf control programs were conducted in adjacent Subunits 20D (1980), 20E (1981-83), and in extreme northern Unit 12 (1981-83). Grizzly bear harvest was increased in 1982 by liberalizing regulations, and habitat enhancement programs were conducted during the late 1980s. Between 1982 and 1989, the moose population in Unit 12 increased due probably to these management programs and also because favorable climatic conditions prevailed during this period. However, the population remained at a low density (0.4-0.6 moose/mi^2).

Unit 12 has been an important moose hunting area for local residents, hunters from Southcentral Alaska and guided nonresidents, and also an important wildlife viewing area for tourists driving the Alaska Highway. During the 1960s when the Unit 12 moose population was high, hunting seasons and bag limits were liberal and hunter participation and success were high. Moose were commonly viewed while traveling the area's highways. During that period, the needs of the consumptive and nonconsumptive users were met. Since the unit's moose population declined, the hunting season and bag limit has become very restrictive and the total harvest does not even meet the local resident subsistence needs. Also, the Upper Tanana Valley is the first spot in Alaska visited by thousands of travelers driving the Alaska Highway. Most of these travelers are here to view Alaska's wildlife. Since the mid-1970s, few tourists observe a moose in this area.

MANAGEMENT DIRECTION

Management Goals

Protect, maintain, and enhance the moose population in concert with other components of the ecosystem and thereby assure perpetuation of the population and its capability of providing:

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

Management Objectives

- Increase the moose population from an estimated 2,500-3,500 to 4,000-4,500 by the year 2010.
- Maintain a minimum posthunting sex ratio of 40 bulls:100 cows.

Northwestern Unit 12 (Robertson River, Upper Tanana Valley):

- Increase the moose population from an estimated 400-800 moose by the year 2000.
- Maintain a minimum ratio of 20 bulls:100 cows along the north slope of the Alaska Range.

METHODS

Composition Surveys

Sex and age composition were estimated in October and November 1991-93 using aerial contour and transect surveys. The same areas in Unit 12 were surveyed each year. All moose observed were classified as either large bulls (antlers ^{3}50 inches), medium bulls (antlers larger than yearlings but <50 inches), small bulls (spike, cerviform, or palmate-antlered yearling bulls), cows without calves, cows with one calf, cows with two calves, lone calves, or unidentified moose.

Harvest

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

Food Habits

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

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Based on data collected during annual moose contour surveys and two-area specific censuses (1989 and 1990), the moose population in Unit 12 increased slowly from 1982 until 1989 but then has stabilized or declined slightly. Since 1989, yearling survival has declined (Fig. 1) to a level below what is necessary for population growth. The 1992 population estimate in Unit 12 was 2,500-3,500 moose. The estimated density was 0.42 to 0.58 moose/mi^2 (160-226/1,000 km^2) of suitable moose browse.

Past research has indicated predation was the primary factor maintaining the Unit 12 moose population at a low density. Because predator management is not an option in the majority of Unit 12, I expect the moose population to remain at a low density (0.2-0.6 moose/mi^2) for an extended time.

Population Composition:

Moose composition surveys (Table 1) were conducted in Unit 12 between 17 October and 18 November 1992; 1,071 moose were classified during 33.4 survey hours (32.1 moose/hr). Counting conditions were difficult during 1992 due to early, deep snows. In many areas, most of the moose had moved off the rutting areas and into the trees. For example, along the north face of the Nutzotin Mountains total counts were down by 82%. To obtain an adequate population composition sample, we spent considerably more time surveying in the treed areas. Therefore, the 1992 moose/hr counts are not comparable to other years.

The 1992 bull:cow ratio was lower than the 5-year average of 51:100 but above the overall unit objective of 40:100. Between 1988 and 1992, the number of large (34.7%, s.d. = 2.19) and medium (41%, s.d. = 3.14) bulls in the population have remained stable. However, the number of yearling bulls has declined steadily. During the report period, the greatest decline in the bull:cow ratio occurred in the Little Tok and Robertson River drainages. The decline in the Little Tok River was probably related to both moderate harvest rates the past 2 years and poor yearling recruitment. In the Robertson River, the decline was probably more due to poor yearling recruitment. In response to the declining bull population in the Little Tok River, a spike/fork or 50-inch regulation was enacted in 1993.

The 1992 calf:cow ratio was lower than the 5-year mean of 27.6:100, but comparable to the previous 2 years. The best calf survival was in the Robertson River drainage and along the adjacent north face of the Alaska Range. The higher calf survival in these areas may be due to the moderate to high grizzly and black bear harvests along the north face of the Alaska Range and along the Tanana River. In fall 1993, the Unit 12 calf:cow ratio was 35.6:100, the highest recorded since 1978. Only in the Little Tok River was calf survival low to average (24.3:100). The increase in calf survival was probably due to extremely favorable climatic conditions that have prevailed since April 1993. Calf survival was also found to be high in the adjacent Subunit 13C (Bob Tobey, pers. commun.) and Subunit 20E.

<u>Distribution and Movements</u>:

Moose are throughout Unit 12 below an elevation of about 4,000 feet. In total, the amount of suitable habitat is about 6,000 mi^2 (15,540 km^2). Most moose in Unit 12 migrate between seasonal ranges; the longest known movements are for moose that rut in the Tok River area, including Dry Tok Creek. Many cows migrate as far south as the Gakona River for calving, return to the Tok River for the rut, and then move north to the Tanana River during mid- to late winter.

Very few resident moose exist on the Northway-Tetlin Flats and in the Tok River Valley (ADF&G files). A few resident moose are near Tok and Tanacross. Year-round poaching of both sexes has contributed to the decline of resident moose in lowland areas near human settlements. According to long-time residents of Unit 12, the Tok River Valley used to support a large population of resident moose, but excessive harvests in the late 1960s and early 1970s noticeably reduced this population. The population of moose in the Tok River Valley has been increasing the past 2 years, in apparent response to the 1990 Tok River Fire and moderate harvests of predators.

<u>Mortality</u>

<u>Harvest:</u>

<u>Season and Bag Limit</u>. Seasons and bag limits in Unit 12 during regulatory year 1993 is as follows:

	Resident	Nonresident
That portion drained by the Little Tok River upstream from and including the first eastern tributary from the headwaters of Tuck Creek: One bull with spike-fork antlers or 50-inch antlers with four or more brow tines on one side.	1 Sept.-15 Sept.	5 Sept.-15 Sept.
That portion lying east of the Nabesna River and south of the winter trail running southeast from Pickeral Lake to the Canadian border.	1 Sept.-30 Sept.	1 Sept.-30 Sept.
Remainder of Unit 12:		
Resident Hunters: One bull.	1 Sept.-15 Sept.	
Nonresident Hunters: One bull with 50-inch antlers.		5 Sept.-15 Sept.

<u>Game Board Actions and Emergency Orders</u>. In spring 1991, the Board of Game reestablished the moose hunt in that portion of Unit 12 drained by the Little Tok River upstream from and including the first eastern tributary from the headwaters of Tuck Creek. The board established the season dates as 1-15 September for residents and 5-15 September for nonresidents. During spring 1993, the board restricted the bag limit in this area to one bull with spike/fork antlers or 50-inch antlers with four or more brow tines on one side.

At the October 1991 meeting, the board adopted a regulation that prohibits land- and-shoot hunting of wolves after 1 July 1992. In June 1993, the board passed a statewide regulation that allowed same-day-airborne hunting of wolves. However, most of Unit 12 is under federal ownership and the amount of hunting opportunity under this regulation will probably be limited.

<u>Hunter Harvest</u>. Total reported harvest in Unit 12 during the fall 1992 season was 71 bull moose which is 18.6% lower than the 5-year average of 87.2 (Table 2). The lower harvest

was due to local residents hunting along the Tanana River which had much lower success compared with previous years. During 1992, most of the harvest occurred in the Tok River (32) and Chisana River (10) drainages.

The reported harvest represented only about 2% of the population and probably had little impact. However, in Unit 12, out-of-season poaching may be as high as 40 moose of either sex, and the unreported harvest of moose for Native funeral potlatches is as high as 15-20 annually. Most of this harvest occurs near the communities and along the road system. The total Unit 12 annual human-induced harvest is probably closer to 4-5% of the population including localized high harvest of cow moose. At this harvest level, the moose population around human settlements will continually be maintained at a low level.

Antler size was reported for 68 bulls resulting in a mean of 43.7 inches, similar to the 5-year average of 44.0. Ten bulls (14.7%) were judged to have been yearlings (antlers <30 inches), 27 (39.7%) were 2-4 years old (antler spread 30.0-49.9 inches), and 30 (44.1%) were mature bulls (antler spread >50 inches). Antler spreads were estimated for 279 bulls observed during posthunting aerial surveys, and the age composition was 22.9% yearlings, 40.5% 2-4 years old, and 36.6% mature bulls. Similar to the adjacent Subunit 20E, large bulls seemed more vulnerable to harvest during 1992.

Hunter Residency and Success. In Unit 12, local residents, nonlocal residents, and nonresidents accounted for 51%, 42%, and 5% of the moose hunters, respectively. Two percent of the hunters did not report residency. Local hunters harvested 23 (32%), nonlocals 35 (49%), and nonresidents 12 (17%) of the 71 bulls reported (Table 3).

During 1992, 479 hunters reported hunting moose in Unit 12, exceeding the 5-year average of 402. The number of local and nonlocal residents reporting to have hunted in Unit 12 has increased. I suspect that the higher number of local resident reports was not due to a large increase in the number of local hunters, but to an increase in the reporting rates. The higher number of nonlocal hunters was probably due to the shorter seasons, more restrictive bag limits, and the motorized vehicle restrictions imposed in the adjacent Unit 13. The overall unit success rate was 15%, substantially lower than the 5-year mean of 22%.

Harvest Chronology. In Unit 12, the greatest moose harvest normally takes place during the second week of the season (Table 4). The apparent harvest decline during the third week of the season during the last 2 years was due to the shortening of the season to 15 days in most of Unit 12. The number of hunters that utilized the longer season in southern Unit 12 remained comparable to past years. Most of these hunters are guided nonresidents or residents of Chisana.

Transport Methods. In Unit 12 during the past 5 years, the transportation type used by most hunters was highway vehicles (38.8%), boats (13.4%), 3- or 4-wheelers (12.3%), airplanes (9.6%), other ORVs (8.1%), and horses (6.2%). Method of transport was unknown for 10%

of the hunters. Hunters using highway vehicles have the lowest average success rate (15.1%). Hunters using horses have the highest success rate (61.6%). Horses are primarily used by guides to transport nonresident hunters. Traditionally, boats and 3- or 4-wheelers have not been efficient means of transportation for hunting moose in Unit 12 because of crowded hunting conditions along the major rivers and trails.

Other Mortality:

Predation by wolves and grizzly bears is the greatest source of mortality for moose in Unit 12 and has maintained the population at a low density (0.42-0.58 moose/mi^2) since the mid-1970s. In contrast to other areas that contain sympatric moose, wolf, and grizzly bear populations, on the Northway-Tetlin Flats, wolves were the primary predator on moose calves instead of grizzly bears. Wolf predation also seemed the greatest source of adult mortality. However, in other areas of Unit 12, fall composition data indicate grizzly bear predation on moose calves to 5 months of age was high.

Since 1989, tens of thousands of Nelchina and Mentasta caribou have wintered in or migrated through Unit 12. The apparent effect of this large seasonal food source has been an expanded Unit 12 wolf population. Since 1989, the fall Unit 12 wolf population has increased 34-41% and during 1992-93, there were 230-243 wolves in a minimum of 28 packs. The Unit 12 grizzly bear population is stable at an estimated natural interior grizzly bear density (16-20 bears/1,000 km^2). Considering the status and trend of the major moose predators, I expect the Unit 12 moose population to remain at a low density for an extended period.

Habitat

Assessment:

Only about 6,000 mi^2 in Unit 12 are considered to be moose habitat. However, excessive wildfire suppression for nearly 30 years has allowed vast areas of potentially good moose habitat to become cloaked in spruce forests that lack high-quality deciduous moose browse. In response, habitat enhancement work has been conducted in Unit 12 since 1982. Over 1,600 acres of old-age, decadent willows have been intentionally disturbed to stimulate crown-sprouting of new leaders. This work has produced an estimated 2 million pounds of additional browse each year for wintering moose. In eastern Unit 12, the U.S. Fish and Wildlife Service has conducted prescribed fires to benefit moose on the Tetlin National Wildlife Refuge.

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

From June to September 1990, a wildfire burned approximately 97,000 acres of primarily decadent black spruce muskeg in the Tetlin Hills and the adjacent Tok River lowlands. Quality moose browse species have recolonized much of this area and in response, the area's moose population is increasing. Quality moose winter browse supplies are expected to continue the next 15-20 years.

Nonregulatory Management Problems/Needs

Because of the effects of abnormal weather conditions on moose distribution during fall 1992, the results of the composition survey data were difficult to interpret and could not be compared with other years. Even when trend count data is collected during the best conditions, it takes 3-4 years to interpret and still there is no measure of confidence around the results. Therefore, I believe we would get better information by changing from our existing survey techniques to using a superstrat census technique (McNay, pers. commun.). In order to cover the most important management areas in the Upper Tanana/Fortymile Valleys, I recommend the development of three traditional study areas and surveying each on a 3-year interval.

I plan to try this technique starting in fall 1994. I have set up three study areas: 1) the Mosquito Flats which has been censused in 1981, 1989, and 1992; 2) the Ladue River which has been censused in 1992; and 3) the Tok/Robertson River which was censused in 1990. I will survey the Tok/Robertson River in 1994, the Mosquito Flats in 1995 and the Ladue River in 1996. During the off years for an area, I will continue (up to 3 years) to conduct some traditional trend counts to compare data with results of the superstrat technique. I will be able to do the annual superstrat survey for about $2,500-$3,000 less than the cost of annual traditional trend count surveys.

CONCLUSIONS AND RECOMMENDATIONS

Moose are far less numerous in Unit 12 than they were in the 1960s. The population increased during the late 1980s, but since 1989 has stabilized or slightly declined. Moose numbers, especially in the vicinity of the road system and any communities, are very low. Presently, annual harvests and hunter success are only one-third to one-half of what they had been in the 1970s. Furthermore, every year hundreds of Alaska Highway travelers comment on the lack of wildlife in the Upper Tanana Valley. Habitat is not limiting, but predation and possibly illegal hunting in certain areas are maintaining the moose population at low densities. At the current moose population size and trend, the needs of consumptive and nonconsumptive users are not being met.

In June 1993, the Alaska Board of Game decided not to conduct a wolf control program in Northwestern Unit 12. Because predation is the main limiting factor on the unit's moose population, the management objective to increase the moose population in the Robertson River/Tanana River area will probably not be met.

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

A recommendation to change the moose surveying technique in Unit 12 and Subunit 20E was presented. I suggested we conduct a superstrat survey once every 3 years in three different study areas within the Upper Tanana/Fortymile Valley. By changing, I believe we will gain more accurate and precise data at a reduced cost. Furthermore, since the survey areas would be much larger and contain all available habitat types, weather anomalies should have less effect on the survey outcome.

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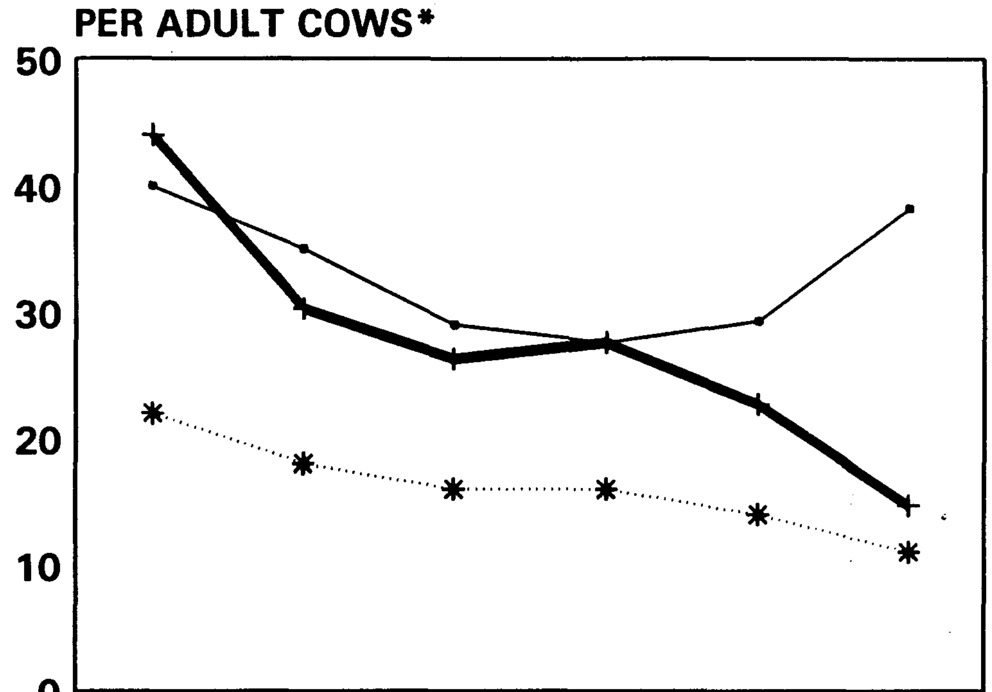
UNIT 12 MOOSE YEARLING AND CALF RATIOS 1988-1993



	1988	1989	1990	1991	1992	1993
CALVES	40	35	29	27.6	29.3	38.2
YEARLINGS	44	30.3	26.3	27.6	22.7	14.7
PROP. OF RECRUITS	22	18	16	16	14	11

YEAR

* prop. of recruits = yrl/yrl + adults x 100

Fig. 1. Trend of yearling and calf moose survival in Unit 12, 1988-93.

Table 1. Unit 12 aerial moose composition counts, 1988-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1988-89	64	18	33	189	17	943	1,133	40
1989-90[a]	50	13	30	223	17	1,094	1,317	44
1990-91	47	12	25	185	15	1,071	1,256	40
1991-92	49	12	24	200	14	1,264	1,472	44
1992-93	45	10	26	165	15	906	1,071	32
1993-94[b]	26	7	36	187	22	662	850	57

[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.

Table 2. Unit 12 moose harvest and accidental death, 1988-93.

Regulatory year	Harvest by Hunters							Accidental death			
	Reported				Estimated						
	M (%)	F (%)	Unk	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1988-89	79 (98)	0	2	81	15-20	30-40	45-60	4-5		4-5	130-146
1989-90	76 (100)	0	0	76	15-20	30-40	45-60	4-5		4-5	125-141
1990-91	94 (96)	0	4	98	15-20	30-40	45-60	4-5		4-5	147-163
1991-92	109 (99)	0	1	110	15-20	30-40	45-60	4-5		4-5	159-175
1992-93	71 (100)	0	0	71	15-20	30-40	45-60	4-5		4-5	120-136
1993-94[a]	71 (100)	0	0	71	15-20	30-40	45-60	4-5		4-5	126-141

[a] Preliminary data.

Table 3. Unit 12 moose hunter residency and success, 1988-92.

Regulatory year	Successful: Local[a] resident	Nonlocal resident	Nonresident	Total[b](%)	Unsuccessful: Local[a] resident	Nonlocal resident	Nonresident	Total[b](%)	Total hunters
1988-89	27	39	15	81 (25)	103	134	6	243 (75)	324
1989-90	31	24	22	78 (22)	148	117	15	282 (79)	360
1990-91	45	26	17	98 (23)	186	131	15	332 (77)	430
1991-92	48	49	13	110 (27)	160	132	9	305 (73)	415
1992-93	23	35	12	71 (15)	222	164	13	408 (85)	479

[a] Residents of Units 12 and Subunits 20E and eastern 20D are considered local residents. Major population centers are Eagle, Chicken, Boundary, Northway, Tetlin, Tok, Tanacross, Slana, and Dot Lake.
[b] Total may include hunters who did not specify whether or not they were residents.

Table 4. Unit 12 moose harvest chronology by time period, 1988-93.

Regulatory year	Harvest periods: 9/1-9/6	9/7-9/13	9/14-9/20	9/21-9/27	9/28-10/5	Total[a]
1988-89	25	29	21	2	2	81
1989-90	24	20	24	4	2	76
1990-91	18	41	28	4	3	98
1991-92	34	45	22	4	1	110
1992-93	25	31	6	4	4	71
1993-94[b]	23	34	10	4	0	71

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

Table 5. Unit 12 moose harvest percent by transport method, 1988-93.

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1988-89	12	18	11	8		24	27		81
1989-90	18	21	8	12		9	29	3	76
1990-91	17	15	21	11		6	23	5	98
1991-92	10	14	10	25		14	25	2	110
1992-93	18	23	10	11		10	28	0	71
1993-94	7	20	11	23		17	20	3	71

LOCATION

<u>Game Management Unit</u> 13 (23,376 mi^2)

<u>Geographical Description</u> Nelchina and Upper Susitna Rivers

BACKGROUND

Although moose densities in Unit 13 were low during the early 1900s, they started to increase during the 1940s. Moose were abundant throughout the 1950s and early 1960s, the population peaking in the 1960s. Moose numbers declined during the late 1960s and early 1970s, because of severe winters, increased predation, and large human harvests of both bulls and cows. The low in the population probably occurred in 1975, when 41 moose per hour and 15 bulls:100 cows were observed during fall surveys. The number of moose counted during fall surveys started increasing in 1978 and climbed at an average annual rate of 5% a year until 1987 when the population peaked.

Unit 13 historically has been an important area for moose in Alaska. Annual moose harvests were large, averaging over 1,200 bulls and 200 cows, during the late 1960s and early 1970s. Hunting seasons were long, with both fall and winter hunts. As moose numbers began to decline, harvests were reduced by eliminating the cow season in 1972, winter season in 1972 and reducing fall bull seasons to 20 days in 1975. Harvests in the late 1970s averaged about 775 bulls per year, but bull:cow ratios in the population were low. Beginning in 1980 the bag limit was changed from any bull, to bulls with an antler spread of at least 36 inches or 3 brow tines on at least 1 antler. Under this management regime, the 1980 bull harvest dropped to 557, down 34% from the 1979 harvest of 848. From 1981 through 1988 the harvest increased, peaking in 1988 with 1,259 moose harvested. In 1985, the regulation for Subunit 13A West was changed to allow the taking of only those bulls with spiked or forked antlers. In 1987 a limited permit hunt for any bull was also established in 13A West. Cow hunts were held in 1988 for the first time in over 15 years. Moose seasons were reduced in length and permit hunts canceled in 1990 in response to population declines attributed to severe winters with deep snowfalls.

MANAGEMENT DIRECTION

<u>Management Objectives</u>

Population Objective: The Unit 13 management objective is to increase the unitwide population to about 25,000 moose with a minimum of 25-30 bulls:100 cows, with a wide range of age classes, but a minimum 10-15 adult bulls:100 cows in the population.

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

METHODS

Aerial surveys were conducted during the fall to learn sex and age composition and population trends on count areas located throughout the unit. Censuses have been conducted periodically in different portions of the unit to obtain population estimates. Harvests were monitored by requiring permit and harvest ticket reports from all hunters. Habitat conditions have been periodically monitored by examination of browse utilization transects located in different portions of the unit. Active habitat management activities included crushing riparian willow along a moose wintering area. Other attempts at habitat improvement include updating the Copper River Fire Management Plan. In this plan large portions of the unit are included in a limited fire suppression category, in which wildfires would be allowed to burn once ignition occurs. In addition, staff evaluated and responded to land-use proposals that could affect moose habitat.

RESULTS AND DISCUSSION

Population Status and Trend

The total number of moose counted per hour during the annual fall sex and age moose composition counts is considered a good indicator of trend in moose numbers. A 26% reduction in the moose per hour figure implies that moose numbers declined substantially between 1987 and 1991. The current data suggests that the overall Unit 13 moose population has been stable the last 2 years (Table 1). Likewise, moose density estimates obtained between 1987 and 1991 show a 30% decline, but now appear stable. The current density estimate of 1.4 moose/mi^2 obtained in both 1991 and 1993 represents the lowest density estimate obtained since 1983. Moose counts are repeated yearly on established count areas using approximately the same search intensity and are considered a reliable indicator of long-term trends in moose numbers. Year-to-year variation in count data does occur, however, due to movement patterns of moose.

Composition data for 1993 on a subunit basis are presented in Table 2. Subunit comparison of moose per hour survey data between 1991 and 1993 suggest that although moose numbers appeared relatively stable on a unitwide basis, differences in moose population trends exist among subunits. Between 1992 and 1993, the number of moose counted per hour increased in Subunit 13C. Count figures in subunits 13A and 13E were relatively stable the last 2 years. Subunits 13B and 13D have had overall downward trends in the moose per hour figures since 1987 or 1988. Between 1987 and 1991 all of the subunits except 13A experienced large (range 21-35%) declines in the moose per hour figures.

Population Size:

Census data between 1987 and 1991 produced population estimates of 5,913 $\pm$725 moose in 13A, 4,644 $\pm$512 in 13B and 3,096 $\pm$ 461 moose in 13C. Density estimates were 3.1 moose/mi^2 in 13A, 1.9 moose/mi^2 in 13B and 1.6 moose/mi^2 in 13C. A population estimate based on censuses in every subunit was not available for the entire unit.

Population Composition: Population composition data collected during fall sex and age composition counts from 1988 through 1993 are presented in Tables 1 and 2. The bull:cow ratio in Unit 13 declined 19% from 1988 to 1989, was stable through 1992, then declined (8%) again in 1993. The unit-wide yearling bull:cow ratio declined from 12 yearlings:100 cows in 1988 to 6:100 in 1991, then increased slightly to 8:100 in 1993. There were 15 large (i.e., older than 1 year) bulls:100 cows observed unit-wide in 1993. This just meets the management objective of 15 adult bulls:100 cows for the unit as a whole.

Analysis of ratio data collected on fall sex and age composition counts may not give indications of changes in abundance if decreases or increases between sex and age group occurs simultaneously. Because of this, unit and subunit-wide trends in composition are also examined by comparing the number of bulls, cows, and calves counted per hour. Between 1988 and 1992 both the number of bulls per hour and the number of cows per hour in Unit 13 declined each year. The reason the bull:cow ratio declined only in 1988 was that in all other years the decline in bull and cow numbers was proportional. In 1993 the bull/hour figure continued to decline while the number of cows per hour increased slightly.

Comparison of bull:cow ratios was also examined on a subunit basis. The bull:cow ratio in subunit 13A declined 50% from 30 to 15 adult bulls:100 cows in 1993. This is a direct result of a change in hunting regulations for 1993 that allowed for a very high harvest of adult bulls. Prior to 1993, bulls were increasing in 13A because the bag limit prohibited virtually all harvests of adult bulls. Subunits 13B and 13E also showed a small decline in the bull:cow ratio this last year. Subunits 13C and 13D had an increase in the bull:cow ratio. The 1993 ratio of 13 large bulls:100 cows obtained in 13B and 8:100 in 13E are below management objectives of 15 adult bulls:100 cows. Analysis of bull per hour count figures on a subunit basis revealed trends similar to those observed for bull:cow ratios in Subunits 13A and 13E where bulls:hour declined and in 13C where there was an increase. In 13B there was a slight increase in the number of bulls counted per hour compared to a decline in the bull:cow ratio and the number of bulls counted declined in 13D while the bull:cow ratio increased.

The calf:cow ratio in Unit 13 declined dramatically (39%) between 1988 and 1991, but has increased over the last 2 years, and the current ratio of 25:100 approaches values obtained in the mid 1980s. The number of calves counted per hour indicated a similar unitwide trend. However, the rate of increase is lower (30%) in the calf per hour figure than suggested from a 47% increase in the calf:cow ratio. The only subunit not showing an increase in the calf:cow ratio or calf per hour figure sometime in the last 2 years was 13D.

Composition data show a decline in the number of cows counted per hour has occurred in every subunit since 1989. Most of this decline occurred between 1989 and 1991. The magnitude of the decline in the cow base varies between subunits and was not as great as the decline in the number of bulls or calves. The number of cows counted per hour in Subunits 13C and 13B increased slightly during 1993, also suggesting a more stable cow base in these subunits last year. The cows per hour figure in 13A was lower in 1993 than in 1992 but still higher than previously observed, suggesting a stable cow base. Cows declined in Subunits 13E and 13D last year.

Distribution and Movements:

Data from fall composition surveys, censuses and stratification flights suggested that in recent years moose densities were highest in Subunits 13A and 13B. Subunit 13D had the lowest density. Moose were especially abundant in the Alphabet Hills (Subunit 13B), the eastern Talkeetna Mountains (Subunit 13A), and the upper Susitna River (Subunit 13E).

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

Mortality

Harvest:

Season and Bag Limit. Season dates in 1990 were 5-9 September. The bag limit was 1 bull having 36-inch or larger antlers or 3 brow tines on 1 side in all of Unit 13 except 13A West where the bag limit was 1 bull having a spike or fork antler. A federal subsistence hunt was established in 1990 for Unit 13 residents only with only 1 permit issued per household and a bag limit of any bull. This hunt has been held since then on federal lands open to subsistence hunting, with season dates of 25 August 20 September Season dates for the 1991 state hunt were 5-11 September. The bag limit in that portion of subunit 13A West, north of the Black River, was increased to include bulls with a minimum antler spread of 50 inches or 3 brow tines. The 1992 season was increased in length by 7 days with season dates 1-14 September; however, use of motorized vehicles (except boats) off a maintained highway or road between 1-7 September was prohibited.

Game Board Actions and Emergency Orders: The Board of Game held an emergency board meeting in June 1992 to consider changes in the 1992 moose hunting season for Unit 13. During this meeting the Board established the Tier I subsistence moose hunt that excluded nonresidents but lengthened the moose seasons by 7 days. In addition, a vehicle restriction was enacted that prohibited use of motorized vehicles (except boats) off state maintained roads and highways for moose hunting or transportation of hunters between 26 August and 7 September. The purpose of the vehicle restriction was to give preference to those subsistence hunters who did not have motorized vehicle access off the road system. This emergency Board meeting and resulting changes were the result of a lawsuit against the state for not providing a preference for subsistence users. During the March 1993 scheduled meeting of the Board of Game, major changes in the Unit 13 hunting seasons dates and bag limits for moose were made. During this meeting the Board adopted a season of 20 August-20 September., with a bag limit of 1 bull having a spike or forked horn antlers or antlers with a width of 50 inches or 3 brow tines on 1 side. This is the first major change in the definition of a legal bull in Unit 13 since the 36-inch regulation was adopted in 1980. Moose hunting season dates and bag limits are now standardized throughout the game management units along the road system in southcentral region effective for the 1993 season. During this meeting, the Board also opened nonresident hunting in the unit and established a drawing permit hunt for cows in subunit 13A West.

Hunter Harvest. In 1992, the reported harvest for Unit 13 was 607 moose from the combined state and federal subsistence seasons (Table 3). This represented a 12% decline in the harvest from the previous year's take of 689. Because of a series of severe winters, moose seasons were reduced 3 years ago. Moose harvests for the past 3 years with the shorter hunting seasons have averaged 606 moose a year, a decline of 46%, compared to a mean harvest of 1,218 moose for the prior (1988-89) 2 years before the season was reduced. A total of 2,473 hunters reported hunting in Unit 13 during 1992. This is the lowest reported hunting pressure since 1979 and is 43% below the 1989 figure of 4,362 hunters. Part of the reason for decreased hunting effort and harvest in 1992 was the severe winter-like weather during the hunting season with record cold temperatures and deep snows. Also Mt. Spurr erupted and covered important moose hunting areas with up to 1 inch of volcanic ash, greatly restricting the use of vehicles for fear of damage to the engines from the ash.

Included under the general state harvest were moose taken in the western half of Subunit 13A (13A West), where a spike—fork regulation has been in effect since 1985. This antler restriction limited the harvest to approximately half of the yearling bull population, thereby protecting larger bulls while still ensuring recruitment of some yearling bulls. The spike-fork harvest in 1992 was 72 yearling bulls. The average harvest in this area since 1985 has been 80 spike-fork bulls (Range = 47-117). This harvest strategy has been effective, allowing bull:cow ratios to increase. Because of this increase, beginning with the 1991 season, a harvest of large bulls with 50-inch or larger antlers was allowed in that portion of 13A West between the Black River and the Susitna River. There were 38 large bulls taken in 1991 and 32 in 1992. Low kill rates were attributed to the remoteness of the area and lack of access. These totals are included in the total harvest figures.

Permit Hunts. The federal subsistence hunt replaced a previous State registration subsistence hunt in 1990. This action was a result of federal takeover of subsistence hunting on federal lands following the McDowell decision by the State Supreme Court. This decision disallowed rural preference under State law. Federal law includes a rural residency preference. The Bureau of Land Management (BLM) assumed management of subsistence moose hunting on federal land and issued registration permits to applicants who were rural residents of Unit 13.

Permits were issued both in Glennallen and in other rural communities by BLM representatives. Only 1 permit was issued per household. The bag limit was any bull. Harvests under this permit hunt were 74 bulls in 1990, 102 bulls in 1991 and 52 bulls in 1992. In 1992, 659 permits were issued and 344 reported hunting. Hunter success rates in this hunt have declined from 22% in 1990, to 19% in 1991, and 15% in 1992.

Hunter Residency and Success. Unit 13 residents accounted for 14% of the moose harvests in Unit 13 in 1992, an appreciable decline from the 23% average success rate for unit residents in 1990 and 1991 (Table 4). Nonresident moose hunters took 9% of the unitwide moose harvest in 1989, the last year they could hunt.

The hunter success rate for moose in Unit 13 was 25% during 1992. Hunter success rates during the past 3 years (1990-92) with reduced seasons have averaged 22% compared to an average success rate of 28% reported during the prior 2 years (1988-89) with longer seasons. One of the reasons the success rate didn't decline even more is that the number of individuals who reported that they hunted dropped considerably. Successful 1992 moose hunters spent an average of 5.0 days hunting, compared with 6.5 days for unsuccessful hunters in 1992. This is an increase in the amount of time spent in the field compared to 1990 when successful hunters averaged 4.3 days and unsuccessful 4.8 during the 5-day season. Even before the season reduction in 1989, a successful hunter spent only 5.5 days hunting and 6.1 days by unsuccessful hunters.

Harvest Chronology. Chronology data in 1990 and 1991 have little meaning because the hunting seasons were only 5 and 7 days long. Chronology data for 1992 (Table 5) indicates a majority of the moose harvest occurred late in the season. In 1992 when an early season extension occurred but off-road vehicle travel restrictions were enacted an increased moose kill early in the season did not occur. This is a harvest pattern similar to that observed in 1988 and 1989 before the season length was reduced. It appears that there has been a shift in hunting effort during the past few years. More moose have traditionally been killed during the early part of the season, simply because more hunters were in the field at that time. Increased hunting effort may now be occurring later in the season, as bulls become more susceptible because of the approaching rut and visibility increases due to leaves falling off the brush.

Transport Methods. Most successful hunters continued to use off-road vehicles. Highway vehicles, 3— and 4-wheelers and aircraft were also popular transport methods (Table 6). Highway vehicles were the most important (54%) transportation method for federal subsistence hunters in 1992, following a pattern observed by subsistence hunters every year.

Other Mortality:

Brown bear and wolf predation on moose directly influences moose abundance in Unit 13. Brown bears are major predators of moose calves and kill a high percentage of the annual calf production (Ballard et al. 1981). Brown bears are considered relatively abundant in Unit 13 for an interior population. Brown bear harvests by sport hunters increased during the 1980s.

Bear numbers probably have been reduced over much of the important moose range in northern Unit 13, especially along the Upper Susitna River (Subunits 13B and 13E). Whether this reduction in brown bear numbers has resulted in an increase in calf survival is unclear. Research, to determine the effects of increased brown bear harvests on moose calf survival, has not been conducted. One possible observation is that along with increased bear harvests, moose numbers increased between 1980 and 1987. This increase occurred during periods when wolves were also more abundant and presumably taking more moose.

Wolf numbers in Unit 13 increased in 1990 and have been high ever since. As a result wolf predation has become a much more important factor controlling moose abundance. Prior to 1990, spring estimates of wolf numbers in Unit 13 after the hunting and trapping season, averaged 150 wolves. Since 1990 spring estimates have averaged 233 wolves. The fall 1992 estimate was approximately 310-335 wolves for a resulting density of 7-8 wolves 1000 km^2. During the last 4 years wolf densities peaked in portions of 13B as high as 23.2 wolves/1000 km^2. Field observations of wolf predation on moose have increased notably. Predation on caribou during the winter has not increased to take the pressure off the moose population because most of the Nelchina herd leaves Unit 13 for 6-7 months and winters in Unit's 12 and 20 and in Canada.

Natural mortality attributed to deep snow conditions increased during the winters from 1988-89 through 1992-93. Winters during this period were classified as severe, based on deep snow depths observed at 17 snow courses scattered throughout the unit. Although these winters are considered severe on a unitwide basis, snow depths have varied between subunits. Observations in different portions of Unit 13 over the years have led to the conclusion that moose mortality due to deep snow conditions has not been density dependent. There appears to be a threshold effect where once snow reaches a certain depth, calf mortality increases. As snow depths increase, yearlings, then adult bulls, and finally adult cows also start dying. I have observed this pattern of differential winter mortality between years and subunits where moose numbers were both low and high. In addition to killing moose, deep snows often make it easier for wolves to take moose, thus predation rates also increased.

<u>Preliminary 1993 Harvest</u>. Preliminary harvest figures were obtained for the 1993 moose season by hand tabulating harvest report forms. To date a total of 1,124 moose have been reported taken in Unit 13 during the 1993 season under the new spike-fork or 50-inch regulation. This is an 81% increase in the unit-wide harvest over the 1992 reported kill. However, 450 (40%) of these bulls were taken in Subunit 13A West, most of which had been closed to the taking of adult bulls since 1990. The harvest of 674 bulls in the remainder of Unit 13 was similar to the previous year's take for the same portions of the unit. A breakdown of the harvest composition includes 18% spike/fork (n = 200), 31% $\leq$= 50-inch antlers with 3 or more brow tines (n = 343), and 51% $\geq$ 50-inch antlers (n = 558). Initial indications are that the spike-fork 50-inch regulation may be an effective harvest strategy that limits the take of bulls enough in Unit 13 to prevent a decline in the bull:cow ratio and still allow long hunting seasons.

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 prior to 1950, when fire suppression activities were initiated. Since then negligible acreage has burned. The most significant fire in recent years occurred in 1991, when approximately 5,500 acres burned on the west-side of Tazlina Lake in Subunit 13D. This was the first wildfire in a limited suppression area that was allowed to burn following procedures mandated by the Copper River Fire Management Plan. This plan, established several years ago, has for the most part been ignored and all wildfires have been suppressed, even if they occurred in an area designated as a limited suppression. Fire suppression has reduced the amount of seral habitat available as moose browse and has lowered the moose carrying capacity over extensive portions of Unit 13. Currently, climax upland and riparian willow communities are the most important habitat for moose in the unit. Evaluation of browse in these habitat types from 1983 to 1986 suggested browse species were able to withstand the level of use occurring at that time.

Use of prescribed fires is another method of improving moose habitat. However, the climate in Unit 13 typically limits the use of prescribed fire to only the very driest years. Also, liability associated with the use of prescribed fire decreases the possibility of extensive use, especially around areas with human habitation. Habitat improvement by mechanical methods such as crushing is an alternative to burning. To be effective, mechanical treatment must be done on sites where moose are known to concentrate especially during critical winter months which, in Unit 13, means riparian habitats. However, mechanical treatment is expensive, thus limited to small but important concentration areas near the road system where access for heavy equipment is available. A small strip of riparian willow habitat along the Gulkana River above Paxson that is important winter habitat and heavily browsed by moose during recent severe winters was cut over with the use of a hydro-ax in the spring of 1993. Initial willow regeneration was good. Additionally sites for mechanical treatment are being sought, especially along the Copper River in Subunit 13C where moose also winter during years of deep snow conditions.

CONCLUSIONS AND RECOMMENDATIONS

Moose numbers declined appreciably in Unit 13 between 1988 and 1991. Moose numbers were stable or declined only slightly between 1991 and 1993. Between 1988 and 1991 moose had declined by an estimate of 20 to 30%. Analysis of fall count data indicates this decline occurred in all sex and age classes of moose. This decline followed a period between 1980 and 1988 when moose numbers generally increased because of mild winters, reduced predation, and restricted human harvests.

Components of the decline in moose numbers included both increased adult mortality and decreased calf recruitment. Between 1988 and 1991 adult mortality increased and calf production and/or survival to fall declined. Beginning in 1992 adult survival and overall unitwide calf production and/or survival to fall increased. However, calves were not surviving the winter and being recruited into the population as yearlings. Lower yearling bull ratios support this conclusion. Severe winters and increased predation by wolves are considered to be the main causes of adult mortality and decreased calf production and survival. Variations in calf production and survival between subunits are thought to reflect both varying snow depths and wolf densities between subunits from year to year. Currently, overwinter survival of calves must be improved if moose numbers are to increase. If severe winters continue or the wolf population increases, it is likely moose numbers will decline further.

Management actions taken in 1990 to halt the decline of moose included reducing the harvest of bulls by shortening the season and eliminating cow hunts. Season reductions were effective and bull harvests were greatly reduced. The overall unitwide bull:cow ratios during this period did not decline after the initial drop in response to the first bad winter. However, in some subunits with heavy hunting pressure the harvest restrictions were not enough and ratios did decline. Some decline in the bull:cow ratio was expected even with a reduced harvest because bulls (both yearlings and adults) have higher natural mortality rates than cows during severe winters. Postrut bulls are in poorer body condition than cows and are more vulnerable to deep snow conditions. Also, on federal lands, subsistence hunting for any bull negated the effect of the 36-inch minimum antler regulations and contributed to the decline in adult bulls. Bull:cow ratios currently are below management objectives in Subunits 13B, and 13E.

Instituting a unitwide bag limit of 1 bull having a spike or forked antler or a 50-inch minimum spread was a management attempt to allow unlimited hunter participation, and a long hunting season without decreasing bull:cow ratios below stated objectives. The theory behind this management strategy is that at least half of the yearling bulls have antlers larger than spike forks and will not be harvested, thus assuring annual bull recruitment. Also, 2 or 3 cohorts of bulls with antlers smaller than 50 inches or having less than 3 brow tines will not be harvested and will be available to accomplish yearly breeding requirements. This harvest strategy appears to be working in units with a considerable amount of forested habitats or limited access.

Preliminary results from the 1993 season in Unit 13 suggests this harvest strategy may also work in Unit 13. Overall, the observed drop in the bull:cow ratio was attributed to a very high adult bull harvest in 13A West where adult bulls had been almost completely protected for 3 years. In those subunits (13B and 13E) with adult bull:cow ratios below the current management objectives, much of the decline in bulls occurred in prior years. Complete analysis of the 1993 harvest will be necessary before drawing final conclusions. However, based on fall 1993 composition count data that was obtained after the hunting season, I recommend maintaining the spike/fork, 50-inch regulation and 20 August.-20 September dates for the 1994 season.

Continued monitoring of this new hunting regulation will be needed. Emphasis should be placed on determining just what the bull:cow ratio will be maintained at under this strategy. It may well be that the current adult bull:cow management objective is not attainable. Management options to decrease harvest levels under the current bag limit, if needed, include shortening the season and/or implementing vehicle use restrictions in certain areas or over specific time portions of the moose season. Specific areas of management concern include 13E and 13B where bull:cow ratios are below management objectives. In Subunit 13B the bull:cow ratio is also adversely affected by the federal subsistence hunt bag limit that allows taking any size bull by local residents. Also of concern is Subunit 13A, because the 13A West habitat is more open with less timber therefore visibility is better and access by ORV's is very good. Subunit 13A has a long history of overharvest because good visibility and easy access leads to a high harvest of whatever class of bulls is legal.

Research is needed in Unit 13 to assess a number of management issues. Moose movement studies are needed to determine the effect movement has on fall trend count results. Some count differences between years may reflect movements of moose rather than population changes. Mortality studies are also needed. The causes and rates of adult and calf mortality must be determined. By being able to better enumerate moose numbers and determine sources and rates of mortality, we will be able to make more pertinent and effective decisions pertaining to moose management in Unit 13.

LITERATURE CITED

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Table 1. Unit 13 fall aerial moose composition counts and estimated population size, 1988-93.

Regulatory Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves %	Adults	Total moose observed	Moose /hour	Density moose mi^2 (range)
1988/89	31	12	28	18	5629	6846	72	1.8 (.5-3.0)
1989/90	25	10	21	15	5371	6279	65	1.6 (.6-2.8)
1990/91	25	5	18	13	5427	6209	59	1.5 (.5-2.8)
1991/92	25	6	17	12	5556	6295	58	1.4 (.6-2.6)
1992/93	25	9	24	16	5398	6438	61	1.6 (1.1-2.5)
1993/94	23	8	25	17	4072	4905	60	1.4 (0.4-2.8)

Table 2. Unit 13 fall aerial moose composition counts, 1993.

Subunit	Bulls: 100 cows	Yearling bulls:100 cows	Calves: 100 cows	Calves %	Total moose observed	Moose /hour	Density moose mi^2 (range)
13A	22	7	20	14	1451	62	1.5
13B	20	7	28	19	2293	60	1.5
13C	30	11	24	22	545	79	2.3
13D	89	8	19	9	150	26	0.4
13E	15	7	19	14	466	60	1.1

Table 3. Unit 13 moose harvest[a] and accidental death, 1988-92.

Regulatory Year	Hunter Harvest: Reported M	Reported F	Reported Total[b]	Estimated Unreported	Estimated Illegal	Estimated Total	Accidental Road	Accidental Train[c]	Accidental Total	Grand total
1988/89	1231	28	1259	25	10	35	50	70	120	1414
1989/90	1178	0	1178	25	10	35	50	151	201	1414
1990/91	521	0	521	25	10	35	50	31	81	637
1991/92	688	1	689	25	10	35	50	35	85	809
1992/93	607	0	607	25	10	35	50	93	143	785

[a] Includes permit hunt harvest
[b] Includes unknown sex.
[c] 13E

Table 4. Unit 13 moose hunter[a] residency and success for all hunts, 1988-92.

Regulatory Year	Successful: Local[b] resident	Nonlocal resident	Nonresident	Total[a]	Unsuccessful: Local[b] resident	Nonlocal resident	Nonresident	Total[a]
1988/89	263	821	113	1259	665	2138	104	3070
1989/90	249	818	111	1178	506	2598	80	3184
1990/91	123	397	1	521	622	1520	2	2144
1991/92	149	539	1	689	709	1634	4	2347
1992/93	84	523	0	607	532	1331	3	1866

[a] Includes unspecified residency.

Table 5. Unit 13 moose harvest chronology percent[a] by time period, 1988-92.

Year	Season dates	Week of Season 1st	2nd	3rd	4th	5th	n
1988/89	25 Aug.-20 Sept.[b]	2	13	36	30	19	1,344
1989/90	25 Aug.-20 Sept.[b]	2	15	31	28	24	1,263
1990/91	5-9 Sept.[b]	2	2	71	7	5	
	25 Aug.-20 Dec.[c]						
	1-31 Dec.[b]	4	4	3	1	1	606
1991/92	5-11 Sept.[b]	3	50	42	5	--	644
	25 Aug.-20 Sept.[c]						
1992/93	1-14 Sept.[b]	1	7	27	61	4	587
	25 Aug.-20 Sept.[c]						

[a] State and federal subsistence, and general hunts totaled.
[b] State hunt.
[c] Federal hunt.

Table 6. Unit 13 moose harvest percent by transport method, 1988-92.

Regulatory year	Percent of Harvest: Airplane	Horse	Boat	3- or 4- wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1988/89	19	4	6	14	0	32	19	6	1,344
1989/90	20	4	8	18	0	28	19	3	1,263
1990/91	9	3	9	18	6	27	24	4	606
1991/92	12	4	11	22	0	31	16	4	689
1992/93	14	5	10	18	0	26	23	4	607

LOCATION

<u>Game Management Unit</u> 14A (2,561 mi^2)

<u>Geographical Description</u> Matanuska Valley

BACKGROUND

Moose numbers in the Matanuska Valley increased from low levels before 1930 to numbers ranging between 2,000 and 7,000. Land clearing and fires, occurring during settlement in the 1930s and 1940s, promoted increases in moose winter habitat. Intensive predator control by the federal government during the 1940s and 1950s aided rapid moose population growth. Moose numbers peaked in the late 1960s. A stratified random census conducted in February 1966 (Rausch 1967) suggested Subunit 14A contained a wintering population of between 5,000-7,000 moose. Moose numbers declined in the early 1970s, following 2 deep snow winters and large cow harvests. The population again peaked during the late 1980s and has remained high.

In the 32 years following statehood, hunters harvested more than 18,250 moose in Subunit 14A. Annual harvest levels in the first 12 years (1960-71) ranged from 200-1,300. While the harvest was predominantly bulls, averaging 350 annually, harvest of antlerless moose reached significant levels in peak harvest years (1962-63, 1965-66, and 1971-72). The antlerless moose harvest was 1,100 in 1962-63 and 479 in 1971-72. Antlerless moose seasons were eliminated during 1972-77, and the mean annual harvest of bulls declined to 251 (range = 167-346). Antlerless seasons were again allowed during 1978-79 to 1992-93 (with the exception of 1990-91). During this period mean bull harvest was 338 (range = 201-530) and mean cow harvest was 111 (range = 39-173).

During the early 1980s nonhunting mortality became responsible for up to 25% of total annual moose mortality. A construction boom in the Matanuska Valley and a series of moderate snow depth winters resulted in increased conflicts between man and moose. Moose browse declined on traditional winter ranges while browse increased along roadways and in subdivisions. The new browse sources attracted moose to areas with increased vehicle traffic. Motorists began killing more than 100 moose annually. Trains killed 4-45 moose annually. Additionally, illegal harvest increased proportionally to the human population. With annual human-caused mortality exceeding 800 moose, population numbers appeared to stabilize at 5,000-6,000 moose.

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

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.

Management Objectives

To maintain a population of about 5,000-5,500 moose with a minimum sex ratio of 20 bulls:100 cows.

Human Use Objective

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

METHODS

During 1-6 December 1991, a population census of the subunit was conducted using stratified random sampling (Gasaway et al. 1986). That portion of Subunit 14A ≤ 3,000 ft. elevation (1,591 mi^2) was subdivided into 119 sample units (SU). SUs were classified into 4 density strata (low, medium, high, and super-high). We sampled 28 SUs which included 5 low, 11 medium, 8 high and 4 super-high. Intensive subsampling was conducted in 26 SU to estimate a sightability correction factor (SCF). During the census, sex and age composition were recorded and populations by sex and age were calculated using MOOSEPOP (D. Reed pers. comm.)

During 13-14 November 1992, 19 of the 28 SU sampled during December 1991 were again surveyed, without conducting intensive subsampling to estimate a SCF. Seventeen SU were completed and results were compared to results obtained from surveys of the same 17 SU in 1991. The relationship of the 1991 SU composition ratios to the calculated ratios of the population, derived from MOOSEPOP, was assumed to be the same relationship between the 1992 observed ratio and the actual 1992 population composition. Population trend was calculated by a direct comparison of total moose observed in the 17 SU between 1991 and 1992.

Between 25-29 November 1993, a "Becker survey" was conducted in the subunit. We sampled 27 SU which included 5 super-high strata, 11 high, 6 medium and 5 low. Intensive subsampling of 19 SU allowed the estimation of a SCF, applicable to this survey. MOOSEPOP was used to calculate population size and sex and age composition.

We surveyed moose during March-April in primary wintering areas of the subunit to assess calf over-winter survival and potential recruitment.

The harvest of bulls during the general season was obtained from successful hunters by harvest reports and 1 reminder letter. Drawing-permit reports were required of successful antlerless moose hunters. Numbers of moose killed by trains was provided by the Alaska Railroad Corporation, and numbers of moose killed by highway vehicles, killed illegally, or killed in defense of life or property (DLP) were provided by Department of Public Safety.

Incisors from nonhunting mortality and from antlerless moose permit hunts were collected for age determination and population age structure evaluation. Preparing specimens and estimating age was begun on a backlog of these biological specimens from as far back as 1986. Results of this evaluation are incomplete.

RESULTS AND DISCUSSION

Population Status and Trend

Moose numbers in Subunit 14A remained stable at high densities (Table 1). In spite of moderate winter mortality during 1989-90, estimated densities of moose appeared higher than during 1988. Increases in moose numbers associated with Point McKensie agriculture project may have compensated for localized declines caused by winter conditions.

Population Size:

The December 1993 survey resulted in an estimate of 5,672, $\pm$798 (80% confidence intervals) total observable moose, a density of 3.6 observable moose/mi^2 (Table 1). Snow and frost in trees caused the SCF to reach 1.31, which was higher than the 1.17 SCF obtained during December 1991. In 1991, a fall census produced a higher point estimate of 5,885 observable moose; however, a post-census evaluation of SU strata classification caused us to conclude the true observable population was probably closer to 5,600. The fall 1993 estimate supports the validity of that post-census evaluation.

Population Composition:

The December 1993 survey indicated the bull:cow ratio had recovered to 16:100 (Table 1). Following the hard winter of 1989-90, the bull:cow ratio declined to 14 bulls:100 cows. The spike/fork/50-inches (S/F/50") antler size restrictions for hunters enforced for the first time during fall 1993 was primarily responsible for the recovery. The November 1992 fall composition survey suggested the ratio had declined further to 12 bulls:100 cows. The earlier decline was blamed on winter mortality and hunter impacts (Griese 1993), and between 1991 and 1992 the primary cause was hunting mortality. Short-yearling recruitment in spring 1992 was only slightly higher than the previous 2 years of low recruitment (Table 2), which suggested that winter conditions remained an important factor. Short-yearling recruitment during 1992-93 improved as a result of a mild late winter and spring.

The fall calf component declined 21% during 1988-1992 (Table 1). Any one or combination of the following factors may be responsible for that decline: 1) increasing summer/fall predation on calves, 2) reduced calf vitality due to nutritional stresses (on the cow) caused by unfavorable weather or declining habitat carrying capacity, or 3) low mature-bull:cow ratios during rut.

Mortality

Harvest:

Season and Bag Limit. The season for subsistence, resident and nonresident hunters was 1-20 September during 1991-92. The bag limit was 1 moose; however, antlerless moose could be taken by drawing permit only, and 100 permits were issued. During 1992-93 the season remained unchanged but 400 antlerless moose permits were issued.

Game Board Actions and Emergency Orders. In response to a request by the department to liberalize the number of antlerless permits, the Board of Game authorized up to 400 drawing permits to be issued during fall 1992. The request was based on an apparent recovery of moose densities.

Declining bull:cow ratios and increased hunting effort in the subunit caused by restricted opportunities in adjacent subunits prompted the Board of Game to adopt antler restrictions for a legal moose in Subunit 14A (in addition to most road accessible areas of southcentral Alaska). A legal bull became a male with a spike or fork antler on 1 side, or with 3 or more brow tines on 1 side or whose antler width was 50 inches or greater. In addition the Board increased season length to 32 days (20 August to 20 September).

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

Hunter Harvest. The combined reported harvest of the general season and permit hunts for 1991-92 and 1992-93 was 534 moose (490 bulls, 39 cows, 5 unspecified) and 694 (530 bulls, 157 cows, 7 unspecified), respectively (Table 3). After only 1 year of reduced season length and 2 years of reduced numbers of antlerless moose permits, harvest levels surpassed pre-1990 levels.

Composition of hunter harvest failed to meet pre-1990 levels. During 1986-89 hunters harvested moose at a ratio of 100 bulls:34 cows (Griese 1993). During 1990-92 that ratio increased to 100:15. In 1992-93, though cow harvest approached pre-1990 levels, the sex ratio in the harvest was only 100:30. Preliminary harvest reports for fall 1993, however, suggest that high bull:cow harvest ratios in the past 3 years were compensated somewhat by this fall's ratio of nearly 100:100. Other human-caused mortality appears not to be sex selective.

Moose mortality, caused by humans by means other than legal hunting (not including unreported legal harvest), subsided from record levels during the winter of 1989-90 (412) to near the previous 3-year mean of 184 moose (Griese 1993). During 1991-92 and 1992-93 mortality from these factors averaged 187 moose (Table 3). Moose killed by collisions with highway vehicles comprised 80% of the total. The number of moose killed by trains, within the subunit boundary, declined from pre-1989-90 levels which approached 16% (24% during 1989-90) to a 2-year average of 6%.

Permit Hunts. Patterns of success and participation for antlerless moose hunt permittees were consistent with past patterns. In spite of fluctuations in number of permits issued (100-400) during 1991-92 and 1992-93, 39% of permittees were successful (Table 5). In the 2 years previous to 1990-91, 41% of permittees were successful. Participation in hunting by permittees during this 5-year period ranged from 87-89%.

Hunter Residency and Success. Hunter participation in the general bull hunting season reached record levels during fall 1992-93; 3,344 individuals hunted Subunit 14A during 1992-93 compared to 2,855 hunters the previous fall (Table 4). We believe more hunters chose Subunit 14A as a hunt destination due to a longer season, fewer access restrictions, and higher moose densities than other southcentral game management units. Increase in use did not cause any changes in residency characteristics of hunters.

Hunter success increased from 14% during 1990-91 to 17% and 16%, during 1991-92 and 1992-93, respectively (Table 4). High hunter participation prevented hunter success from recovering to pre-1990 levels. During 1986-89 hunter success was 18%, with 428-456 successful hunters (Griese 1993). The number of successful hunters increased to 539 during fall 1992.

Harvest Chronology. With the exception of 1990-91, harvest chronology during 1988-1992 was remarkably consistent among years. The abbreviated general season length (10 days) during 1990-91 produced 211 moose (81% of the harvest) during the first week (Table 6). In other years, harvest during the first, second and third weeks produced approximately 52%, 22% and 22% of the total harvest, respectively.

Transport Methods. Highway vehicles and 3- or 4-wheelers were the dominant means of transportation among successful moose hunters because of the many roads and good trail access in much of the subunit. Hunters using these methods have accounted for over 55% of the moose harvest in the past 5 years (Table 7). The increase in use of 3- or 4-wheelers probably reflects increases in vehicle ownership, expanding trail systems, and perhaps a sense of increasing competition.

Other Mortality:

Natural mortality for adult moose during 1991-92 and 1992-93 was assumed to be 6-8% (R. Modafferi pers. comm.), while over-winter calf mortality was calculated at 55 and 35%, respectively. During 1989-90 and 1990-91 calf mortality through April reached an estimated 60% (Griese 1993). Winter calf mortality, previously calculated for the subunit for mild to moderate winters, was 20-25%.

Predation may be having an increasing influence on over-winter calf survival. Wolf numbers appear to be increasing, with reestablishment of the Knik River wolf pack, evidence of 1 or 2 wolf packs using the Matanuska River, and sightings of wolves near the Susitna River and Palmer Hayflats State Game Refuge.

Habitat

Enhancement:

Funds were appropriated through legislation to enhance moose habitat in response to high levels of winter moose mortality during 1989-90. During 1991-1993 expenditures within Subunit 14A included a controlled burn of 900 acres southwest of Willow, mechanical treatment of 250 acres, and experimentation on the effects of domestic cattle grazing on vegetation (W. Collins pers. com.).

Funds were also used for purchase of important moose habitat. The purchase of 160 acres of privately owned land within the MVMR will enable federal funds to be used for reclamation of open pit coal mines. Reclamation design will optimize production of seral vegetation, enhance access for vegetation maintenance, and provide for unobstructed public access to the MVMR. Reclamation activities are scheduled to begin during 1994.

CONCLUSIONS AND RECOMMENDATIONS

The population size objective was exceeded during 1991-92. The probability was >50% that the moose population exceeded the upper limit of the population objective of 5,500 moose.

Preventing further population growth, and perhaps reducing the moose number through the optimum harvest of cows, should be the objective in subsequent years. Antlerless moose permit hunts should be used to tailor the winter distribution of moose to take advantage of localized habitat abundance. The S/F/50" antler regulation should correct low bull:cow ratios if enforced for 4-5 years.

The population objective bull:cow ratio (>20:100) was not attained. Low bull:cow ratios were caused, primarily, by a higher than usual bull:cow ratio in the hunter harvest during 1990-92. However, a 100:100 harvest ratio during fall 1993, began what is expected to be a steady recovery of the fall bull:cow ratio. The objective ratio is expected to be achieved during fall 1995 as an effect of the S/F/50" antler restriction.

The human use objective (600-700 moose harvested by hunters) for the period 1991-1992 was attained as average harvest reached 614 moose. However, preliminary harvest data for fall 1993 and modeling predictions for future harvest (Fig. 1) suggest that harvest levels for 1993-97 may be below the minimum objective of 600 moose, primarily due to the S/F/50" antler restriction.

Long term benefits of the S/F/50" regulation outweigh the disadvantages. The S/F/50" regulation is expected to increase bull:cow ratios to >20:100, to weatherproof (to protect during deep snow winters) bull:cow ratios making annual changes to season length unnecessary, to allow greater season length, to increase viewing opportunity of bull moose, and to allow opportunity for school age children to participate in family hunting activities. Disadvantages of the regulation can be expected soon after adoption and include greatly reduced bull harvest during the first 3 years, confusion and disfavor by some hunters, and an increase in illegal killing and wanton waste of bull moose (Schwartz et al. 1992).

Bull harvest during the first year of this regulation was predicted to reach 230 bulls in Subunit 14A (Fig. 1). By the sixth year, harvest was predicted to stabilize at 92% of previous levels. Hunter disfavor, a product of misunderstanding and an unwillingness to change hunting patterns, can be resolved through education and time. Schwartz et al. (1992) observed a reduction in the illegal take of antlerless moose and an increase in wanton waste of sublegal bull moose. Education is also important in reducing illegal kills and wanton waste, but providing legal deterrents is paramount.

Bull:cow ratios may exceed objectives in later years. However, if bull cow ratios exceed objective levels, excess bulls may be harvested through adding open season days following the rut or issuing a calculated number of "any bull" permits.

I recommend that the S/F/50" regulation be retained for a minimum of 5 years. To observe and analyze the full effect of this type of harvest strategy and the associated education program requires a complete cycle of bull cohorts from yearling through age 5 (Schwartz et al 1992). Most bulls are expected to have antlers making them legal by age 5 and all bulls by age 6 will become legal.

I recommend we annually assess fall population and composition and spring composition to optimize opportunity to harvest annual recruitment. Random stratified censuses should be conducted during fall every fifth year, with alternating Becker surveys and modified composition surveys between censuses. Spring composition surveys assure recruitment levels.

This pattern of surveys and censuses would allow maximum allocation of antlerless moose permits, and allow human use objectives be achieved sooner.

Human use objectives are unlikely to be reached again before 1997. Current goals and objectives were adopted by the department during a predator/prey management evaluation open to public and Board scrutiny. The need to add antler restrictions to the harvest to correct bull:cow ratios was not anticipated in that evaluation. To reach an average harvest of 600 moose sooner would require the conversion of a significant portion of highway-killed moose to the hunter harvest.

Conversion of a significant number of highway-killed moose to the hunter harvest is unlikely, given current options. Investment in highway construction standards, necessary to reduce mortality of moose by highway vehicles, is not currently favored by Alaska Department of Transportation due to costs and priorities. The expense of constructing a moose-proof highway (McDonald 1992) is prohibitive until the number of moose and humans killed or injured become publicly unacceptable or financially justified. Under the current program of distributing road-killed moose to the public, the public is given the impression that poor Alaskans are benefitting from this "necessary evil," thus making it acceptable. We are unsure that "Give Moose a Brake" signs, which post cumulative roadkill statistics by week, heighten driver awareness as intended. Intercepting as many of the moose destined to cross major highways through selective harvest is currently being attempted. Finally, effecting habitat changes that would intercept and hold migrating moose appears difficult because of cost and land ownership patterns.

I recommend we identify all potentially beneficial sights for controlled burns and seek permission to conduct burns as weather and funds permit. Habitat manipulation by controlled burns is clearly the most reliable and cost effective method to produce significant quantities of early seral stages in Subunit 14A (W. Collins, per. com.). The 900 acre burn southwest of Willow is a good example of its effectiveness.

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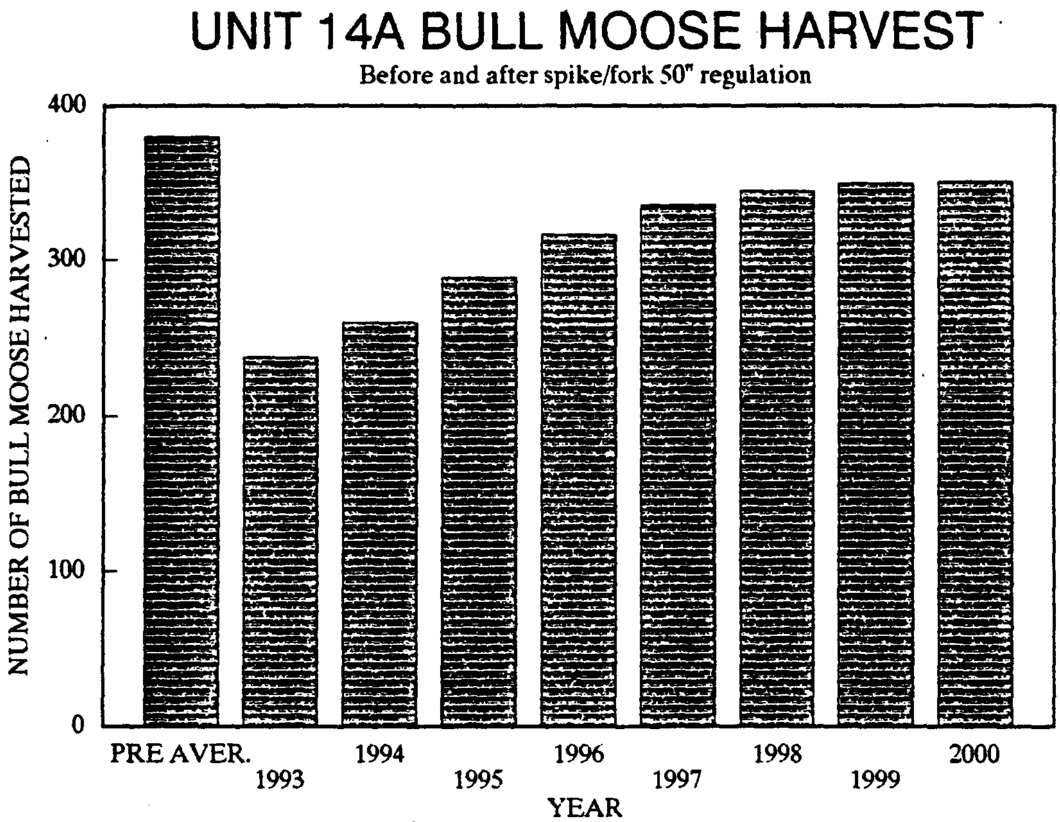

Figure 1. Comparison of past average bull moose harvest to predicted harvest under a "spike/fork/50-inches/3-brow tine" antler restriction in Subunit 14A, Alaska (C.A. Schwartz)

Table 1. Subunit 14A fall aerial moose composition surveys and censuses, 1988-1993.

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	Total moose observed	Moose/ mi^2	Estimated population size
1988/89[a]	29	10	47	27	1,271	1,692	3.2	5,137±895[b]
1989/90[c]	27	9	40	24	1,070	1,409	n/a	4,500-6,000
1990/91[d]	--	--	--	--	--	--	--	4,000-5,500
1991/92[a]	14	5	39	26	1,110	1,472	3.7	5,885±706[b]
1992/93[e]	12	5	37	25	743	984	n/a	5,200-6,700
1993/94[f]	16	11	37	24	942	1,232	3.6	5,672±798[b]

[a] Gasaway, et al (1986) census.
[b] 80% confidence intervals.
[c] Sample from count areas 1, 5B, 7, 8, 9, & 10.
[d] No surveys flown.
[e] A sampling of 1991 survey units.
[f] Becker survey.

Table 2. Subunit 14A late winter aerial moose composition surveys, 1988-1992.

Regulatory year	Date	Count Areas	Total moose	Calves[a]	(%) Calves
1988/89	02/16-28	5&8	981	219	22
1989/90	03/15	5&6	393	64	16
	04/10-13	5,6,7&8	175	22	13
1990/91	03/04-11	5,6&8	1,348	167	12
1991/92	02/25	7	121	26	21
	04/10	3,4,5,6&8	546	76	14
1992/93	03/24	4,5,6,7&8	693	131	19

[a] Calves = short yearlings

Table 3. Subunit 14A moose harvest[a] and accidental death, 1988-92.

Regulatory year	Reported M	Reported F	Reported Total[b]	Estimated Unreported[c]	Estimated Illegal[d]	Estimated Total	Accidental deaths[e] Road	Accidental deaths[e] Train	Accidental deaths[e] Total	Grand total
1988/89	454	150	612	31	18	49	140	20	160	821
1989/90	448	173	624	31	62	93	250	100	350	1,067
1990/91	258	0	259	20	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

[a] Includes permit hunt harvest.
[b] Total includes moose of unknown sex.
[c] This estimate was derived by taking minimum of 5% of the total reported kill.
[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. Subunit 14A moose hunter[a] residency and success, 1988-92.

Regulatory year	Successful Local[b] resident	Successful Nonlocal resident	Successful Nonres	Successful Unk	Successful Total(%)	Unsuccessful Local[b] resident	Unsuccessful Nonlocal resident	Unsuccessful Nonres	Unsuccessful Unk	Unsuccessful Total	(%)	Total hunters
1988/89	423	11	5	17	456 (18)	1,950	53	20	84	2,107	(82)	2,563
1989/90	426	14	12	1	453 (18)	2,004	50	17	22	2,093	(82)	2,546
1990/91	242	3	8	6	259 (14)	1,466	22	14	26	1,528	(86)	1,787
1991/92	469	11	9	6	495 (17)	2,286	39	12	23	2,360	(83)	2,855
1992/93	500	12	12	15	539 (16)	2,629	50	24	102	2,805	(84)	3,344

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

Table 5. Moose harvest data by permit hunt[a] in Subunit 14A, 1988-92.

Regulatory Year	# Applicants	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	Cows	Total
1988/89	10,864	400	13	48	39	13	143	156
1989/90	12,380	400	11	46	43	8	163	171
1990/91[b]	---	0	---	---	---	---	---	---
1991/92	7,057	100	13	48	39	0	39	39
1992/93	11,000	400	12	49	39	3	154	157

[a] Permit hunts 919 and 920 combined.
[b] Permit hunts discontinued for 1990/91.

Table 6. Subunit 14A moose harvest chronology[a], 1988-92.

Regulatory year	Before season opened	Weeks of season					After season closed	Unknown	Total
		1st	(%)	2nd	3rd	4th			
1988/89	6	236	(52)	103	91	-	8	12	456
1989/90	2	260	(57)	96	77	-	7	11	453
1990/91[b]	2	211	(81)	36	-	-	2	8	259
1991/92	0	260	(52)	109	110	-	5	15	499
1992/93	0	260	(48)	120	144	-	0	15	539

[a] Does not include harvest from drawing permit hunts.
[b] Open season = Sept. 1-10, other years = Sept. 1-20.

Table 7. Subunit 14A moose harvest[a] percent by transport method, 1988-92.

Regulatory Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk	Total sample size
1988/89	5	5	12	17	0	12	42	7	456
1989/90	8	5	16	19	0	9	37	7	453
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

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

LOCATION

Game Management Unit: 14B (2,152 mi^2)

Geographical Description: Western Talkeetna Mountains

BACKGROUND

Prior to 1900, moose populations in Subunit 14B probably fluctuated in response to vegetation changes brought about through natural wildfires. Moose densities increased during 1900-1950 following predator control and land-clearing associated with human settlement (LeResche et al. 1974). Peaks in population numbers probably occurred late in the 1960s and again in the late-1970s to early-1980s. High hunter harvest during 1971-72 and 2 consecutive deep snow winters (1971 and 1972) that caused high natural mortality produced an abrupt decline in the population. In spite of deep snow during 1984-85, mild winters during the remainder of the 1980s allowed population increases.

The first reliable estimate of population size occurred in December 1987, when the population was estimated at 2,900 moose. A deep snow winter in 1987-88 initiated a decline, then winter 1989-90 brought record snow levels and significant moose mortality. Consecutive surveys during fall 1989 and fall 1990 confirmed a 35% decline in moose numbers during that winter; the estimate in fall 1990 was approximately 1,800 moose. Since 1990 the population has remained at or below that level.

Fall composition surveys conducted during the late-1950s indicated inaccessible portions of Subunit 14B had bull:cow ratios of 66 bulls:100 cows in some years. Areas accessible by road or rail had much lower ratios. During 1968-1985 the bull:cow ratio averaged 30 bulls:100 cows, only slightly higher than the average during 1987-1992 (29 bulls:100 cows). During the late-1950s through 1984, fall calf:cow ratios generally ranged between 25-40 calves:100 cows (with an average of 30 during 1968-1984). During 1987-92 the average declined to 24 calves:100 cows.

Population identity studies conducted during 1980-1990 in the Susitna Valley revealed unexpected movement patterns (Modafferi 1992). Moose that spend the summer in southern Subunit 14B (south of the Kashwitna River) generally travel south to wintering areas in Subunit 14A near Houston, Wasilla and Palmer. Moose that summer north of the Kashwitna River generally travel west to winter in low-elevation riparian areas along the Susitna and Talkeetna Rivers. Also, some 14B moose winter in remote alpine areas.

Paralleling the Susitna River are the tracks of the Alaska Railroad Corporation (ARC) and the George Parks Highway. Human settlement in this transportation corridor (TC) has produced attractive moose browse. Moose wintering here share their winter range with moose from Subunits 16A, 14A and 13E.

Population identity studies helped identify areas containing important seasonal habitat. In 1989, critical postrut and early winter moose habitat on the west-slope of Willow Mountain was designated by the legislature as the Willow Mountain Critical Habitat Area (WMCHA).

Moose numbers in Subunit 14B are limited primarily by available habitat, predation and mortality due to collisions with autos and trains. Available habitat appears to be declining due to lack of events (such as natural fire or logging) that might produce forest succession stages containing prime moose browse (Rausch 1977).

Hunter harvest of moose has fluctuated with season/bag limit restrictions. Hunting seasons have generally become more restrictive in response to improved access and weather-related changes in population levels. Cow seasons were conducted intermittently from the early-1960s through 1987. These seasons were initiated to take advantage of a presumed harvestable surplus, and to hopefully reduce moose mortality due to auto/train collisions. Late-winter harvests probably included moose from adjacent subunits.

From 1966 to 1970, hunters killed an average of 144 moose annually, predominantly bulls. Liberal cow seasons allowed peak harvests to reach 372, 534 and 347 moose during 1971, 1984 and 1987, respectively (Griese 1993). There have not been cow seasons since 1987.

Because wintering areas are associated with the main transportation route between Fairbanks and Anchorage, conflicts with trains and highway vehicles are many. Accidental mortality (which includes moose from Subunits 16A, 13E and 14A) often exceeds Subunit 14B hunter harvest. The number of moose killed by trains and highway vehicles is a function of snow depth, population density, moose movements and proximity of available browse to roads/rails. During 1989-90, 411 moose died in auto/train collisions; previous peaks in accidental mortality occurred during 1970-71, 1978-79, 1982-83, 1984-85 and 1987-88. Efforts by the ARC to reduce moose mortality due to trains increased during winter 1989-90, at the urging of this agency and the public. Public and media reaction to the increasing moose deaths also prompted release of emergency funds by the Governor and private donations for a "Save the Moose" effort. Many citizens, private organizations, state and federal agencies also contributed labor and resources.

MANAGEMENT DIRECTION

Management Goal

The moose management goal for Subunit 14B is to produce high yields of moose for humans and to provide maximum opportunity to participate in hunting for moose.

Management Objective

The moose management population objective for Subunit 14B is to increase the population to 2,500-2,800 moose by 1995, with a posthunting sex ratio of not less than 20 bulls:100 cows. The human use objective is to achieve and maintain an average annual harvest of 200-300 moose by 1997.

METHODS

During November 1992, a "Becker survey" (E. Becker pers. commun.), a modified version of the stratified random sampling census technique (Gasaway, et al. 1984), was conducted. This survey produced confidence intervals for estimates of observable moose, but did not produce a sightability correction factor (SCF). Following the survey, SCFs were estimated, based on past SCFs, for each density strata (1.4, 1.35 and 1.25 for low, medium and high density areas respectively). Composition data recorded during the survey allowed estimation of observable moose by sex and age. Surveys were not conducted during 1991.

Harvest of moose by hunters was monitored with harvest reports from any person who reported hunting in the subunit. Numbers of moose killed by trains was provided by the ARC, and numbers of moose killed by highway vehicles, killed illegally, or killed in defense of life or property (DLP) were provided by Department of Public Safety.

RESULTS AND DISCUSSION

Population Status and Trend

Moose numbers in Subunit 14B appeared to be stable or decreasing slightly prior to the winter of 1989-90 (Table 1). During that winter the population declined approximately 35% due to heavy snows and subsequent starvation and human-induced accidental mortality. In recent years the population has remained low.

Population Size:

During 10-12 November 1992, the moose population in Subunit 14B was estimated at 1,582 $\pm$178 moose (Table 1). This estimate was derived by applying SCFs (by strata) to the estimate of 1,164 $\pm$ 130 (80% confidence interval) observable moose.

Population Composition:

The bull:cow ratio during fall 1992 was 27 bulls:100 cows (Table 1). A significant decline in the proportion of bulls occured between 1987 and 1989, possibly aided by the cessation of cow harvest and improved hunter access. Since 1989, the bull:cow ratio has remained relatively stable at 24-27 bulls:100 cows.

Calf survival to fall has remained relatively low but stable in recent years, with calves comprising 14-16% of the fall population (Table 1). Recruitment to the population appeared low; fall 1992 surveys yielded only 4 yearling bulls:100 cows.

Mortality

Harvest:

Season and Bag Limit. During both 1991-92 and 1992-93 the season for resident and nonresident hunters was 1-10 September; the bag limit was 1 bull. During both seasons the portion of Subunit 14B west of the Anchorage-Fairbanks powerline intertie remained closed to moose hunting.

Game Board Actions and Emergency Orders. During 1986-1989 season length varied from 20-30 days, and the bag limit was either 1 moose or 1 bull (Griese 1993). The low population remaining after the severe winter of 1989-90 prompted the Board (in an emergency session) to close Subunit 14B to moose hunting during 1990-91. A 10-day season was authorized the following year.

During spring 1993, the Board approved a new moose season, incorporating a selective harvest strategy based on antler restrictions, for all of Unit 14. The fall 1993 season was 20 August to 20 September, and the legal animal was a bull with spike or fork antler on either side (yearlings), or a bull with antlers 50 inches wide or having 3 brow tines on 1 side (SF/50 regulation). The area west of the Anchorage/Fairbanks powerline intertie was again opened for hunting.

Hunter Harvest. Hunter harvest was low during 1991-92 and 1992-93 (Table 2), due to low moose numbers, relatively short seasons, and the prohibition on hunting in the TC. In both years, harvest was within predicted (from population modeling efforts) sustainable limits; considering also that the objective bull:cow ratio was lowered from 30 to 20 bulls:100 cows.

Using the current population management objectives, modeling predicted approximately 115 males (and 0 females) would be available to harvest during 1993. However, harvest was projected to reach only 45 bulls under the SF/50 regulation. Preliminary harvest from fall 1993 was 29 bulls, of which 7 were yearlings.

Hunter Residency and Success. Resident hunters of Subunits 14A and 14B accounted for 50-55% of the 1991-92 and 1992-93 moose harvest in Subunit 14B (Table 3). The proportion of local resident hunters has increased during 1988-1992; it is likely that with the decline in moose numbers following winter 1989-90, and subsequent short (or closed) seasons, most nonlocal hunters have sought moose hunting opportunities elsewhere.

Hunter success was 15% during 1991-92, and decreased to 11% during 1992-93 (Table 3). During previous years hunter success had been as high as 20%, especially during the years (1986-87, 1987-88) of either sex moose seasons.

Harvest Chronology. During 1991-92 and 1992-93 over 70% of the harvest occurred during the first week of the season (Table 4). While this was higher than past seasons, the difference can be attributed to the restricted length of the season (10 days).

Transport Methods. Most successful hunters used 3- or 4-wheelers during the 1991-92 and 1992-93 seasons (Table 5). The use of these vehicles has increased significantly, with concomitant decreases in highway vehicle use. However, the patterns in mode of transport are logically explained when season length and area closures are considered. When the moose season was reopened after 1990-91, the area around the TC remained closed, and the season was only 10 days long. These restrictions favor hunters using 3- and 4-wheelers and airplanes.

Other Mortality:

During 1991-92 and 1992-93 moose mortality due to auto/train collisions and (estimated) illegal kill exceeded the reported hunter harvest, but was much lower than accidental/illegal mortality during 1988-89 or 1989-90 (Table 2). The reduction in mortality due to these factors is probably due to the reduction in moose density following winter 1989-90, to shallower winter snow depths and renewed efforts by ARC to prevent moose mortality.

However, moose killed during winter in Subunit 14B are not necessarily summer residents of that area. Radiotelemetry studies have demonstrated that in some years up to 60% of moose killed by trains and highway vehicles in Subunit 14B were moose that were summer residents of Subunit 16A or Subunit 13E (R. Modafferi pers. commun.). In addition, up to 20% of moose killed during winter by trains/cars in Subunit 14A were summer residents of Subunit 14B and Subunit 16A. Therefore, moose killed by trains or vehicles in Subunit 14B cannot simply be subtracted from any 1 population.

Severe accidental mortality during winter 1989-90 resulted in an emergency appropriation from the legislature for a "Save the Moose" effort. One result of this new funding was the initiation of a department effort to identify promising habitat enhancement techniques (Collins 1993). Also, a cooperative agreement between the department and ARC was signed, outlining actions taken by both agencies to attempt to reduce future moose mortality (Griese 1993). This agreement appears to be working well; the ARC readily committed funds during both 1991-92 and 1992-93 to remove browse near tracks, pack parallel trails and run pilot cars (when deemed necessary). However, the research and development committee, formed in the cooperative agreement and charged with investigating methods/devices to reduce train-moose collisions, has failed to make substantial progress actually testing any device or idea presented.

Calf survival to November is relatively low, probably due to predation. Moose calves and adults in Subunit 14B are preyed upon by brown bears, black bears and wolves. There have not been studies of calf mortality in this area, but studies in Unit 13 determined up to 83% of calves were killed by predators; brown bears accounted for 73% of this mortality (Ballard et al. 1991). Predation rates will probably decline as access in Subunit 14B improves and predator numbers decline.

Natural winter mortality for adults was estimated at 7-8% for adults (Modafferi pers. commun.) and 45% for calves. These figures, applied to the number of moose surviving to December, were used in modeling population dynamics. During both 1991-92 and 1992-93 maximum snow accumulation reached approximately 60 inches in Willow during February and approximately 50 inches in Talkeetna in late January before receding. In comparison, during 1989-90 snow depths reached 93-95 inches in Willow and Talkeetna in early March before receding.

Habitat

Enhancement:

Enhancement of 145 acres was conducted in southwestern Subunit 14B during 1991. Black spruce areas which were mechanically cleared and scarified contained 850,000 birch seedlings per acre 1 year later (Collins 1993). Mixed-forest areas, which had originally been clearcut (but not scarified), had approximately 400-4,000 birch seedlings per acre (W. Collins pers. commun.).

Several sites in Subunit 14B were identified as suitable for prescribed fire, especially the north side of Willow Mountain and the area between (southern) Iron Creek and Little Willow Creek. Indeed, probably any portion of the subunit east of the TC would benefit from fires. However, despite a very successful prescribed burn 6 miles southwest of Willow during summer 1993, state Department of Natural Resources (DNR), Division of Forestry (DOF) personnel are reluctant to consider burning areas east of the intertie due to the human development in the area (W. Collins pers. commun.).

CONCLUSIONS AND RECOMMENDATIONS

Progress was not made toward the objective of increasing the size of this population by 1995. Given current levels of predation and recent weather patterns, it is unlikely this population will reach the objective level (2,500-2,800 moose) without habitat changes that produce seral stages beneficial to moose during winter. Furthermore, it is not possible to effect habitat changes in time to increase the moose population by 1995. However, the posthunting sex ratio is well above the desired ratio of 20 bulls:100 cows. The sex ratio should remain above the objective level with the SF/50 regulation. The harvest objective was not achieved, reflecting moose numbers in Subunit 14B.

I recommend the department first survey residents of southcentral Alaska (primarily Subunits 14B and 14A) to determine if attempts to increase the moose population are warranted. These public-opinion (PO) surveys would best be conducted using mail or phone questionnaires, followed by local meetings as needed. If PO surveys do not support our current management objectives, the objectives should be revised.

If PO surveys indicate support for attempts to increase moose numbers in the subunit, the department should identify areas (away from the TC) most suitable for habitat alteration, then implement a 15-year program to increase available winter habitat. The program should include:

1. A public education program outlining recent moose population and habitat changes, results of the public-opinion survey, results of the prescribed fire near Willow, and costs and benefits of different types of land treatments;

2. clearly defined interim objectives regarding amount of land treated and by what method, and moose population parameters;

3. coordination with DNR/DOF personnel to conduct habitat alteration through fire, logging or mechanical means;

4. regular moose population surveys to evaluate the effectiveness of the program.

Assuming sufficient area was enhanced during the first 5 years of the program, and winters were "average;" I would expect an increase in moose numbers by year 15 of the program. The department should continue to discourage creation of good winter moose habitat in the TC, especially along the railroad and roads.

A Gasaway survey should be conducted in November 1994 (the seventh year since the 1987 Gasaway survey). Although population composition parameters resulting from Becker surveys are almost certainly less biased than those derived from trend surveys flown in areas where moose visibility is best, it is important to evaluate how well Becker surveys elucidate trends in population size. Subsequently, I recommend biennial Becker surveys, with a Gasaway survey every 5-8 years.

The harvest objective will not be met without an increase in moose numbers. Simple population modeling efforts indicated approximately 115 bulls could be harvested during fall 1993 (while maintaining a sex ratio of 20 bull:100 cows). The SF/50 regulation limited potential harvest to approximately 45 bulls. Harvest could be increased by issuing drawing permits for any bull, however, I do not recommend permit hunts until composition surveys indicate a bull:cow ratio of at least 40 bull:100 cows. Completion of a reliable Gasaway survey would enable us to provide maximum harvest.

I recommend the department consider proposing a small controlled-use area in Subunit 14B. The area surrounding WMCHA may be ideal for providing quality hunting opportunity while only slightly restricting motorized access. A major ORV trail lies within WMCHA just above treeline on Willow Mountain, and the Willer-Kash road (including the proposed extension) lies approximately 2 miles west of the WMCHA boundary. Between the 2 is a narrow corridor approximately 4 miles wide and 12 miles long; if hunters were restricted from using motorized access within this corridor they would still be no more than 2 miles from their vehicle.

One facet of the moose management goal in southcentral Alaska is to provide maximum opportunity to hunt moose. With steadily increasing access (primarily via 4-wheelers) in this area, some hunters have complained that mechanized hunters show no consideration for non-mechanized hunters and refuse to leave their ORV, thereby "road-hunting" from their 4-wheelers. Other conservationists are concerned about increasing habitat damage due to ever-widening ORV trails, especially through swamp/muskeg areas. Concerns regarding off-road vehicle use, and concomitant effects on harvest, in Subunit 14B were first outlined in 1976 (Rausch 1977).

Road and trail development is occurring rapidly in Subunit 14B. In an effort to provide access to timber and other resources, DNR plans to extend the Willer-Kash road (in southern 14B) to the Kashwitna River (Department of Natural Resources 1991). Construction of at least 1 off-road vehicle (ORV) trail leading to the north end of WMCHA is also planned. In other parts of Subunit 14B, numerous trails lead (generally eastward) from roads in the Caswell Lakes, Montana Creek and Larson Lake areas. The western portions of 14B are increasingly popular with snowmachiners in winter and spring. Improved human access may lead to lower natural moose mortality due to predators, increased hunter efficiency, increased disturbance of moose during critical postrut or calving periods, and localized habitat damage due to off-road vehicles.

With the current SF/50 hunting regulations, a controlled-use area is not justified based on biological concerns. Instead, the justification should reflect the desire to provide a diversity of hunting opportunities, and the vast amount of area in southcentral Alaska where ORV use is not restricted. In 1974, similar concerns about the need to provide a diversity of hunting opportunities led to creation of the Sourdough Controlled Use Area near Glennallen. However, near the major population centers of Anchorage and the Matanuska-Susitna valleys, few opportunities exist where nonmotorized hunters have a relatively good chance of harvesting a moose without walking several miles.

Increasing use of motorized equipment in important seasonal habitats may also displace moose from those areas (R. Modafferi, pers. commun.). Access restrictions during the hunting season would not address concerns regarding effects of motorized vehicles (primarily snowmachines) on moose occupying postrut areas. It may be possible to compare habitat use of moose on Willow Mountain (during the rut and postrut) with moose in similar habitats (perhaps Mt. Yenlo or Beluga Mountain) that receive little or no snowmachine use. If it appears moose distribution on Willow Mountain has been altered, seasonal restrictions to snowmachine use could be considered.

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Table 1. Subunit 14B fall aerial moose composition counts and census, 1987-1992.

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Adults observed	Total moose observed	Observable moose/mi^2	Population estimate
1987/88[a]	37	9	30	18	906	1,097	3	2,814 ± 248[c]
1988/89[b]	--	--	--	--	--	--	--	--
1989/90[d]	24	5	26	16	474	563	3	2,760 ± 550[c]
1990/91[d]	27	9	20	14	609	754	2	1,795 ± 247[c]
1991/92[b]	--	--	--	--	--	--	--	--
1992/93[e]	27	4	22	15	580	659	1	1,582 ± 178[c]

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

[b] No surveys conducted.

[c] 80% C.I.

[d] These data derived from "Becker Surveys" conducted in November. SCF estimated at 1.3.

[e] These data derived from "Becker Surveys" conducted in November. SCF estimated at 1.4, 1.35 and 1.25 for low, medium and high density strata, respectively.

Table 2. Subunit 14B annual moose harvest and accidental death, 1988-92.

Regulatory year	Reported M	Reported F	Reported Total[a]	Estimated Unreported[b]	Estimated Illegal[c]	Estimated Total	Accidental Road	Accidental Train	Accidental Total	Grand total
1988/89	134	2	140	7	6	13	40	87	127	280
1989/90	174	0	174	9	25	34	60	351	411	619
1990/91	0	0	0	0	4	4	8	17	25	29
1991/92	53	0	53	3	5	8	17	46	63	124
1992/93	34	0	34	2	5	7	10	24	34	75

[a] Total includes moose of unknown sex.

[b] This estimate was derived by taking 5% of the total reported kill

[c] Includes moose taken in defense of life or property.

[d] Road and train are minimum numbers; in most years actual kill was probably higher.

Table 3. Subunit 14B moose hunter residency and success 1988-92.

Regulatory Year	Successful Local[a] resident(%)	Successful Nonlocal resident(%)	Successful Nonres	Successful Unk	Successful Total	Unsuccessful Local[b] resident	Unsuccessful Nonlocal resident	Unsuccessful Nonres	Unsuccessful Unk	Unsuccessful Total	Total hunters
1988/89	63 (45)	67 (48)	2	8	140	797	25	13	64	899	1,039
1989/90	75 (43)	84 (48)	10	5	174	630	34	19	14	697	871
1990/91[c]	0	0	0	0	0	10	1	0	0	11	11
1991/92	29 (55)	22 (42)	2	0	53	282	6	5	1	294	347
1992/93	17 (50)	14 (41)	3	0	34	259	10	5	6	280	314

[a] includes only residents of Subunits 14 (A) and 14 (B).

[b] Includes all Unit 14 residents.

[c] No open moose season.

Table 4. Subunit 14B moose harvest chronology, 1988-1992.

Regulatory year	Before season opened	Weeks of Season 1st(%)	2nd	3rd	4th	After season closed	Unk	Total
1988/89[a]	0	49 (35)	19	24	41	3	4	140
1989/90[a]	1	48 (28)	24	36	62	0	2	173
1990/91[b]	0	0	0	0	0	0	0	0
1991/92[c]	0	41 (77)	8	--	--	3	1	53
1992/93[c]	0	24 (70)	5	--	--	5	0	34

[a] 1-30 September season.
[b] No open season.
[c] 1-10 September season.

Table 5. Subunit 14B moose harvest percent by transport methods, 1988-92.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	ORV	Highway vehicle	Unk	Total all methods
1988/89	18	1	7	19	27	24	4	140
1989/90	16	2	10	26	18	25	3	173
1990/91[a]	--	--	--	--	--	--	--	0
1991/92	9	0	2	38	40	11	0	53
1992/93	26	0	0	41	15	15	3	34

[a] No open season

LOCATION

<u>Game Management Unit:</u> Subunit 14C (1,912 mi^2)

<u>Geographical Description:</u> Anchorage Area

BACKGROUND

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

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

Annual harvests have fluctuated dramatically in recent decades. A record harvest of nearly 500 moose (50% females) occurred in 1965, while only 18 moose were harvested in 1978. These diverse harvests were due to changes in seasons and bag limits rather than changes in the moose population. Annual harvests increased steadily during the late 1980s and early 1990s, but declined in 1992-93. The 5-year mean harvest is 177 moose (37% cows).

MANAGEMENT DIRECTION

<u>Management Objective</u>

The moose management objective for Subunit 14C is to maintain a population of 2,000 moose and a posthunting sex ratio of no less than 25 bulls:100 cows.

METHODS

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

RESULTS AND DISCUSSION

Population Status and Trend

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

Moose are adversely affected by snow depths from 70-90 cm, which impede movement, and depths greater than 90 cm, which restrict movement to the extent that adequate food intake may be unattainable (Coady 1974).

The Soil Conservation Service has measured snowpack at several locations in Subunit 14C for several decades (Alaska Basin Outlook Reports). Local snow depths can vary substantially within moose winter habitat. Three locations--Hillside (el. 2,080 feet), South Campbell Creek (el. 1,200 feet), and Portage Valley (el. 50 feet)--are representative of winter moose habitat in the Anchorage area. Average annual snowpacks (1961-1990) measured on the first day of February do not exceed 28 inches in any of these locations. Average annual snowpacks measured on the first day of March and April range from 32-35 inches at the Hillside and Portage Valley sites.

The 5 winters considered in this report (1988-89 to 1992-93) had snowpacks greater than average for 1 February through 1 April. Of 45 snowpack measurements (i.e., 3 locations x 3 months x 5 years) only 5 have been below the 30-year average, whereas 40 measurements have been greater than 28 inches and 25 have been greater than 36 inches. The winters of 1989-90, 1991-92, and 1992-93 were all substantially worse than average on the Hillside, with snow depths ranging from 41-55 inches on the first day of February, March, and April. The most severe winter on the Hillside occurred in 1991-92, when the snowpack was still 43 inches on 1 May. South Campbell Creek experienced the deepest snowpacks in 1991-92 and 1992-93. Portage Valley had severe snowpacks in all 5 years; however, the 3 worst years (1988-89, 1990-91, 1991-92) had snow depths ranging from 51-82 inches on the first day of February, March, and April.

Vehicles and trains collided with moose more frequently than average in 1989-90 and 1991-92 (Table 2), because moose were using cleared areas as movement corridors. Natural mortality probably increased during the severe winters as well. The subunit's moose population has been maintained near the management objective of 2,000 by reducing harvests. Continued severe winters will exacerbate overbrowsing, which is likely to result in substantial losses of moose in subsequent years.

Population Size. We estimate a population of 2,030 moose in Subunit 14C (Table 1). About 300 moose are believed to inhabit the Anchorage Management Area (excluding the Hillside count area) when composition counts are conducted in adjacent areas. This is 150-200 more than previous estimates.

Population Composition. Population composition has been relatively stable in most count areas since the severe winter of 1989-90. The percentage of calves in the herd ranged from 19-26%. The bull:cow ratio ranged from 31:100 to 41:100. Calf survival has declined in recent years as measured by the yearling bull:cow ratio (Table 1). The greatest declines in the yearling bull:cow ratio occurred in the Twentymile River, Eklutna - Thunderbird Creek, and Hunter Creek count areas. The proportion of calves in the population has also declined in the Eklutna - Thunderbird Creek and Hunter Creek count areas.

Distribution and Movements. Moose are year-long residents, ranging from sea level to an elevation of 3,500 feet. During winters with substantial snow accumulation, most moose are found at elevations below 1,500 feet. Movements of several miles or more by both sexes occur during the breeding season in late September through October and again before green-up in late March and early April.

Mortality

Harvest:

Season and Bag Limit. The seasons for resident and nonresident hunters in the Fort Richardson Management Area were 3 September-15 November and 15 December-15 January in 1991-92, and 8 September-15 November and 15 December-15 January in 1992-93. The bag limit was 1 moose by drawing permit. Hunting was limited to archery only except during the fall season when muzzleloading rifles were permitted north of Eagle River. Up to 150 permits for bulls and antlerless moose were issued, 25 for muzzleloading rifle hunters. An additional 15 drawing permits for both sexes were issued for Elmendorf Air Force Base in 1991 and 1992. The bag limit was 1 moose, and the season was 3-30 September in 1991 and 8-30 September in 1992. There was not an open season in the Anchorage Management Area. The season for resident and nonresident hunters in the Peters Creek Management Area was 3-30 September in 1991 and 8-30 September in 1992. The bag limit was 1 moose by drawing permit and archery only; 25 permits were issued in 1991 and 1992. The open season for resident and nonresident hunters in the Eklutna Lake Management Area was 3-30 September in 1991 and 8-30 September in 1992. The bag limit was 1 moose by archery only. The hunt was administered by registration permit; up to 10 bulls and 5 cows could be harvested. The open season for resident hunters in the remainder of Subunit 14C was 3-20 September in 1991 and 8-20 September in 1992. The bag limit was 1 moose; Alaska residents could take antlerless moose by drawing permit only (30 permits were issued in 1991 and 40 in 1992). The open season for the Twentymile River area was 20 August-30 September for bulls and 20 August-31 October for antlerless moose in 1991 and 1992. The bag limit was 1 moose by drawing permit with 60 permits for bulls and 70 permits for antlerless moose issued in 1991 and 1992. Hunts were limited to Alaska residents.

<u>Board of Game Actions and Emergency Orders</u>. Several regulation changes occurred during this report period. Beginning in 1991-92 the Board of Game directed the department to allocate the 125 drawing permits for the Fort Richardson Management Area for bulls and antlerless moose depending on the fall composition count. The Board increased the number of drawing permits for the combined Placer/Twentymile hunt from 40 to 60 antlered moose and 60 to 70 antlerless moose. The antlerless season for this hunt was extended from 30 September to 10 October. All antlerless moose hunts were reauthorized. No emergency orders were issued during the past 5 years.

The Board of Game adopted a regulation that prohibits intentional feeding of moose, except under terms of a permit issued by the department. This regulation takes effect in July 1993.

<u>Hunter Harvest</u>. During the 1991-92 and 1992-93 seasons, 210 and 170 moose were harvested, respectively, with averages of 117 bulls and 72 cows annually (Table 2). Approximately 42% of the bulls were taken during the general season. The remaining moose were taken in permit hunts.

<u>Permit Hunts</u>. During the 1991-92 season 642 hunters were issued permits to hunt moose in Subunit 14C. Of these, 157 (34%) were successful. In the 1992-93 season 589 permits were issued and 106 (25%) were successful (Table 4). Drawing permit hunts were very popular. In 1991, 8,608 hunters applied for 350 available drawing permits (4,732 of the applications were for the 130 permits available for the combined Placer/Twentymile hunt), and in 1992, 8,690 hunters applied for 360 available drawing permits (4,657 of the applications were for the 130 permits available for the combined Placer/Twentymile hunt). An additional 292 hunters in 1991 and 229 hunters in 1992 obtained registration permits for the Eklutna Valley registration archery hunt. Despite its apparent popularity, the success rate for this hunt, while never high, has steadily declined to 1% in 1992-93 (Table 4).

<u>Hunter Residency and Success</u>. Residents of Unit 14 accounted for 93% of the moose harvested in Subunit 14C in 1991 and 1992 (Table 3). Residents of other units and nonresidents accounted for 3% and 1% of the total harvest, respectively.

<u>Harvest Chronology</u>. 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 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 subunit when the day after Labor Day is later than usual (e.g., 8 September in 1992). Therefore, a large block of 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 a large portion of the moose summering in the Fort

Richardson-Elmendorf-Ship Creek area becomes accessible in lowland areas of Fort Richardson.

Transport Methods. Approximately one-half to three-fourths of all successful moose hunters reached their kill sites by highway vehicle (Table 6). The high proportion of walk-in hunters is due to the prohibition on motorized vehicles in most of Chugach State Park and the proximity of most moose habitat to roads and trails. Approximately 20% of successful hunters have used boats in recent years and 5-10% use horses.

Other Mortality: Moose killed by vehicles and trains accounted for about one-third of total known mortality. During 1991-92 at least 129 moose were killed by vehicles and 24 by trains. Over the past 5 years, a mean of at least 117 moose were killed in collisions (Table 2). These are conservative figures because not all collisions are reported and some moose undoubtedly die from injuries without being discovered.

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

Habitat

Assessment:

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

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

CONCLUSIONS AND RECOMMENDATIONS

Major population objectives for the subunit were met. The bull:cow ratio exceeded 25:100 and over 2,000 moose are estimated in the subunit.

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

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 moose-vehicle collisions cost an average of $15,150 for vehicle repairs; emergency, medical, and legal services; and lost wages (ADOTPF 1994). This is an average annual cost of at least $1,545,000 based on the number of moose-vehicle collisions reported during this 5-year report period. Moose also cause considerable damage to ornamental plants, vegetable gardens, and fruit trees in winter and spring. Interactions between residents and moose that have been fed have increased since the severe winter of 1989-90. A large number of residents have continued feeding local moose and, when a handout is not immediately forthcoming, these moose are often highly aggressive towards people. Area staff spend considerable time listening and responding to complaints and reports of injured moose. On the other hand, much damage is tolerated by residents, and moose are considered a desirable species by many residents and visitors. Public education regarding moose behavior and biology may improve public tolerance and reduce conflict situations. We could greatly improve our understanding of Anchorage residents' level of awareness, attitudes, and willingness-to-pay to maintain the moose population at existing levels by conducting a sociological and economic survey in the Anchorage area.

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Table 1. Subunit 14C fall aerial moose composition counts and estimated population size, 1988-92.

Area	Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Total moose observed	Moose /hour	Estimated population size[a]
Twentymile[b]	1988/89	45	26	66	31	137	91	
	1989/90 [c]	29	15	31	19	176	68	
	1990/91	38	13	63	31	153	128	
	1991/92	34	12	33	20	151	95	
	1992/93	38	6	34	20	110	79	165
Hillside	1988/89	48	19	35	19	148	53	
	1989/90	47	20	31	18	171	53	
	1990/91	81	27	31	15	110	60	
	1991/92	--	--	--	--	--	--	
	1992/93	--	--	--	--	--	--	165
Fort Richardson	1988/89	45	19	47	24	511	35	
Elemendorf	1989/90	34	14	37	22	527	33	
Off base Ship Cr.	1990/91	--	--	--	--	--	--	
	1991/92	38	34	38	21	490	32	
	1992/93	35	12	33	20	355	--	600
Eagle River[d]								165
Peters Creek	1988/89	17	6	40	26	74	44	
	1989/90	12	5	37	25	64	28	
	1990/91	18	14	47	29	84	61	
	1991/92	14	4	28	20	71	37	
	1992/93	--	--	--	--	--	--	105
Eklutna-Thunderbird	1988/89	43	14	32	19	135	36	
	1989/90	41	15	35	20	116	39	
	1990/91	32	2	35	21	104	23	
	1991/92	19	3	22	16	95	25	
	1992/93	18	3	21	15	92	32	130

Table 1. (cont'd.)

Area	Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Total moose observed	Moose /hour	Estimated population size[a]
Bird-Indian	1988/89	49	20	24	14	85	43	
	1989/90	--	--	--	--	--	--	
	1990/91	--	--	--	--	--	--	
	1991/92	--	--	--	--	--	--	
	1992/93	--	--	--	--	--	--	130
Hunter Creek	1988/89	44	17	55	28	187	94	
	1989/90	44	23	32	18	148	57	
	1990/91	29	11	23	15	194	58	
	1991/92	25	7	16	11	180	64	
	1992/93	--	--	--	--	--	--	270
Anchorage								
(except Hillside)								300
Subunit 14C	1988/89	41	17	50	26	1,434	49	
total	1989/90	35	15	34	20	1,202	41	
	1990/91	37	12	38	22	645	53	
	1991/92	31	8	30	19	987	39	
	1992/93	32	9	31	19	557		2,030

[a]Estimate based on most recent count, using sightability factor of 0.67.
[b]Does not include adjacent Portage River drainage in Unit 7.
[c]Aerial survey conducted 5 January 1990 (1-2 months later than normal).
[d]Last surveyed in 1987.

[redacted]

Table 2. Subunit 14C moose harvest and accidental death, 1988-92.

Regulatory year	Reported				Estimated			Accidental death			Grand Total
	M(%)	F(%)	Unk	Total	Unreported	Illegal	Total	Road	Train	Total	
1988/89	113 (72)	43 (28)	1	157	10	10	20	91	13	104	281
1989/90	113 (64)	62 (36)	1	176	10	10	20	108	17	125	321
1990/91	94 (55)	77 (45)	2	173	10	10	20	91	11	102	295
1991/92	118 (56)	91 (44)	1	210	10	10	20	129	24	153	383
1992/93	116 (68)	53 (32)	1	170	10	10	20	90	10	100	290

Table 3. Subunit 14C moose hunter residency and success, 1988-92.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total[b] (%)	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	
1988/89	140	6	10	157	424	13	7	453	610
1989/90	166	6	2	176	429	20	6	457	633
1990/91	160	6	6	173	426	20	3	475	648
1991/92	193	10	4	210	486	26	5	520	730
1992/93	162	2	3	170	489	21	7	530	700

[a]Residents of Unit 14 (majority from Subunit 14C).
[b]Includes unknowns.

Table 4. Subunit 14C moose harvest data by permit hunt, 1988-92.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessul hunters	Percent successful hunters	Bulls(%)	Cows(%)	Unknown	Total harvest
910,911	1988/89	20	--[a]	50	50	3(100)	0 (0)		3
Portage	1989/90	70	--[a]	46	54	6 (40)	9(60)		15
	1990/91	100	--[a]	41	59	14 (47)	16(53)		30
	1991/92	130	--[a]	38	62	21 (57)	16(43)		37
	1992/93	130	--[a]	49	51	11 (50)	11(50)	1	23
921,929	1990/91	15	7	0	100	8(57)	6(43)		14
Elmendorf, AFB	1991/92	15	13	8	92	7(58)	5(42)		12
	1992/93	15	0	13	87	6(46)	7(54)		13
(archery)									
922,923[b]	1988/89	30	13	35	65	6(35)	11(65)		17
Fort	1989/90	25	8	25	75	10(56)	8(44)		18
Richardson	1990/91	25	12	36	64	4(29)	10(71)		14
(muzzleloader)	1991/92	25	8	43	57	8(62)	5(38)		13
	1992/93	25	0	44	56	8(57)	6(43)		14
924,925,926	1988/89	60	7	32	68	18(47)	20(53)		38
927,928	1989/90	100	9	37	63	25(44)	32(56)		57
Fort	1990/91	125	11	59	41	12(27)	32(73)	1	45
Richardson	1991/92	125	9	39	61	28(41)	41(59)		69
(archery)	1992/93	125	15	64	36	23(61)	15(39)		38
941	1988/89	15	20	75	25	--	3(100)		3
Hunter-Knik	1989/90	25	12	55	45	--	9(100)	1	10
	1990/91	15	27	36	64	--	7(100)		7
	1991/92	15	7	29	71	--	10(100)		10
	1992/93	15	20	42	58	1(14)	6 (86)		7

Table 4. (cont'd.)

Hunt No. /Area	Regulatory year	Permits issued	did not hunt	Percent unsuccessul hunters	Percent successful hunters	Percent Bulls(%)	Cows(%)	Unknown	Total Harvest
942	1988/89	20	25	60	40	--	6(100)		6
Ship	1989/90	0	--	--	--	--	--		--
	1990/91	0	--	--	--	--	--		--
	1991/92	0	--	--	--	--	--		--
	1992/93	10	20	100	0	--	0(0)		0
943	1988/89	15	20	83	17	--	2(100)		2
Peters and	1989/90	15	27	82	18	--	2(100)		2
Little Peters	1990/91	15	20	92	8	--	1(100)		1
	1991/92	15	20	33	67	--	8(100)		8
	1992/93	15	7	57	43	--	6(100)		6
948,949	1990/91	25	16	76	24	2(40)	3(60)		5
Birchwood	1991/92	25	8	87	13	1(33)	2(67)		3
(Peters Creek M.A.)	1992/93	25	12	86	14	2(67)	1(33)		3
975	1988/89	151	24	93	7	8(100)	0(0)		8
Eklutna	1989/90	173	28	94	6	5(71)	2(29)		7
(registration	1990/91	220	27	94	6	6(75)	2(25)	1	9
archery)	1991/92	292	32	98	2	3(60)	2(40)		5
	1992/93	229	24	99	1	2(100)	0(0)		2
Totals for all	1988/89	311	19[c]	68	32	35(46)	42(54)		77
permit hunts	1989/90	408	20[c]	64	36	46(43)	62(57)	1	109
	1990/91	540	20[c]	69	31	46(37)	77(63)	2	125
	1991/92	642	22[c]	66	34	68(43)	89(57)		157
	1992/93	589	18[c]	75	25	53(51)	52(49)	1	106

[a]Unknown, because some hunted in adjacent Unit 7.

[b]1988/89 season archery only.

[c]Percentages do not include hunt area 910 and 911 permits.

Table 5. Subunit 14C moose harvest[a] chronology (percentage by time period), 1988-1992.

Regulatory year	Harvest Periods 9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	n
1988/89	18	31	14	28	9	80
1989/90	18	17	18	26	20	67
1990/91	38	42	20	--	--	48
1991/92	33	46	22	--	--	53
1992/93	18	57	26	--	--	64

[a]Does not include permit hunts.

Table 6. Subunit 14C moose harvest percent by transport method, 1988-92.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3-or 4-wheeler	Snowmachine	Off-road vehicle	Highway vehicle	Unknown	n
1988/89	6	8	4	1	1	4	70	6	157
1989/90	1	5	11	2	0	2	73	6	176
1990/91	3	9	20	3	0	1	62	3	173
1991/92	5	8	18	1	0	2	60	6	210
1992/93	7	9	18	2	0	1	54	8	170

LOCATION

Game Management Unit: 15A (1,314 mi^2)

Geographic Description: Northern Kenai Peninsula

BACKGROUND

Historical records and reports from residents suggest moose were abundant throughout the century in Subunit 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 probably stimulated moose numbers to increase throughout the 1950s and 1960s. Although seasons were long and either sex harvest was allowed, the moose population increased beyond its carrying capacity and extensive over-browsing occurred by the late 1960s. Harsh winters from 1971 to 1974 reduced the moose population over the entire Kenai Peninsula. Estimates for Subunits 15A and 15B suggest the combined population estimate declined from 7,900 in 1971 to 3,375 by 1975. Subunit 15A represents approximately 75% of these estimates or a decline from 5,925 to 2,531 moose. By 1982, the moose population estimate for Subunit 15A had increased to 3,041.

In 1987 and 1990 estimation methods described by Gasaway (1986) were used in the subunit for the first time. They suggested an approximately stable population trend in the range of 3,014 - 3,850 moose. Although a census has not been completed since 1990, the population is believed to be stable due to recent mild winters.

In the last 2 decades no large forest fires similar to the 1947 and 1969 Kenai Peninsula burn have occurred. Consequently, relatively 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 on the Kenai Peninsula in recent decades has 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 resident Alaska wildlife. The Kenai National Wildlife Refuge is the largest landholder in Subunit 15A and actively participates in 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. There is a need for this pattern of close coordination and cooperation whenever possible, to continue indefinitely.

A selective harvest strategy with a spike/fork-50 inch bag limit was initiated on the entire Kenai Peninsula in 1987, including Subunit 15A. The proportion of males in the population has subsequently increased and hunters appear generally satisfied with the selective harvest strategy. A 5-year evaluation of selective harvest on the Kenai was completed in 1993.

MANAGEMENT DIRECTION

Management Objectives

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

The primary moose management objective in Skilak Loop Wildlife Management Area (SLWMA) is to provide a variety of opportunities to view moose in a natural setting, throughout the year. A second objective is to provide opportunities to view all components of the moose community, including behaviors and habitat. The third objective is to provide opportunities to harvest moose when a reduction in numbers is desirable to achieve the other objectives.

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

In addition to the resident population, moose from surrounding areas commonly winter in SLWMA, with up to 300 wintering animals. The habitat will be managed to provide for 130 resident moose plus 170 additional wintering moose.

METHODS

Aerial surveys were conducted in November and December of each year in selected trend count areas to ascertain sex and age composition. In 1991 and 1992, 8 of 13 count areas in Subunit 15A were surveyed.

A population estimate for Subunit 15A was developed from data collected in February 1990. The techniques used were described in Gasaway (1986). The first estimate using these techniques was done in 1987. The 1987 results were not strictly comparable with the 1990 estimates. A small number of sample units containing unexpectedly high densities of moose were not flown in 1987 because of poor weather. The 1987 calculation subsequently underestimated the 15A moose population (Taylor 1990). A complete census of Subunit 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 subunit was 3,432 ± 12.18% (3,014-3,850) at the 90% C.I. The 1987 estimate was 2,702 ± 9.6% (2,441-2,963) at the 90% C.I. These data suggested a substantial 3-year population increase. However, the 1987 calculation significantly underestimated the Subunit 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 3,014-3850 moose was consequently more accurate. The number of moose in the subunit probably did not change between 1987 and 1990. No population estimate was developed in 1991-92 or 1992-93.

Population Composition:

In 1992, 1,331 moose were observed in fall composition surveys, compared with 1,690 in 1991 (Table 1). Calves comprised 23% of the 1992 sample and occurred in the proportion of 36:100 cows. The 1991 and 1992 calf composition data were virtually identical. Bulls were observed at a ratio of 16:100 cows, 6 bulls:100 cows less than 1991. Yearling bulls observed declined from 7:100 in 1991, to 5:100 in 1992, following a moderately high snow accumulation during the winter of 1991-92.

Mortality

Harvest:

Season and Bag Limit. The general hunting season in Subunit 15A was from 1-20 September. The bag limit was 1 bull with spike-fork or 50-inch antlers. There was an archery-only season from 25-29 August with the same bag restrictions. Also a drawing permit-only hunt in Skilak Loop Wildlife Management Area extended from 21 September through 30 September; up to 20 permits were issued. The bag limit was 1 antlerless moose and taking of calves and females accompanied by calves was prohibited.

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

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

Hunter Harvest. In 1992, 143 moose (141 bulls and 2 cows) were harvested by 1,207 hunters during the general season (Table 2). The 1992 harvest declined by 23% when compared to the 1991 harvest of 185 moose. This reduction in harvest reflects moderate winter losses sustained by the Subunit 15A population for moderately deep snows during the winter of 1991-92.

Included in the total harvest figures for Subunit 15A were results of an 25-29 August archery season. Information requested on harvest ticket reports did not include time of hunt and it was not possible to determine how many hunters went afield during the archery season. Data collected at field check stations was used to estimate hunter participation. An estimated 200 to 250 archery hunters participated during the 25-29 August 1990 and 1992 archery only hunts. They reported a harvest of 9 and 12 bulls for the years 1991 and 1992, respectively.

The highest reported harvest for archers during this season was in 1989, when 18 bulls were taken. Archers did not report harvesting any bulls in the 50-inch or larger category in either year. Archers were required to follow the same antler restrictions imposed on hunters during the general season.

Of the 185 moose harvested in 1991, 162 (88%) were reported with antler spread data. Since the current bag limit was designed to focus the harvest on a portion of the yearlings and on mature bulls, an assumption was made that bulls less than 35 inches met the yearling (spike-fork) requirement and equal to or greater than 35 inches were mature bulls (having 3 brow tines or an antler spread greater than 50 inches). Sixty-nine percent (N=111) of the harvest was spike-fork bulls and 31% (N=51) were mature bulls. Nineteen percent (N=30) of the reported harvest was bulls with an antler spread greater than or equal to 50 inches. In 1992, 131 (92%) of the 143 moose harvested were reported with antler spread data. The harvest was comprised of 89 (68%) yearlings and 42 (32%) mature bulls.

Permit Hunts. A total of 1,219 and 1,448 applications was received for 20 permits issued to hunt antlerless moose in SLWMA in 1991 and 1992, respectively. All permittees hunted, in each year, resulting in 11 moose taken in 1991 and 6 in 1992 (Table 3). All moose harvested were females and ranged in age from 1 to 16 years with a mean age of 7 years for the 2 years combined.

Hunter Residency and Success. The 1991 hunter success was 15% compared to 12% in 1992. In 1991, 151 (84%) successful hunters were unit residents, 26 (15%) were nonunit residents, and 2 (1%) were nonresidents, N=179. Five (3%) successful hunters failed to report their residency. Residency reported for unsuccessful hunters was: unit residents 813, nonunit state residents 185, nonresidents 13, and unspecified residency 10 (Table 4). Successful hunters averaged 5.3 days compared to 6.3 days for all hunters.

In 1992, 121 (88%) successful hunters were unit residents, 14 (10%) were nonunit residents and 2 (2%) were nonresidents, N=137 (Table 2). Six (4%, N=143) successful hunters failed to report their residency. Residency reported for unsuccessful hunters in 1992 was: unit residents 874, nonunit residents 171, nonresidents 15, and unspecified residency 4. Successful hunters averaged 6.3 days compared to 6.9 days for all hunters.

Harvest Chronology. Thirty-four percent of the 1991 and 33 percent of the 1992 harvest occurred during the first 5 days of the September season (Table 6). The second highest harvest period in 4 of the past 5 years was the last 5 days of the season.

Transport Methods. Sixty-one percent of the 1991 successful hunters reported highway vehicles as their means of transportation. Boats were the second most common (16%) means of transportation. Hunters using ATV's or horses combined accounted for 16% of the reported harvest by transportation means. Hunters using aircraft as their means of access reported the lowest percentage at 4%. The 1992 transportation data compared closely with 1991, when 59% of successful hunters reported using highway vehicles (Table 5). In 1992 aircraft were the second highest with 13% percent of the hunters using aircraft.

Other Mortality:

Crippling loss by hunters and loss to predation was unknown. In 1991, 171 moose were reported killed by automoble/wildlife accidents; comprised of 87 (51%) calves, 70 (41%) adult females, 14 (8%) adult males. The 1992 reported kill of 115 moose by vehicles was 33%

lower than 1991 (Table 4). Composition of moose killed in 1992 was similar to 1991. A public awareness program, intended to reduce the number of automobile/moose collisions was begun in 1990 (Del Frate and Spraker 1991) and the mild winter of 1992-93, reducing the concentration of moose, may have contributed to the reduced number of collisions in that year.

Habitat

Assessment:

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

Enhancement:

In May 1991, approximately 8,320 acres burned in the southeastern portion of Subunit 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. Substantial statewide publicity regarding the beneficial effects of wildfire for forest succession wildlife was derived from the Pothole Lake fire.

A 10,369 acre area in the Mystery Creek Road vicinity was scheduled to be burned by U.S. Fish and Wildlife Service in the fall of 1991. Unfavorable weather conditions in 1991 and 1992 prevented this prescribed burn project from being completed.

Approximately 40% of this area is scheduled to be left untreated as scattered islands for wildlife cover and seed source for re-vegetation.

CONCLUSIONS AND RECOMMENDATIONS

A preliminary review of the selective harvest strategy in Subunit 15A reveals the following trends. The bull to cow ratio increased from a 5-year (1982-86) average of 13:100 to 23:100 in 1990. Hunter effort and harvest declined by 31% and 43%, respectively the first year (1987), when compared to the mean during the 5 years before the program. Effort and harvest showed a slight increasing trend during the next 3 years (1988-90).

If a similar increase in bull to cow ratio is observed during the 1991 fall survey, I recommend an increase in season length to 1-30 September, with only spike/fork bulls legal from 21-30 September. A longer season would better serve the demands of the public while still maintaining the selective harvest strategy objective of protecting bulls in the age classes of 2 to 4 years of age.

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

During the 2-year report period, the 1989-90 winter was most severe and exerted significant mortality on segments of the moose population, particularly calves-of-the-year. This winter-caused mortality is reflected in the reduced number of yearlings observed in the following fall 1990 composition surveys. Decreased hunter success in 1990 was also probably related to very few yearling moose being available to hunters. The number of moose killed by automobiles declined substantially from the severe winter of 1989-90 to the following winter of 1990-91. The reduction may have been partially caused by weather conditions and reduced moose population size. However, the department also began, at that same time, a substantial community awareness effort to reduce moose/automobile accidents. The "Give Moose a Brake Program" may also have contributed to reduced roadside moose kills in 1990-91.

Unlike other game management units in southcentral Alaska, no emergency reduction in the 1990-91 moose season or bag limit was necessary due to effects of the previous severe winter. The conservative nature of the spike/fork/50-inch bag limit on the Kenai Peninsula allowed the department to continue the same recreational opportunity as in previous years. The 1990-91 moose harvest did decline substantially (46%) due to reduced availability of yearlings compared to the previous 1989-1990 season. However, approximately the same number of hunters reported hunting in Subunit 15A both seasons.

No changes in management objectives or seasons and bag limits are recommended at this time.

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Table 1. Subunit 15A aerial moose composition counts and estimated population size, 1988-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1988/89	18	7	45	28	835	1,155	78	--
1989/90	22	7	36	23	1,340	1,737	57	--
1990/91	23	3	35	22	1,231	1,580	--	3,432
1991/92	22	7	34	22	1,321	1,690	--	3,400
1992/93								

Table 2. Subunit 15A moose harvest[a] and accidental death, 1988-92.

Regulatory year	Hunter Harvest: Reported M (%)	F (%)	Unk.	Total	Estimated: Unreported	Illegal	Total	Accidental death: Road	Train	Total	Grand total
1988/89	140	0	16	156			40	135		135	311
1989/90	178	0	3	181			40	205		205	426
1990/91	92	2	2	97			40	119		119	256
1991/92	184	0	1	185			40	169		169	394
1992/93	141	2	0	143			40	99		99	282

[a] Excludes permit hunt harvest.

Table 3. Subunit 15A moose harvest data by permit hunt, 1986-90.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
944	1988/89[a]								
Skilak	1989/90	20	--	--	--	0	8		8
Loop	1990/91	20	15	50	35	0	7		7
	1991/92	20	0	45	55	0	11		11
	1992/93	20	0	70	30	0	6		6
Totals for	1988/89[a]								
all permit	1989/90	20	--	--	--	0	8		8
hunts	1990/91	20	15	50	35	0	7		7
	1991/92	20	0	45	55	0	11		11
	1992/93	20	0	70	30	0	6		6

[a] Hunt began in fall 1989.

Table 4. Subunit 15A moose hunter[a] residency and success, 1988-92.

Regulatory year	Successful: Local[b] resident	Successful: Nonlocal resident	Successful: Nonresident	Successful: Total (%)	Unsuccessful: Local[b] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Total(%)	Total hunters
1988/89	133	16	2	156	826	186	12	1,052	1,208
1989/90	159	18	2	181	753	140	14	917	1,098
1990/91	77	14	3	97	662	199	18	901	998
1991/92	151	26	2	185	813	185	13	1,021	1,206
1992/93	121	14	2	143	874	171	15	1,064	1,207

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

Table 5. Subunit 15a moose harvest[a] percent by transport method, 1988-1992.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
1988/89	3	8	18	2	1	8	95	21	156
1989/90	11	5	27	9	0	5	115	9	181
1990/91	6	4	13	8	0	4	54	8	97
1991/92	4	6	16	5	0	5	61	4	185
1992/93	13	3	12	5	0	4	59	4	143

[a] Excludes permit hunt harvest.
[b] Data not available.

Table 6. Subunit 15A moose harvest[a] chronology percent by time period, 1988-92.

Regulatory year	Harvest periods 8/25-8/29	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	*n*
1988/89	12	45	15	15	14	0	136
1989/90	10	36	16	11	22	6	181
1990/91	5	38	13	17	21	6	97
1991/92	5	34	11	23	23	4	185
1992/93	8	33	18	13	25	4	143

[a] Excludes permit hunt harvest.

LOCATION

Game Management Subunit: 15B (1,121 mi^2)

Geographical Description: Kenai Peninsula

BACKGROUND

Historical records and reports from Kenai Peninsula residents suggest moose in Subunit 15(B) 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 the primary reason for the expansion of this population. A wildfire that burned approximately 500 mi^2 in Subunit 15(A) in 1947 also benefitted moose with improved winter range. A series of harsh winters from 1971 to 1974 subsequently reduced the moose population in Subunit 15(B). Population estimates suggest a decline from 1,975 moose in 1971 to 843 by 1975. A census in February 1990 indicated a slight increase since 1975, estimating the current moose population at 1,042. Because habitat conditions are generally declining with plant succession and predation effects are unchanged, the slight increase may be attributed to a reduction in harvest due to the selective harvest program initiated in 1987.

MANAGEMENT DIRECTION

Management Objectives

Central Kenai Peninsula: Maintain a population of moose with a bull to cow ratio of 15/100 and allow for maximum opportunity to participate in hunting in 15(B) West. In 15(B) East, maintain a population of moose with a bull to cow ratio of 40/100 and provide for the opportunity to harvest a trophy size bull under aesthetically pleasing conditions.

METHODS

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

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

A 1990 census of the 650 mi^2 of suitable moose habitat in 15(B) revealed a population estimate of 1,042 moose, with a 90% confidence interval ranging from 779 to 1,305 or $\pm$25%. The estimated mean density was 1.2 moose per mi^2, with a range of 0.3 to 3.0. Since the census was conducted during February, after most bulls had shed their antlers, herd composition by sex was not determined. However, age composition of the population was, and calves comprised 9.5%. The range for estimated percent calves of the population was 6.8 to 12.2% or $\pm$ 28% at the 90% confidence interval.

This estimate indicates a slight increase in population size when compared to 843 animals estimated in 1975. Winters have been normal or mild since the mid-seventies with the exception of 1989-90 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 15(B) West is believed to be unchanged due to the relatively normal winters since that time.

Population Composition:

Insufficient data was collected to determine sex and age composition for the entire subunit. Aerial surveys were completed in 2 of 5 count areas in 15B east, in 1992, and 143 moose were observed (Table 1). Composition for this partial count was: 20 calves and 50 bulls per 100 cows and calves comprised 12% of all moose observed (Table 1).

Mortality

Harvest:

Season and Bag Limit.

	Resident Open Season	Nonresident Open Season
Subunit 15(B), that portion bounded by a line running from the mouth of Shantatalik Cr. on Tustumena Lk., 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 Lk.; then south along the western side of Skilak R., Skilak Glacier	Sept.1-Sept.20 Sept.26-Oct.15	Sept.1-Sept.20 Sept.26-Oct.15

and Harding Icefield; then west along the Subunit 15(B) boundary to the mouth of Shantatalik Cr. One bull with 50-inch antlers by drawing permit only; up to 100 permits will be issued.		
Remainder of Unit 15(B) One bull with spike-fork or 50-inch antlers.	Sept.1-Sept.20	Sept.1-Sept.20

Game Board Actions and Emergency Orders. No changes in seasons, bag limits or area boundaries occurred during this reporting period. Due to the success of the selective harvest program the season should be increased to 20 August to 20 September for 1993.

Hunter Harvest. In Subunit 15(B) West, 39 moose (38 bulls and 1 moose of unspecified sex) were reported by 286 hunters, in 1991. In 1992, 48 moose (47 bulls and 1 moose of unspecified sex) were harvested by 320 hunters (Table 2). The mean harvest during this 2-year period (44) represents an 8% decline when compared to the mean harvest (48) from 1988 to 1990.

Of the 39 moose reported by hunters in 1991, 36 (92%) included antler spread data. Since the current bag limit is designed to focus harvest on yearling and mature bulls, we assumed that antlers less than 35 inches met the yearling (spike-fork) requirement and antlers greater than or equal to 35 inches were from mature bulls. The harvest comprised 22 (61%) spike-fork and 14 (39%) mature bulls. Ten (28%) of the harvested bulls had an antler spread greater than or equal to 50 inches. Successful hunters averaged 6.4 days afield compared to 6.6 days for all hunters.

Forty (83%) of the 48 moose harvested in 1992 were reported with an antler spread. Thirty (75%) of these were yearling bulls and 10 (25%) were mature. Five (13%) of these bulls had an antler spread of 50 inches or larger. Successful hunters averaged 3.9 days afield compared to 7.8 days for all hunters.

In addition to harvest, 72 moose were reported killed in 15(B) West by vehicles from 1 July 1991 to 30 June 1992. Road kills comprised 30 (42%) cows, 32 (44%) calves and 8 (11%) bulls. In the same period for 1992-93, 42 moose were killed in automobile/wildlife accidents; comprised of 18 (44%) cows, 19 (45%) calves and 5 (11%) bulls. The reduction in automobile/moose accidents in 1992-93 was probably a result of a more widely distributed moose population due to the mild winter.

Permit Hunts. Subunit 15(B) East is managed as an area where hunters are able to view and harvest large antlered bulls. Hunters are allowed to harvest bulls with an antler spread of 50 inches or larger, or bulls with antlers having 3 brow tines on at least 1 antler. It was also mandatory for successful hunters to present the antlers of their harvested bull for an official measurement by department staff. Hunters were selected by a random drawing with 100 permits issued for 2 separate seasons. A total of 2,701 and 2,983 applications were received during 1991 and 1992, respectively. Permittees reported harvesting 38 bull moose in 1991 and 26 in 1992 (Table 4). In 1991, 66 (66%) of the 100 permit holders hunted yielding a success rate for hunters of 58%. In 1992, 76 (76%) of the permit holders hunted, resulting in a success rate for hunters of 34%. The mean antler spread from bulls harvested during 1991 was 54 inches with a range of 34 to 69 (*N*=34). Eighty-two percent (28 of 34) of these bulls had an antler of 50 inches or larger and 41% (14 of 34) were 60 inches or larger. Following the moderately severe winter of 1991-92, the 1992 harvest and average antler size declined. The average antler of a bull harvested in 1992 was 52 inches with a range of 38 to 63. Seventy percent (16 of 23) of the bulls taken had an antler spread of 50 inches or larger and nine% (2 of 23) had a spread 60 inches or more.

Hunter Residency and Success. Thirty-one (80%) of the 39 successful hunters in 1991 were unit residents, 3 (8%) were nonunit residents and 5 (13%) did not report residency (Table 3). Unsuccessful hunters comprised 197 (80%) unit residents, 42 (17%) nonunit state residents, 5 (2%) nonresidents and 3 (1%) unspecified residency. Hunter success was 14% (*N*=39 of 286). In 1992, 40 (83%) of 48 successful hunters were unit residents, 6 (13%) nonunit residents, 1 (2%) nonresident and 1 (2%) hunter did not report residency. Two hundred seventy-two hunters reported as unsuccessful with similar residency percentages as unsuccessful hunters in 1991. Hunter success was 15% for 1992, (*N*=48 of 320).

Transport Methods. In Subunit 15(B) West, 59 and 67% of the successful hunters reported highway vehicles as their primary means of transportation in 1991 and 1992, respectively (Table 5). The second most common transportation means was horses, at 15% in 1991, and 3- or 4-wheeler with 8% in 1992. Aircraft were not used in 1991, but were used by 4% of the successful hunters in 1992. In Subunit 15(B) East, over 90% of the successful hunters used horses as their primary transport method to access their hunting area in each year.

Other Mortality:

The extent of weather related mortality and predation by wolves and bears is unknown in Subunit 15(B). 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.

Habitat

Assessment and Enhancement:

The last large acreage habitat enhancement occurred when a wildfire burned most of the subunit in about 1890. With the exception of the 1947 wildfire that burned 30,600 (8%) of the 398,000 acres below timberline, no significant habitat enhancement has occurred in this subunit since 1890. Approximately 3,700 acres of primarily winter habitat was enhanced using a variety of mechanical tree removal techniques in 1968 by U.S. Fish and Wildlife Service. 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 acreages (less than 50 acres) have also been designated as wood cutting areas for noncommercial use. Judging from the relative density of moose found in the wood cutting areas, I believe these small logged areas provide additional moose browse. However, the overall assessment of moose habitat quality in 15(B) is relatively poor and declining due to natural plant succession.

CONCLUSIONS AND RECOMMENDATIONS

The reported harvest in Subunit 15(B) West of 39 moose in 1991 and 48 in 1992 indicates a normal harvest when compared to 48 moose killed annually the first 3 years of the selective harvest program. A mean of 72 bulls was harvested annually during the 5-year period (1982-86) prior to initiation of the selective harvest program in 1987. Forty-seven has been the mean harvest since 1987, with no apparent trend. A comparison of these mean harvests indicates a mean reduction of 35% in harvest during the first 6 years of the program. A similar comparison of hunting effort shows an initial decline followed by a slight increasing trend from 272 in 1988 to 320 in 1992. A population modeling effort using estimated recruitment and mortalities parameters predicted the harvest would approach the 72 mean reported prior to the program by 1991. The current level with no upward trend does not suggest this objective harvest will be met. One possible explanation was moderate to severe winters resulting in high calf mortality during 1987-88 then again in 1989-90 and 1991-92. The model prediction was based on normal winter mortality. Winter mortality was believed to be significant, reducing the number of bulls available for harvest. The decline in hunting effort also contributed to reduced harvest.

The trophy bull moose hunt in 15(B) East continues to provide excellent hunting opportunities and is popular among resident hunters. The harvest of 38 bulls during 1991 was the highest harvest since the permit area was established in 1977. The harvest declined in 1992 following the moderately severe winter of 1991-92, resulting in a harvest of 26 bulls. These 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 Subunit 15(B) continues to deteriorate due to wilderness lands management policies which 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. Subunit 15B fall aerial moose composition counts and estimated population size, 1988-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1988/89[a]								
1989/90	17		30	20	204	230		1,042
1990/91[a]								1,042
1991/92[a]								1,042
1992/93	50		20	12	126	143		1,042

[a] No data available

Table 2. Subunit 15B moose harvest[a] and accidental death, 1988-92.

Regulatory year	Hunter Harvest										
	Reported				Estimated			Accidental death			Grand total
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	
1988/89	40	1	7	48			20	57	--	57	125
1989/90	41	0	0	41			20	90	--	90	151
1990/91	54	0	0	54			20	65	--	65	139
1991/92	38	0	1	39			20	72	--	72	131
1992/93	47	0	1	48			20	42	--	42	110

[a] Excludes permit hunt harvest.

Table 3. Subunit 15(B) West moose hunter[a] residency and success, 1988-92.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total(%)[c]	Local[b] resident	Nonlocal resident	Nonresident	Total(%)[c]	
1988/89	41	4	0	48	199	16	2	224	272
1989/90	39	1	1	41	213	24	2	244	285
1990/91	53	0	0	54	202	28	4	241	295
1991/92	31	3	0	39	197	42	5	247	286
1992/93	40	6	1	48	247	24	1	272	320

[a] Excludes hunters in permit hunts.
[b] Resident of GMU 15
[c] Total includes hunters on unknown residence.

Table 4. Subunit 15(B) East moose harvest data by permit hunt, 1988-92.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
Totals for	1988/89	100	30	57	43	30(100)	0(--)	--	30
all permit	1989/90	100	38	60	40	25(100)	0(--)	--	31
hunts	1990/91	100	29	56	44	31(100)	0(--)	--	31
0930-0939	1991/92	100	34	42	58	38(100)	0(--)	--	38
	1992/93	100	24	66	34	26(100)	0(--)	--	26

Table 5. Subunit 15(B) West moose harvest[a] percent by transport method, 1988-1992.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1988/89	0	19	4	2	0	0	63	13	48
1989/90	2	15	0	0	0	5	68	10	41
1990/91	2	15	2	2	0	2	63	15	54
1991/92	0	15	8	10	0	0	59	8	39
1992/93	4	6	2	8	0	2	67	10	48

[a] Excludes permit hunt harvest.
[b] No data available

Table 6. Subunit 15(B) moose harvest[a] percent by time period, 1988-92.

Regulatory year	Harvest periods: 9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	n
1988/89	44	8	8	23	17	48
1989/90	27	17	27	29	0	41
1990/91	39	20	13	29	4	54
1991/92	36	10	21	26	8	39
1992/93	48	13	19	17	4	48

[a] Excludes permit hunt harvest.
[b] No data available.

LOCATION

Game Management Unit: 15C (2,441 mi^2)

Geographical 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 Subunit 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. Human development in these areas is a serious threat to moose habitat.

Recently, bark beetles have infested many old-growth spruce stands in Subunit 15C. In 1993, an aerial survey showed 265,972 acres of land were infested with spruce bark beetles (Jim Peterson ADNR pers. comm.) and much of the mature overstory had died. Logging has been initiated in response to the beetle damage. To date, the majority of logging has occurred on private land although state timber sales have been planned. Reduction of old-growth forests may be beneficial to the moose population by enhancing nutritional quality and availability of winter food plants.

MANAGEMENT DIRECTION

Management Objective

The moose management objectives are to maintain a population of 3,000 moose and a minimum posthunting sex ratio of 15 bulls:100 cows.

METHODS

A Gasaway (1986) style moose census was completed in March of 1992 encompassing the lowland portion of Subunit 15C, west of the Fox River valley. Aerial sex and age composition surveys were conducted in November and December of both years in selected trend count areas. Aerial surveys were made only when snow cover was extensive and moose sightability was high.

Annual moose harvest data were collected through the statewide harvest reporting system and reported through the Wildlife Information Data Base (WIDB) software. We documented winter moose mortalities from the Homer Bench that were found incidental to ADF&G field activities or reported by the public. Whenever practical, carcasses were inspected to determine their location, sex, age class, the probable date and cause of death. A leg bone was collected to examine bone marrow for fat content.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Results from aerial surveys and harvest reports suggests that the moose population has remained stable since the mid 1980s. The 1991-92 winter was considered moderately severe in most of the region. The 1992-93 winter was considered normal with very little winter mortality. We believe the moose population has remained stable at 2,500-3,000 animals.

A complete Gasaway (1986) style census was completed during late winter when snow conditions were optimum. The lowland portion of Subunit 15C (1,190 mi^2) was censused. A population estimate of 2,079 moose was calculated from survey results. Confidence intervals around the estimated population ranged $\pm$ 20% for 80 % CI (1,677 - 2,491) to $\pm$ 31% For 95 % CI (1,425 - 2,734). Low sightability of moose was the largest factor for the high CI. The true population for the census area probably was near the upper confidence limits. An additional 200-300 moose were estimated in the mountainous portion of Subunit 15C outside the census area.

Population Composition: Two of 8 count areas were surveyed during 1991, fall sex and age composition surveys. Nine hundred thirteen moose were classified with ratios of 40 calves:100 cows and 36 bulls:100 cows. Two count areas were again surveyed in 1992 (834 moose), resulting in 33 calves:100 cows and 28 bulls:100 cows. Yearling bulls:100 cows dropped from 18 in 1991 to 10 in 1992 reflecting the severity of the previous winter even though there were 23% calves in 1991. Calf percentage was 21% in 1992 (Table 1).

Mortality

Harvest:

Season and Bag Limit. There was a Tier II subsistence season from 1-30 September in a portion of Subunit 15C southwest of a line from Point Pogibshi to the point of land between

Rocky and Windy Bay. The bag limit was 1 bull. The remainder of Subunit 15C moose season was from 1-20 September for 1 bull with spike-fork or 50-inch antlers.

Game Board Action and Emergency Orders. The Board of Game considered but rejected proposals to change or eliminate the Lower Kenai Controlled Use Area during the spring 1992 Board meeting. A limited entry antlerless moose season was proposed for the spring 1993 meeting. The local advisory committee failed to support this hunt and therefore, the Board decided not to consider the proposal without committee support.

Hunter Harvest. In 1991, 294 moose were harvested by 1,131 hunters during the general season (Table 2). One hundred seventy-nine (61%) hunters reported taking spike/fork bulls (less than 35 inches) compared to 98 (33%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Seventeen (6%) indicated either unknown size or illegal classification.

In 1992, 185 moose were harvested by 1,171 hunters during the general season (Table 2). Ninety (49%) hunters reported taking spike/fork bulls compared to 84 (45%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Eleven reports (6%) indicated either unknown size or illegal classification. Successful hunters averaged 5.1 and 5.0 days hunting in 1991 and 1992, respectively.

Permit Hunts. There were no moose harvested in 1991 for hunt T940, however 3 bull moose were harvested in 1992.

Hunter Residency and Success. Hunter success in 1991 was 25%. Two hundred forty-four (86%) successful hunters were Unit 15 residents, 29 (10%) were residents not living in Unit 15 and 9 (3%) were nonresidents (Table 2). Residency reported for unsuccessful hunters was: unit residents 717, nonunit residents 117, nonresidents 5, and unspecified residency 7.

Hunter success in 1992 was 16%. One hundred sixty-three (89%) successful hunters were unit residents, 13 (7%) were residents that did not live in Unit 15 and 7 (4%) were nonresidents (Table 2). Residency reported for unsuccessful hunters was: unit residents 850, nonunit residents 127, nonresidents 7, and unspecified residency 4.

Harvest Chronology. Reported chronology of harvest suggests the highest percentage of hunting occurred during the first 5 days of the season in all years.

Transport Methods. In 1991, 37% of successful hunters reported ATVs as their means of transportation (Table 3). The second common transportation means for successful hunters was highway vehicles (35%). Hunters using horses, aircraft, or boats accounted for 15%, 4%, or 2%, respectively, of the reported harvest by transportation means. Hunters that utilized horses or aircraft had the highest success rates but accounted for only 15% and 4% of the harvest, respectively.

In 1992, 38% of successful hunters reported ATVs as their means of transportation (Table 3). The second common transportation means for successful hunters was highway vehicles (31%). Hunters using horses, aircraft, or boats accounted for 17%, 4%, or 3%, respectively, of the reported harvest by transportation means. Hunters that utilized horses or aircraft had the highest success rates but accounted for only 17% and 4% of the harvest, respectively, during 1992.

Other Mortality:

In addition to reported harvest, a minimum of 49 moose were killed in Subunit 15C by motor vehicles during 1991. At least 45 moose were killed in 1992 by motor vehicles (Table 5). 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.

In 1991-92, a moderately severe winter caused the deaths of a high proportion of moose calves especially in the Homer vicinity. Sixty seven cases of winter mortality were documented with only 10 (15%) older than calves. Of 41 known calves, 28 (68%) were female and 13 (32%) male. In addition, 8 moose were shot in defense of life and property. The 1992-93 winter was considered mild, however 5 cases of winter related mortality were documented.

Habitat

Assessment:

Reduction of some old-growth forest in response to spruce bark beetle infestations through logging has begun in Subunit 15C. Logging and reforestation techniques that encourage hardwood production were recommended. If hardwood production increases in these affected areas moose will probably benefit from regrowth. However, if site preparation is not adequate, grass (*Calamagrostis* spp.) will compete with hardwood and spruce seedlings.

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 identified being significantly affected through project construction and operation. Mitigation focused on compensation for habitat lost from rising lake levels. 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 with the Department of Natural Resources totaling 137 acres. A $150,000 trust fund was established to provide money for moose management. Trustees were selected (one each) from ADF&G, AEA, and the Homer Fish and Game Advisory Committee.

Several habitat enhancement projects were initiated in the Homer Bench. These projects included distribution of willow shoot cuttings and scarification of abandoned hay fields. During the first year approximately 10,000 stems were distributed for planting from the ADF&G office and a handout was made available with planting instructions. About 3,000 stems were distributed in 1993. Approximately 24 acres were scarified using a Percheron disc trencher pulled by a log skidder during late June. An average of 1.5 acres per hour were scarified at a cost of approximately $36.00 per acre including the cost of equipment mobilization.

CONCLUSIONS AND RECOMMENDATIONS

Winter conditions in Unit 15 during 1991-92 were moderately severe and many calves were lost region wide. The 1992-93 winter was considered normal with little documented mortality. Human-caused moose mortality, including road kills and harvest, represented 9-13% of the estimated moose population of 2,500.

Two solutions were identified to address the declining habitat quality and starvation problem; population reduction and habitat enhancement within the affected areas. For the best results we felt that both should occur simultaneously. In response to public outcry about moose calves starving to death during the 1991-92 winter we initiated a habitat enhancement program. The objectives of the program were to enhance moose habitat near Homer by replacing non-desireable plants with beneficial browse species. Approximately $150,000 remains in a moose mitigation trust that has been earmarked for use in the Homer area. We recommend that a portion of this money be allocated to habitat enhancement as soon as possible.

An antlerless moose season by drawing permit was proposed to the Board of Game. This controversial issue failed to gain enough local support so the Board refused to consider the proposal. We recommend that this proposal (up to 50 antlerless moose) be resubmitted during the spring 1995 meeting with the local Advisory Committee's support. The wintering moose population in the Homer area should be reduced to allow browse to regenerate.

The harvest of moose and hunter success under spike-fork/50-inch regulations appeared to fluctuate in response to 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. A thorough review of the selective harvest system was reported by Schwartz et al. (1992).

Impact of predation by wolves and bears is unknown. The unit supports an estimated 50-70 wolves in 5-6 packs. Black bear are abundant throughout the unit and brown bear are common in all drainages supporting salmon which exert additional pressure on Subunit 15C moose. If environmental conditions preclude recruitment of moose, predation may negatively affect the population.

The bull to cow ratio exceeded the management objective during all 5 years since the selective harvest program was initiated. Under the current selective harvest system a longer season may be warranted. However, to avoid shifts in hunting pressure, Subunit 15C season length or bag limit should not be altered until similar changes are recommended for the remainder of Unit 15.

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Table 1. Subunit 15C fall aerial moose composition counts and estimated population size, 1988-92.

Regulatory year	Total Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	moose observed	Moose /hour	Estimated population size
1988/89	12	3	44	28	418	584	35	2,500
1989/90	26	8	33	21	422	536	91	2,500
1990/91	37	16	22	14	253	294	--	2,500
1991/92	36	18	40	23	705	913	66	2,500
1992/93	28	10	33	21	663	834	62	2,500

Table 2. Subunit 15C moose hunter residency and success, 1988-92.

	Successful				Unsuccessful				
Regulatory year	Local[a] resident hunters	Nonlocal resident	Nonresident	Total	Local[a] resident	Nonlocal resident	Nonresident	Total	Total
1988/89	148	16	4	127	552	77	3	641	768
1989/90	125	25	4	156	480	72	11	581	737
1990/91	162	27	3	200	608	90	12	733	933
1991/92	244	29	9	294	717	117	5	846	1,131
1992/93	163	13	7	185	850	127	7	988	1,171

[a] Resident of Unit 15.
[b] Includes unreported residency.

Table 3. Subunit 15C moose harvest percent by transport method, 1988-1992.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
1988/89	6	18	3	17	--	10	33	12	170
1989/90	5	10	4	19	--	21	31	9	156
1990/91	4	16	3	29	--	14	29	6	200
1991/92	4	15	2	24	--	13	35	6	294
1992/93	4	17	3	24	--	14	31	7	185

Table 4. Subunit 15C moose harvest percent by transport method, 1988-92.

Regulatory year	Percent of Harvest: Airplane	Horse	Boat	3- or 4-wheeler	Highway vehicle	Unk.	n
1988/89	6	18	3	27	33	12	170
1989/90	5	10	5	40	31	9	156
1990/91	4	16	3	43	29	6	200
1991/92	4	15	2	36	33	6	294
1992/93	4	17	3	38	31	7	185

Table 5. Subunit 15C moose harvest[a] and accidental death, 1988-92.

Regulatory year	Hunter Harvest: Reported M (%)	F (%)	Unk.	Total	Hunter Harvest: Estimated Unreported	Illegal	Total	Accidental death Road	Train	Total	Grand Total[b]
1988/89	170			170	--	--	30	43	--	43	243
1989/90	156			156	--	--	30	60	--	60	246
1990/91	200			200	--	--	30	83	--	83	313
1991/92	294			294	--	--	30	49	--	49	373
1992/93	185			185	--	--	30	45	--	45	260

[a] Excludes permit hunt harvest.
[b] Does not include losses due to malnutrition and other winter kill.

LOCATION

Game Management Unit: 16A (1,850 mi^2)

Geographical Description: West side Susitna River (Yentna River to Chulitna River)

BACKGROUND

Before 1940, moose were apparently at low densities in Subunit 16A. Habitat changes and reduced predator populations allowed higher densities to develop. Winter die-offs occurred in response to deep snow, but the population rebounded during periods of mild winters. Moose numbers peaked in the 1950s and late 1960s. Deep snow winters caused die-offs during 1971-72 and 1972-73, subsequently the population increased through 1984. Deep snow in 1984-85 caused another decline, but in the absence of cow hunts, numbers again increased. A deep snow winter during 1989-90 caused a 30-40% decline in the population. Recovery of the population since 1989-90 was hindered by subsequent deep snow winters.

The population peaked at 4,000-5,500 moose during 1987 and 1988; however, the first reliable posthunting population estimate, developed during fall 1990, was 2,960 moose. During fall 1990, population composition was measured at 27 bulls:100 cows:31 calves. During the previous population peak, fall composition samples produced calf:cow ratios of 35-43:100 and bull:cow ratios reached 36-41:100.

Hunter harvest in Subunit 16A increased steadily after the subunit was established in 1973. During the 1970s hunter harvest increased from 83 to 167 moose; approximately 25 cows were killed annually. By 1984-85, harvest of both sexes climbed to 308 moose (52 cows), but high mortality that winter caused the harvest to drop to only 102 bulls the following fall. Bull-only-seasons and increased use of 3-or4-wheelers allowed bull harvest to increase to 288 during fall 1989. Harvest dropped to 37 bulls in an abbreviated fall 1990 hunting season, the product of the 1989-90 winter.

Hunter effort has been high by hunters residing outside of Unit 16. Except for 1975-76 (182 hunters), numbers of hunters ranged from 405 to 1,200 hunters. Less than 10% of hunters in all years, except 1990, were residents of Unit 16 while fewer than 5% were nonresidents.

MANAGEMENT DIRECTION

Management Goals

To conserve all populations of wildlife while producing moderate, sustainable levels of moose, allowing sustainable harvest levels of predators to meet desirable predator prey ratios, and enhancing wildlife viewing opportunities within state and national parks.

Population Objectives

To maintain a posthunting moose population of 3,500-4,000 with a sex ratio of not less than 20 bulls:100 cows.

Human Use Objectives

To achieve a minimum annual average harvest of 300 moose by 1997.

METHODS

During November 1992, department biologists conducted a "Becker survey" (E. Becker pers. commun.), a modified version of a stratified random sampling census (Gasaway, et al. 1986). The survey produced an estimate of observable moose and population composition with confidence intervals. A total population estimate was developed by multiplying observable moose by an estimated overall sightability correction factor (SCF) of 1.35. Population surveys were not conducted during 1991-92.

During November-December 1993, we conducted another "Becker survey." Though an attempt was made during this survey to develop a SCF, a small sample size and high variability in samples caused us to use a standardized SCF of 1.3 for population and composition projections.

RESULTS AND DISCUSSION

Population Status and Trend

The size of the Subunit 16A moose population appeared unchanged from 1990-91 through 1993-94. The northern half of the subunit's moose population declined while the southern half appeared to increase. Gains in the south appeared to negate losses in the north. The population was expected to increase in the absence of a deep snow winter.

Population Size:

The 1992 posthunting population was estimated at 2,900 moose (Table 1) which equates to 1.7 moose/mi.2 of moose habitat. The 1993 posthunting season was estimated at 3,284 moose; however a population increase appeared doubtful given the larger confidence interval associated with the survey estimate.

Population Composition:

Fall sex and age composition during 1992 and 1993 reflected stresses of deep snow winters. Fall 1992 sex and age composition was 36 bulls:100 cows:32 calves (19% calves in the population) (Table 1). These ratios were observed to decline during 1993; the composition was estimated at 24 bulls:100 cows:24 calves (16% calves).

Mortality

Harvest:

Season and Bag Limit. During both the 1991-92 and 1992-93 the season for resident and nonresident hunters in Subunit 16A was 1-15 September; the bag limit was 1 bull.

Game Board Actions and Emergency Orders. Following the abbreviated (10-day) fall season during 1990-91 the department recommended a 20-day season; however, the Board of Game chose to be more conservative and adopted a 1-15 September season with a bag limit of 1 bull. This regulation was in effect for 2 years because the Board adopted a schedule for considering bull moose seasons and bag limits every other year.

In spring 1993, the Board adopted antler restrictions for the 1993-94 hunting season. As part of an effort to maximize season length, the department proposed a 20 August to 20 September season for most of road accessible southcentral Alaska. To allow the long season and to "weather-proof" bull:cow ratios and season length, the Board adopted a bag limit of 1 bull with spike or fork antlers on 1 side or with 3 or more brow tines on at least one side or antlers measuring 50 inches or wider (S/F/50"). Because these antler restrictions were expected to unnecessarily produce a higher bull:cow ratio in Subunit 16A, up to 200 drawing permits for any bull were authorized to be issued for a hunt during 1-15 November. Antler restrictions were expected to be in effect for a minimum of 5 years before affects are analyzed.

Hunter Harvest. Annual harvest, following the abbreviated fall 1990 season, increased to an annual reported harvest of 138 moose during falls 1991 and 1992 (Table 2). The 15-day season combined with higher hunter effort during 1991 and 1992 resulted in 100 more moose being taken than recorded during fall 1990.

Hunter Residency and Success. The residency composition of successful moose hunters changed little during the period 1988-1992 (Table 3). Unit 16 residents accounted for a mean of 7% of the annual harvest during that period. Other Alaska residents accounted for 87%.

A reduced density of bulls and eliminating hunting for the last 2 weeks of September, the period of vulnerability for bulls approaching the rut, caused success rates to diminish. Elimination of the last 2 weeks of September during 1991-92 and 1992-93 produced 16% hunter success. This success rate represents an improvement over 7% success observed during 1990-91, but it falls short of the 23% mean success rate for the years 1986-1989 (Griese 1993).

Harvest Chronology. Though elimination of the last 2 weeks of September appeared to be a primary cause for reduced harvest, the number of moose killed during weeks 1 and 2 during 1991-92 and 1992-93 were consistently greater than previous years (Table 4). More hunters participating earlier in the season likely produced the greater early harvest. During the month long September seasons during 1988-89 and 1989-90, 65% of the harvest occurred during the last 2 weeks.

Transport Methods. The largest percentage of successful hunters during 1991-92 and 1992-93 used 3-or4-wheelers (Table 5). In previous years boats were the dominant transportation used by successful hunters (Griese 1993). The shift to 3-or4-wheelers reflects increased ownership by hunters and an increased development of trails. This trend is expected to continue.

Other Mortality:

Reported accidental mortality in the subunit during 1991-92 reached 15 moose, similar to that reported for the deep snow winter of 1989-90 (Table 2). Reported accidental mortality declined in 1992-93.

Estimates of moose killed illegally (unreported) or DLP (reported) changed little since 1990-91. The estimate was 24-25 moose annually (Table 2).

Though mortality by predation has not been quantified in Subunit 16A, wolves and bears have had an increased affect. During March 1993, the Unit 16 wolf population was estimated using a estimated probability sampling survey (Becker pers. commun.). The estimated wolf population found in Subunit 16A during 1993 was more abundant than estimates for the previous 2-decades. This higher wolf population produced several reports from pilots of wolf-killed moose in recent winters. Pilots have also reported spring mortality from emerging brown bears.

Mortality from deep snow winters remains the primary mortality factor in Subunit 16A.

Snow depths. A series of deep snow winters began in 1989-90 and continued through 1992-93. Coady (1974) identified 90 cm as the critical snow depth that precipitated winter mortality in interior moose. In the 10 years prior to 1989-90, maximum monthly snow depth exceeded 100 cm in only 4% of winter months (October-April) measured at Willow, 9% at Talkeetna, and 57% at Chulitna River Lodge (Climatological data: Alaska. Vol. 65-78. National Oceanic and Atmospheric Administration). (Though Chulitna River Lodge is approximately 25 miles northeast of the Subunit 16A boundary, elevation and snowfall patterns are similar to the Peters-Dutch Hills in northern 16A.) In contrast, during 1989-90 through 1992-93, 100 cm was exceeded 43%, 54% and 79% of months measured at the respective sites. Maximum monthly snow depth exceeded 200 cm 4%, 4%, and 39% of months at those sites during 1989-90 to 1992-93. In the previous 10 years 200 cm was never reached.

Habitat

Enhancement:

Though a controlled burn of 1-2,000 acres is planned in the next 2 years (W. Collins pers. commun.), a large area has ever been manipulated in Subunit 16A specifically for moose by department efforts. Recent data for winter vegetation use by moose suggest in most winters, high bushcranberry (*Viburnum edule* (Michx.) Raf.) provides far more biomass to moose than previously expected (W. Collins pers. commun.). In which case, manipulation of habitat that proves detrimental to high bushcranberry abundance and availability, could eliminate a steady, long-term food source.

CONCLUSIONS AND RECOMMENDATIONS

Fall population estimates were below population objectives during 1991-92 and 1992-93. The population estimate for fall 1993-94 approached the lower level of the desired range, 3,500-4,000. The population failed to reach desired levels due to a series of deep-snow winters following the 1989-90 winter, when numbers declined 30-40%. In spite of population levels being below objectives during recent falls, bull:cow ratios exceeded objective levels, reaching 24-36 bulls:100 cows.

Hunter harvest was less than half of the desired human use objective of 300 moose and the prospect of achieving that level by 1997 are unlikely. The most recent 2-year average of moose taken by hunters was 138. It is unlikely that human-use objectives will be mets by 1997 because the population has not escaped affects of deep-snow winters, antler restrictions imposed beginning fall 1993 reduced harvest rates, and most of the subunit remained inaccessible during hunting season. While meeting the objective is unlikely, efforts can be made to optimize harvest through the November drawing permit hunt.

I recommend annual fall composition surveys to allow optimal allocation of drawing permits for bulls in the November hunt. The hunter demand for moose in southcentral Alaska far exceeds the harvestable surplus. While the S/F/50" regulation is expected to allow acceptable harvest levels and produce desirable bull:cow ratios in many road accessible units, we estimated S/F/50" restrictions would unnecessarily restrict harvest in Subunit 16A. Bull:cow ratios were calculated to increase annually in response to S/F/50" restrictions with no other harvest, far exceeding the objective of 20:100. Providing this surplus of bulls to hunters through special permit hunts was part of the selling point when S/F/50" was offered to the public. Up to half of the annual harvest may be taken by permittees. Identifying the annual surplus of bulls caused by this regional program can be most accurately accomplished by annual composition surveys.

I recommend continued effort to collect age/antler formation data from lower Susitna River bulls. Observers during composition surveys and censuses apparently have had difficulty differentiating yearling bulls from older bulls. Proper application of antler restrictions during hunting seasons requires confidence in the age/antler relationship specific to the subunit. Collecting jaws and antler measurements should continue.

Other issues affecting the Subunit 16A moose population warranting concern include the real or perceived increased influence of predators on moose and habitat needs for moose. Responses to the predator issue are likely to include liberalization of hunting and trapping opportunities, possibly including "control" measures. Clearly, becoming familiar with predator:prey ratios will become more important if winters prevent moose population recovery and managing predators moves into a public forum. Winter snow depths are beyond department control, likewise, manipulating significant quantities of habitat would seem to be uncontrollable. As more of the subunit is developed, opportunity for controlled or natural burns, the only truly effective tool, will be diminished. Opportunities for allowing fires should be pursued sooner than later.

No changes in season or bag limits are recommended until the affects of the S/F/50" program can be analyzed.

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Table 1. Subunit 16A fall aerial moose composition counts and estimated population size, 1988-1993.

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	Total moose observed	Population estimate
1988/89	36	12	35	19	392	484	3,800-5,300
1989/90[a]	--	--	--	--	---	---	3,800-5,300
1990/91[b]	27	7	31	19	1,105	1,366	2,961±256[c]
1991/92[a]	--	--	--	--	--	---	2,700-3,200
1992/93[d]	36	11	32	19	779	963	2,900±564[c]
1993/94[d]	24	10	24	16	698	828	3,284±903[c]

[a] No surveys conducted. Population estimated through deductive evaluation.
[b] These data were derived from a population census conducted in December 1990. SCF calculated by strata.
[c] 80% C.I.
[d] These data were derived from a "Becker Survey". SCF estimated.

Table 2. Subunit 16A annual moose harvest and accidental death, 1988-92.

Regulatory year	Reported				Estimated			Accidental			Grand Total
	M	F	Unk	Total	Unreported[a]	Illegal[b]	Total	Road[c]	Train[d]	Total	
1988/89	290	0	4	294	16	20	36	13	0	13	343
1989/90	286	0	2	288	16	30	46	15	0	15	349
1990/91	37	0	0	37	14	10	24	6	0	6	67
1991/92	135	0	3	138	15	10	25	15	0	15	178
1992/93	136	0	2	138	15	10	25	9	0	9	172

[a] This estimate was derived by taking 5% of the total reported kill.
[b] Includes moose taken in defense of life or property.
[c] Road and train are minimum numbers; in most years actual kill was probably higher.
[d] While a train does not travel through Subunit 16A, up to 60% of moose killed by trains in Subunit 14B are from Subunit 16A.

Table 3. Subunit 16A moose hunter residency and success 1988-92.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[a] resident(%)	Nonlocal resident(%)	Nonres	Unk	Total	Local[a] resident	Nonlocal resident	Nonres	Unk	Total	
1988/89	19 (7)	242 (84)	17	10	288	41	713	24	51	829	1,117
1989/90	20 (7)	249 (87)	13	4	286	47	920	28	11	1,006	1,292
1990/91	4 (11)	35 (84)	1	1	37	23	448	9	16	473	510
1991/92	9 (7)	123 (89)	4	2	138	28	673	12	8	721	859
1992/93	7 (5)	126 (91)	4	1	138	34	630	24	21	709	847

[a] Unit 16 residents.

Table 4. Subunit 16A moose harvest chronology, 1988-1992.

Regulatory year	Before season opened	Weeks of season 1st	(%)	2nd	3rd	4th	After season closed	Unk	Total
1988/89[a]	4	57	(20)	37	60	119	2	9	288
1989/90[a]	1	60	(21)	31	65	118	1	10	286
1990/91[b]	1	21	(57)	11	---	---	2	2	37
1991/92[c]	0	72	(52)	53	7	---	1	5	138
1992/93[c]	0	75	(54)	51	6	---	1	5	138

[a] 1-30 September season.
[b] 1-10 September season.
[c] 1-15 September season.

Table 5. Successful moose hunter % by transport method in Subunit 16A, 1988-92.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Orv	Highway vehicle	Unk	Total all methods
1988/89	13	0	26	18	1	15	23	5	288
1989/90	14	1	27	22	1	12	22	2	286
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

LOCATION

Game Management Unit: 16B (10,405 mi^2)

Geographical Description: West side of Cook Inlet and Kalgin Island

BACKGROUND

Before 1940, moose were uncommon in Subunit 16B. Habitat changes and reduced predator influence, due to federal predator control, allowed higher densities. Moose numbers apparently peaked during the 1950s, the late 1960s, and late 1970s. Though the population exhibited an overall declining trend since the 1970s, peaks in numbers also were reported during 1984 and again in 1988. Winter die-offs occurred in response to deep snow, but the population recovered during periods of mild winters. The most significant die-offs occurred during the winters of 1971-72 and 1989-90. Though deep snow was primarily responsible for these die-offs, Faro (1989) implied that predation on moose calves by bears began influencing recruitment and caused an overall declining trend. Predation by wolves was not considered an important factor until 1992.

Hunter harvest levels reflected moose abundance in Unit 16. From 1972, when Unit 16 was divided into subunits A and B, through 1989, annual harvest in 16B averaged 464 moose. Annual harvest ranged from a low of 201 in 1975 to the peak of 842 during 1973. (The harvest reported for 1973 did not reflect the population, which was low following a recent die-off. Rather, the harvest reflected an effort to reduce moose numbers to reduce further degradation of winter habitat.) Peaks in harvest also occurred during 1978 (589 total and 147 cows) and 1984 (616 total and 173 cows). Harvest subsequent to the 1984 peak reflected a general population decline. During fall 1989, the harvest was 345 moose, including 32 cows. Average annual cow harvest during 1972-89 was 110, ranging from 0 to 292.

During the winter of 1989-90 moose numbers declined an estimated 10-15% resulting in a fall 1990 population of 7,300-7,500 moose (Harkness 1993). Harkness based this estimate on a stratified random census of approximately 75% of the subunit's moose habitat and an assumed 30-60% decline in the 1,500-1,600 moose estimated during 1984 for the remainder of the subunit (Faro 1985). Faro (1989) had previously estimated the subunit population at 7,000. The 1990 census results and estimates of the 1989-90 die-off placed the mid-1980 population closer to 8-9,000 moose.

Hunting seasons in mainland Subunit 16B have reflected an effort by the Board of Game to take advantage of a poorly accessed, underutilized moose resource. During 1962-74 hunting seasons in Subunit 16B were liberal, including 20 August to 30 September and 1-30 November seasons for either-sex moose. Although 5-20 day antlerless moose hunts during September continued through 1989 (except 1975), late-season hunts were absent during

1976-82. Increasing numbers of hunters combined with lower moose recruitment caused late-season hunts to be converted to permit hunts beginning in 1983. To assure local residents an opportunity to meet subsistence needs, permits were issued in the subunit or (in later years) as Tier II permits.

The Kalgin Island moose population resulted from a translocation of calves during 1957-59. Numbers grew but were also affected by prolonged deep snow winters. Hunting was allowed during 1969-78 and again beginning in 1981. Annual harvest peaked at 80 moose during 1981-82 but declined to under 10 annually since 1985. The population peaked at 7 moose/mi^2 during 1981 (Taylor 1983) but was intentionally reduced to 1 moose/mi^2 by 1985. High moose densities severely degraded habitat and caused the adoption of restrictive population objectives, to maintain moose densities at less than 1 moose/mi^2 while vegetation recovered (Faro 1990).

MANAGEMENT DIRECTION

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

Management Objectives

Unit 16B (excluding Kalgin Island): To maintain a minimum fall moose population of 6,500 with a posthunting sex ratio of not less than 20 bulls:100 cows.

Kalgin Island: To maintain a fall population of 20-40 moose with a posthunting sex ratio of not less than 15 bulls:100 cows.

Human Use Objectives

To achieve and maintain a minimum 3-year average harvest of 300 moose by 1999.

METHODS

We attempted to conduct fall sex and age composition surveys in the Lone Ridge area during 1992. The single attempt during December fell short of completing a full count area. During 15 November to 3 December, 1993, a "Becker style" aerial survey was conducted in the portion of 16B north of Beluga River. Estimated population size and composition were calculated using MOOSEPOP (D. Reed pers.comm.). Harvest data were obtained from harvest reports.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

During 1993, the Subunit 16B moose population was estimated at 6,700 moose (Table 1). The Becker survey produced an estimated 5,847 ±1,419 (80% C.I.) observable moose. When this estimate was combined with an estimated 700-1,000 from the remainder of the subunit, the total subunit population approached 5,100-8,300 moose. The median point in this range estimate (6,700) represented the low end of densities exhibited during the last 6 years (Table 1) and possibly since the early 1970s.

The subunit population exhibited a declining trend (Table 1). A comparison of population estimates derived from the fall 1990 Gasaway et al. (1986) census and the 1993 Becker survey suggested a 20-30% decline in total observable moose north of the Skwentna River. During the 1993 survey, early deep snow above 1,000 ft. elevation promoted early migration from postrutting concentrations, therefore survey results lacked tight confidence intervals due to moose movement. Moose numbers south of Skwentna River and north of Beluga River remained stable between 1990 and 1993.

Population Composition:

The single attempt to collect sex and age composition in the Lone Ridge area, in southwest 16B, during 1992 produced a sample of 124 moose from a fraction of the total count area. Though antler drop had commenced, we observed ratios of 36 bulls, 5 yearling bulls and 12 calves:100 cows.

During the fall 1993 Becker survey, estimated population composition differed from 1990 census estimates primarily in the calf segment (Table 1), which was 30% lower in 1993. We also suspected low calf survival through fall 1992. Presurvey weather conditions and predation were assumed to be similar in both years.

Mortality

Harvest:

Season and Bag Limit. During 1991-92 and 1992-93, the resident and nonresident open season was 1-20 September on Kalgin Island, with a bag limit of 1 bull. In the Redoubt Bay drainages south of and including the Kustatan River drainage, the resident and nonresident season was 1-10 September, also with a bag limit of 1 bull. In the remainder of the subunit the resident open season was 1-20 September and a 2-week period between December and February announced by emergency order. The bag limit for residents was 1 bull except that up to 75 bulls could be taken during December-February by Tier II permit only. In this same portion of the subunit nonresidents could take 1 bull during 1-20 September.

Game Board Actions and Emergency Orders. Following the significant population declines during winter 198-/90, the Board established a 10-day season on mainland 16B for fall 1990. The fall 1990 census showed evidence of excess bulls in the northern 75% of the subunit, so the Board extended the fall 1991 season length to 20 days and allowed nonresidents to hunt in this area. (Nonresidents were excluded from hunting in 16B the previous fall.) Low moose numbers in the Redoubt Bay drainages supported maintenance of a 10-day season. Concern that Kalgin Island would attract excess hunting pressure caused the Board to adopt season dates uniform with the surrounding areas and to eliminate cows from the bag limit.

Emergency orders set the 2-week, Tier II hunt during 4-17 January, 1992 and 14-27 January and 17-23 February, 1993. The additional week of hunting during February 1993 was allowed because poor hunting conditions in the Tyonek-Beluga area prevented local residents from meeting subsistence needs.

During 1992, the Board adopted antler restrictions for bull moose beginning fall 1993 for most of southcentral Alaska, and portions of 16B were included. In those portions of 16B, north of Beluga River and west of the Kustatan River, a legal bull must have a spike, fork or 3 brow tines on 1 side or have an antler spread of 50 inches or greater (S/F/50"). The antler restriction imposed in Subunit 16B was a precautionary regulation to aid in enforcement of the regulation where it was needed, on the road system. Antler restrictions were unnecessary for population management in northern 16B.

Hunter Harvest. Annual harvest and accidental mortality (Table 2) reflected a combination of season length, bag limit and densities of moose and hunters. During 1991-92 hunter harvest (262-238) increased following restrictive seasons during 1990-91. Elimination of the opportunity to take cows also reduced total harvest. Though fewer hunters participated during the general season, hunter success remained lower than pre-1990 rates (Table 3), a reflection of shorter seasons as well as reduced moose densities.

During the season on Kalgin Island, hunters reported taking 2 and 1 bulls during 1991-92 and 1992-93, respectively.

Permit Hunts. During 1991-92 and 1992-93, late season permits for bull moose were issued to Alaska residents either as Tier II permits or as federal subsistence permits (Table 4). Unit residents represented 39% (77/196) of active, late-season hunters during the 2-year period. During the 3-year existence of Tier II Hunt 979, 28% (124/442) of all permittees killed a moose (Table 4).

Hunter Residency and Success. Combined hunter success (26%) during the 1991-92 and 1992-93 general seasons was greater than during fall 1990 (16%) but less than the combined 1988-89 and 1989-90 success rate (30%) (Table 3). During 1991-92 and 1992-93, Unit 16 residents accounted for 7% of the general harvest, while other residents took 72% and nonresidents took 18%. During the permit hunts, unit residents took 44% of the 97 moose reported taken during 1991-92 and 1992-93 (Table 4). Overall, unit residents reported taking 14% (43/500) of the 1992-93 total harvest.

Transport Methods. Patterns of transportation used by successful hunters reflected a shift in harvest to the late season (Table 5). Use of snowmachines increased after early season reductions following the 1989-90 winter. Successful hunters using snowmachines during 1988-89 represented 9% of all successful hunters, while they represented 19% during 1990-92. Consequently, the number of successful hunters using airplanes declined from 62% to 57%.

Other Mortality. Winter snow depths during 1991-92 and 1992-93 were not of the magnitude observed during 1989-90 and were less likely to cause the level of mortality observed during the latter. No estimates were made for winter mortality during the past 2 winters. However, population estimates for the northern portion of the subunit suggested a 20-30% decrease between fall 1990 and 1993. Recruitment in this area, reflected in the ratio of 9 yearling bulls:100 cows, was only slightly higher than observed in 1990 (Table 1).

The impacts of predation by wolves will undoubtedly increase as wolf numbers increase in the subunit. The Unit 16 wolf population was surveyed during late-winter 1993, and the fall 1992 population was estimated at 48-62. This estimate represents a larger population than the 35-45 estimated by Harkness (1991) for 1989/90. Staff observations and reports from the public also indicated an increasing population of wolves.

CONCLUSIONS AND RECOMMENDATIONS

The mean estimated moose population and observed sex ratio in Subunit 16B exceeded minimum population objectives. However, if the current declining trend, 4-5% annually, continues, the population will fall below objectives by 1996. Kalgin Island population objectives were not measured during 1991-92 to minimize cost of managing this small portion of the subunit.

I recommend a population census of the southern 25% of the subunit moose habitat as a priority. This area was censused during 1984 but little information has been collected subsequently. Sound harvest recommendations depend on current population data. Concurrently, moose numbers on Kalgin Island should be determined.

Habitat conditions on Kalgin Island and in major wintering areas of the mainland need to be evaluated. Population objectives for Kalgin Island depend on the status of vegetation recovery. Harkness (1993) also suggested that habitat on the mainland should be evaluated and implied enhancement (controlled burning) be considered. For many years moose numbers in 16B appeared to be limited by winter habitat and snow depth; they may soon be influenced more by predation.

I recommend that cow moose harvest be limited in Unit 16B to specific areas of overabundance or where predation is not causing a moose population decline. Bear populations were recognized as having an influence on fall calf numbers in Subunit 16B beginning in the 1980s (Faro 1989). Recently, wolves have increased in numbers and few effective harvest options are available for limiting their numbers. Growing numbers of wolves reduce the likelihood of future moose population growth. The expected decline in moose numbers will eliminate the option for future antlerless moose hunts if optimum sustainable harvest is desired.

To reach human use objectives I recommend eliminating antler restrictions in 16B north of the Beluga River. Until hunter effectiveness jeopardizes minimum allowable bull:cow ratios, regulations should allow optimum harvest. During fall 1993, this population had a sex ratio of 34 bulls:100 cows. The population objective, a minimum bull:cow ratio of 20:100, will continue to be exceeded under antler restrictions and limited season length. An option to eliminating the antler restriction would be extending the season to include portions of November and December as well as issuance of limited permits for any bull.

The Board included a portions of Subunit 16B in the S/F/50" antler area for the 1993-94 and 1994-95 seasons. This regulation has proven effective at diminishing the bull harvest on the Kenai Peninsula where hunters have proven effective at harvesting the annual recruitment (Schwartz, et al 1992). The character of northern Subunit 16B, however, allows for only a fraction of the hunter effectiveness observed on the Kenai Peninsula. Based on fall 1993 estimates, an excess of 500-600 bulls remained following the first fall season restricted by the S/F/50" rule.

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Table 1. Subunit 16B fall aerial moose composition counts and estimated population size, 1988-1993.

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	Total moose observed	Moose /mi^2	Population estimate
1988/89	35	11	22	12	1,190	1,359	1.8	8,500±1,000
1989/90	38	12	26	16	1,294	1,536	1.6	8,500±1,000
1990/91[a]	34	7	24	19	1,250	1,534	1.4	7,400±800[b]
1991/92[c]	--	--	--	--	---	---	--	--
1992/93[c]	--	--	--	--	---	---	--	--
1993/94[d]	34	9	21	13	765	879	1.2	6,700±1,600[e]

a Data from a Gasaway, et al (1986) fall census in northern 75% of subunit.
b Includes estimate for northern 75%: 6,456±614 (80% C.I.)
c No surveys conducted.
d Data from fall Becker survey in northern 75% of subunit.
e Includes estimate for northern 75%: 5,846±1,419 (80% C.I.)

Table 2. Subunit 16B annual moose harvest and accidental death, 1988-92.

Regulatory year	Reported M	Reported F	Reported Unk	Reported Total	Estimated Unreported	Estimated Illegal[a]	Estimated Total	Accidental Road	Accidental Other	Accidental Total	Grand total
1988/89	338	35	7	380	25	25	50	2	0	2	432
1989/90	308	32	4	344	25	25	50	10	5	15	409
1990/91	93	5	1	99	15	25	40	2	0	2	141
1991/92	262	0	0	262	20	25	45	1	0	1	308
1992/93	234	1	3	238	20	25	45	0	0	0	283

[a] Includes moose taken in defense of life or property.

Table 3. Subunit 16B moose hunter[a] residency and success 1988-92.

Regulatory year	Successful Local[b] resident	Successful Nonlocal resident	Successful Nonres	Successful Total	(%)	Unsuccessful Local[b] resident	Unsuccessful Nonlocal resident	Unsuccessful Nonres	Unsuccessful Total	(%)	Total hunters
1988/89	13	236	58	328	(30)	27	640	66	756	(70)	1,084
1989/90	8	217	54	282	(29)	31	566	64	678	(71)	960
1990/91	3	64	2	69	(16)	24	322	1	351	(84)	420
1991/92	15	156	35	210	(26)	26	511	41	585	(74)	795
1992/93	14	136	38	193	(25)	26	480	53	570	(75)	763

[a] Does not include individuals participating in permit hunts.
[b] Unit 16 residents.

Table 4. Subunit 16B moose harvest data by permit hunt, 1988-92.

Hunt No.[a]	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Harvest Bulls	Harvest Cows	Harvest Total
981R	1988/89	60	30	22	48	12	17	29
	1989/90	70	20	13	61	22	21	43
982R	1988/89	65	35	28	37	12	12	24
	1989/90	51	22	27	37	11	7	19
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
916F[b]	1991/92	10	60	10	30	1	0	1
(973F)	1992/93	3	0	67	33	2	0	2
Total all permit hunts	1988/89	125	33	25	42	24	29	53
	1989/90	122	20	19	51	33	28	62
	1990/91	141	45	34	21	30	0	30
	1991/92	161	38	24	37	52	0	52
	1992/93	153	29	42	29	45	0	45

[a] R = registration permit (issued in subunit), T = Tier II permit, F = federal subsitence permit.

[b] Federal subsitence hunt; hunt no. changed between years.

Table 5. Subunit 16B moose harvest percent by transport method, 1988-92.

	Percent of Harvest							
Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Orv	Highway vehicle	n
1988/89	64	4	14	3	8	1	7	362
1989/90	60	2	16	2	11	2	8	331
1990/91	52	0	14	1	28	2	3	95
1991/92	54	1	17	3	19	1	2	262
1992/93	52	3	15	3	16	3	2	238

LOCATION

Game Management Unit: 17 (18,800 mi^2)

Geographical Description: Northern Bristol Bay

BACKGROUND

Moose appear to be relatively new inhabitants in the Bristol Bay area, possibly immigrating into the area from Kuskokwim River drainages during the last century. Until recently, populations were low and moose were found primarily in the Nushagak/Mulchatna River system. Local residents harvested moose opportunistically, however, caribou, reindeer, and beaver were historically the main sources of game meat. The Department began collecting data on the Unit 17 moose population in 1971. Then, Faro (1973) reported moose were not abundant in the unit and that animals close to the villages were subject to heavy hunting pressure.

Hunting seasons have varied over the years, but the bag limit has always been restricted to bulls. A general disregard for seasons and bag limits by unit residents for most of the century was suspected to be the principle factor contributing to the historically low densities of moose in the unit (Taylor 1990).

In the last decade, moose populations in subunits 17B and 17C have increased substantially both in number and range. Reasons for this increase include: 1) moderate snowfalls in several successive winters; 2) low predation rates by wolves; and, 3) decreased human harvest of female moose. The reduction in the female harvest was caused in part by a positive response by unit residents to Department education efforts, and in part to an abundance of an alternative big game resource because the Mulchatna caribou herd expanded in size and range (Van Daele 1991).

Moose are now common along the Nushagak/Mulchatna Rivers and all of their major tributaries. They also occur throughout the Wood/Tikchik Lakes area. Moose continually attempt a westward expansion of their range into the Togiak and Kulukak River drainages of Subunit 17A. In spite of an abundance of suitable habitat, a viable population has not become established in the subunit because of suspected illegal harvest by subunit residents.

MANAGEMENT DIRECTION

Management Objectives

The management objectives for the unit are: in Subunit 17A, to establish a minimum population of 100 moose; in Subunit 17B, to achieve and maintain a density of 1 moose/mi^2 on habitat considered good moose range, and in Subunit 17C, to maintain a minimum density of 0.5 moose/mi^2.

METHODS

Aerial surveys of trend count areas in Subunits 17B and 17C were used to sample the sex and age composition of the moose population and to collect data on the population trend in representative portions of the unit. Optimal survey periods were from 1 November through 15 December. During this time moose were usually established on their winter ranges and bulls still retained their antlers. In many years, however, suitable weather conditions, snow cover, and survey aircraft were not available during the optimal period.

Aerial censuses of the population have been conducted in 2 portions of Unit 17. A portion of Subunit 17C was censused in 1983, and in 1987 the upper-Mulchatna River area in Subunit 17B was censused.

Moose populations in Subunit 17A were monitored in cooperation with personnel from the Togiak National Wildlife Refuge. A late winter aerial survey of the Togiak River drainage was conducted. Movement into the subunit was monitored by periodically tracking a sample of moose radio-collared since March 1989.

Harvest data were collected by means of harvest ticket reports and registration permit reports. Non-reporting hunters were sent 1 reminder letter. Harvest monitoring and an enforcement presence were maintained along the Nushagak and Mulchatna Rivers during the September portion of the hunting season.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

The population size in Subunit 17A is estimated to be less than 50 moose; well below the management goal of 100. Two surveys of the Togiak and Kulukak River drainages have been conducted in the past 5 years. In April 1991, 4 moose were observed in 1.3 hrs.

In January 1992, 6 moose were observed in 3.5 hrs of flying. Moose have also occasionally been observed in the drainages between Togiak and Cape Peirce.

The moose population in Subunit 17B was estimated to be 2,500 - 3,000 moose in 1987 (Taylor 1990). That estimate was based on extrapolations from a census in the upper-Mulchatna area. Assuming that 50% of the subunit is "good moose habitat", the management goal for the subunit is about 4,900 moose. Survey data for this subunit were inconsistent and difficult to interpret. Taylor (1988) noted that trend count data were of limited use in estimating moose density in Unit 17, and periodic censuses were the only objective method of assessing trends. Lacking such information, it appeared the moose population size in the subunit was stable and it remained below the management objective.

The moose population in Subunit 17C was estimated to be 1,400 -1,700 moose in 1987 (Taylor 1990). That estimate was based on extrapolations from the moose census conducted in Subunit 17C in 1983. The management objective for the subunit is about 1,750 moose. Survey data suggested the size of subunit population has been increasing since the extrapolated estimates were made and the population probably met the management objective.

Population Composition:

Bull:cow ratios in all areas of Subunits 17B and 17C have remained consistently high (Tables 1, 2, and 3). Some counts reflected an unrealistic representation of the sexes because of sexual segregation and distribution during the surveys. Calf production and survival have fluctuated between areas and years, but they have generally been good to excellent.

Distribution and Movements:

Much of Unit 17 is wet or alpine tundra, and moose are found along the riparian areas in Subunits 17B and 17C. Little is known about specific movement patterns, except they are influenced primarily by the rutting season in late September and by snow conditions in early winter. Extensive use of snowmachines during the beaver trapping season (January and February) displaces some moose from wintering areas, particularly along the Nushagak River.

Preliminary data from the radiotelemetry study indicated that although most radio-collared moose remained in Subunit 17C, there was some movement into Subunit 17A. Two radio-collared moose moved from the Weary River in Subunit 17C to the Kulukak River drainage in Subunit 17A during this reporting period. A final report on this investigation is expected to be available in 1994.

Mortality

Harvest:

Season and Bag Limit. Subunit 17A was closed to moose hunting.

Subunit 17B was divided into 2 sections: the Mulchatna River drainage upstream and including the Chilchitna River; and, the remainder of the subunit. The upstream section was open for resident/subsistence and non-resident hunters from 1-20 September. The remainder of Subunit 17B was open to resident/subsistence hunters from 1-20 September and for subsistence hunters from 1-31 December. Nonresidents could hunt moose in the remainder of 17B from 5-15 September. The bag limit in both areas was 1 bull. Starting in 1991/92, the nonresident bag limit was 1 bull with 50" or greater antler spread or with 3 or more brow tines on at least 1 side.

Subunit 17C was also divided into 2 sections: the Iowithla River drainage, Sunshine Valley, and all portions of the subunit west of the Wood River and south of Aleknagik Lake; and, the remainder of the subunit. Open season for resident hunters was from 1-15 September throughout the subunit. An additional season was open for resident hunters from 1-31 December in the remainder of the subunit. Nonresidents were prohibited from hunting in the subunit starting in 1990/91. The bag limit in both areas was 1 bull.

In 1989/90 an early moose hunting season was open for subsistence hunters from 20-31 August in Subunit 17C and the remainder of 17B. This season was curtailed in 1990/91 as a result of changes in subsistence regulations. The August hunt was reestablished in 1991/92 as a registration hunt with permits available to any resident who applied in person at Dillingham.

Game Board Actions and Emergency Orders. In March 1993 the Board of Game made substantial changes to moose hunting regulations in Unit 17. These changes were intended to offset anticipated increases in hunting pressure resulting from liberalized seasons and bag limits for the Mulchatna caribou herd. The Board also adopted spike/fork - 50" antler restrictions for much of southcentral Alaska, including Unit 17. A registration hunt was established to provide Alaska residents with an opportunity to harvest any sized bull during an extended season. Registration hunt permits could be obtained in person from the Dillingham office only.

Beginning in 1993/94, the general moose season throughout subunits 17B and 17C will be 1 - 15 September. Nonresidents will be prohibited from hunting in 17C. The bag limit for residents will be 1 bull with spike/fork antlers or with 50" or greater antlers. Nonresidents will be restricted to 1 bull with 50" or greater antlers. Moose with 3 or more brow tines on at least 1 side are also legal for all hunters. A registration hunt in subunits 17B and 17C will run from 20 August to 15 September, with a bag limit of 1 bull (any size). The hunt will also extend from 1 - 31 December for both subunits except for the areas south and west of Aleknagik Lake and Wood River; the Iowithla drainage; and, the Mulchatna drainages upstream and including the Chilchitna River.

Hunter Harvest. Moose harvests in Unit 17 have been increasing steadily for the past 10 years, primarily because of increased harvest in Subunit 17B (Figure 1). Subunit 17A has not had an open moose hunting season since 1980/81. In spite of this closure, from 10 to 20 moose, of both sexes, were suspected to be killed annually (Table 4). The reported harvest for the general moose season in Subunit 17B has ranged from 122 in 1989/90 to 178 in 1990/91, with an 5-yr mean annual harvest of 153.0 moose (Table 5). The reported harvest for the general moose season in Subunit 17C has doubled in the past 5 years with a 5-yr mean annual harvest of 46.7 moose (Table 6).

Hunters continued to harvest moose with large antlers throughout this reporting period. During 4 of the last 5 seasons, over 50% of the harvest has consisted of moose with antler spreads of 50" or greater. The largest antlers reported for each of these seasons have exceeded 70" (Table 7).

Permit Hunts. Re-establishment of a registration hunt in 1991/92 allowed all Alaska resident hunters to take moose in subunits 17B and 17C from Aug. 20 -31. About 300 hunters obtained permits each year, resulting in a harvest of 42 moose during both 1991/92 and 1992/93 (Tables 8 and 9).

Hunter Residency and Success. The 5-yr mean annual number of moose hunters participating in general moose hunting season in Unit 17 was 490. There was an increasing trend in the number of hunters during that 5-yr period. Most of the increase was in the number of non-local resident hunters (1988/89 = 127 versus 1992/93 = 193). Hunter success was relatively constant, ranging from 40% to 46% (Table 10). The 5-yr mean annual hunter success for the unit was 41.6%.

Nonresidents accounted for 42% of reporting hunters, residents of Unit 17 accounted for 27%, and other residents of Alaska accounted for 32% of the total number of hunters reporting from 1988/89 to 1992/93. The number of unit residents participating in the hunt was undoubtedly underreported because many individuals fail to obtain or submit harvest tickets. These data did not include resident hunters that participated exclusively in the permit hunts. Local residents accounted for over 90% of the hunters participating in the registration hunt in 1991/92 and 1992/93.

Harvest Chronology. Most of the harvest occurred during the September portion of the hunting season (Table 11). Chronology data did not indicate any consistent patterns. Unit residents were the main participants in the August and December seasons. These seasons were originally established to provide local residents with an opportunity to harvest moose that are not rutting. The regulatory intent was to discourage the illegal killing of female moose and harvests during closed seasons.

Transport Methods. Aircraft were the primary means of access for moose hunters in Unit 17 (5-yr mean = 62%, Table 12). Most unit residents used boats during the August and September seasons and snowmachines during the December season. Off-road vehicles, including 3 and 4-wheelers became prohibited modes of transportation for big game hunters in Subunit 17B in 1990/91.

Other Mortality:

During this reporting period there was no evidence of significant mortality caused by factors other than humans. Predation by wolves and bears occurred regularly but appeared to be relatively inconsequential. Snow depths were below normal during both winters (1991/92 - 1992/93), so moose were able to find abundant forage on winter ranges in riparian areas and winter mortality was light. There were no reports of moose being killed by motor vehicles.

Illegal harvest continued to be a problem in Subunit 17A. Subunit residents actively pursued moose with aircraft and snowmachines during the winter and spring. Both male and female moose were taken. Illegal harvests in Subunits 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 was common to see moose near Nushagak River villages throughout the winters during this reporting period.

Habitat

Assessment:

No formal habitat monitoring programs were conducted in Unit 17. Winter range condition was subjectively assessed while monitoring the September hunting season. Moose winter range along the Nushagak and Mulchatna Rivers, and along the lower reaches of the major tributaries to those rivers, appeared to be in very good to excellent condition. Although there was evidence of heavy browsing, willow stands on gravel bars were abundant and included a good mix of brush heights. Winter range conditions in the middle and upper reaches of the tributaries have not been assessed and were 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 was not practical or necessary.

Lightning caused wildfires are not uncommon in the unit each summer, particularly in Subunit 17B. Fires rarely consumed large areas before they were naturally suppressed. The most important natural force responsible for enhancing moose habitat was the scouring of gravel bars and low-lying riparian areas by ice and water during spring thaw. This was especially true for the Nushagak and Mulchatna Rivers and the lower reaches of the major tributaries to those rivers.

Nonregulatory Management Problems

Dramatic increases in the number of caribou in the Mulchatna herd was affecting 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 was no evidence of large predators following the caribou herd, so when the herd moved out of a pack's territory, moose became their primary source of meat. The same prey shift can be expected when the caribou herd crashes.

CONCLUSIONS AND RECOMMENDATIONS

Moose populations in Unit 17 were stable during this reporting period. The population in Subunit 17C appeared to be at or approaching the management objective. Bull:cow ratios and percent calves observed during annual composition counts of trend areas in Subunit 17C suggested the population was healthy and productive. Although objective habitat evaluations were lacking, 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 prior to antler drop. Late winter surveys of the major drainages were initiated in 1992/93 to supplement fall composition counts. Periodic censuses of portions of the unit would provide the best population information, but no censuses have been funded since 1987.

Moose harvest has increased in Subunit 17B during the past decade. This increase was partially caused by the increase in the number of hunters afield; as more non-local hunters were attracted to the Nushagak/Mulchatna River drainages by the number of caribou in the area. The increased harvest was also a result of improved hunter success. Hunting methods and harvest chronology have remained consistent in recent years, so the increased success may indicate a greater density of moose in the subunit.

The moose population in Subunit 17A remained at a low level in spite of an abundance of suitable habitat and healthy moose populations in adjacent areas. Efforts to work with local residents have been largely unsuccessful to date, and illegal moose harvests continued. An effort involving the Department, Togiak National Wildlife Refuge, and the Togiak Traditional Council will be continued and expanded to educate hunters on the long-term benefits of abiding by existing wildlife regulations. This education effort is being coupled with increased enforcement of the regulations.

The Board of Game has considered the impacts of liberalized caribou seasons on the Unit 17 moose population and has adjusted the moose season for 1993/94. The Board and the

Department will need to continue to manage these 2 ungulate populations in conjunction with each other and with predator populations.

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Figure 1. Reported moose harvest in Game Management Unit 17, 1983 - 1992.

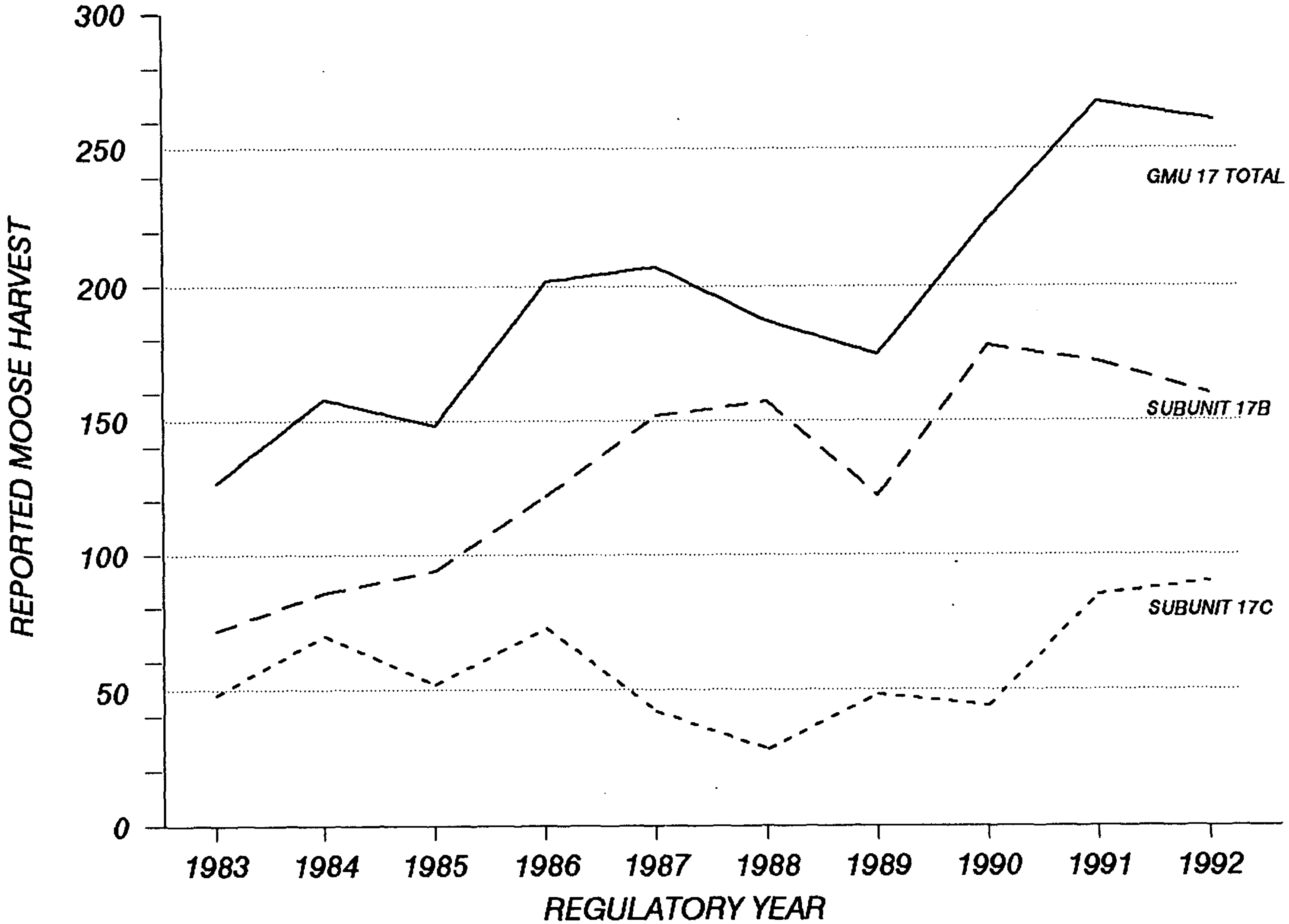

Table 1. Subunit 17C, Iowithla River moose trend count area, fall aerial moose composition counts, 1988-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size[a]
1988/89[b]	71	11	33	35(16)	179	214	89	---
1989/90[c]	---	---	---	---	---	---	--	---
1990/91[d]	59	7	52	38(25)	116	154	53	---
1991/92[e]	58	15	57	51(27)	141	192	144	---
1992/93[f]	74	21	60	48(26)	139	187	75	---

[a] No population estimates for this count area have been made.
[b] Survey flown on 21 Nov. 1988.
[c] No survey flown in 1989/90.
[d] Survey flown on 29 Oct. 1990.
[e] Survey flown on 23 Dec. 1991.
[f] Survey flown on 19 Nov. 1992.

Table 2. Subunit 17C, Sunshine Valley moose trend count area, fall aerial moose composition counts, 1988-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size[a]
1988/89[b]	102	24	44	20(18)	93	113	57	---
1989/90[c]	---	---	---	---	---	---	---	---
1990/91[d]	63	22	43	21(21)	80	101	51	---
1991/92[e]	88	58	49	21(21)	81	102	56	---
1992/93[f]	---	---	---	---	---	---	---	---

[a] No population estimates for this count area have been made.
[b] Survey flown on 5 Dec. 1988.
[c] No survey flown in 1989/90.
[d] Survey flown on 13 Dec. 1990.
[e] Survey flown on 21 Nov. 1991.
[f] No survey flown in 1992/93.

Table 3. Subunit 17C, Lower Nushagak moose trend count area, fall aerial moose composition counts, 1988-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size[a]
1988/89[b]	---	---	---	---	---	---	---	---
1989/90[c]	---	---	---	---	---	---	---	---
1990/91[d]	61	20	63	26(28)	66	92	69	---
1991/92[e]	---	---	---	27(33)	55	82	98	---
1992/93[f]	23	13	86	48(41)	69	117	56	---

[a] No population estimates for this count area have been made.
[b] No survey flown in 1988/89.
[c] No survey flown in 1989/90.
[d] Survey flown on 13 Dec. 1990.
[e] Survey flown on 30 Jan. 1992. Sex determination not attempted.
[f] Survey flown on 14 Nov. 1992.

Table 4. Subunit 17A moose harvest[a] and accidental death, 1988-92.

Regulatory year	Hunter Harvest Reported M (%)	F (%)	Unk.	Total	Estimated Unreported	Illegal	Total	Accidental death	Grand total
1988/89	0	0	0	0	0	15	15	0	15
1989/90	0	0	0	0	0	15	15	0	15
1990/91	0	0	0	0	0	10	10	0	10
1991/92	0	0	0	0	0	20	20	0	20
1992/93	0	0	0	0	0	10	10	0	15

[a] Excludes permit hunt harvest.

Table 5. Subunit 17B moose harvest[a] and accidental death, 1988-92.

Regulatory year	Hunter Harvest Reported M (%)	F (%)	Unk.	Total	Estimated Unreported	Illegal	Total	Accidental death	Grand total
1988/89	156(100)	0	1	157	0	0	0	0	157
1989/90	122(100)	0	0	122	0	0	0	0	122
1990/91	177(100)	0	1	178	0	0	0	0	178
1991/92	155(100)	0	1	156	0	0	0	0	156
1992/93	152(100)	0	0	152	0	0	0	0	152

[a] Excludes permit hunt harvest.
[b] No estimates of unreported/illegal harvests have been made for this subunit.

Table 6. Subunit 17C moose harvest[a] and accidental death, 1988-92.

Regulatory year	Hunter Harvest: Reported M (%)	F (%)	Unk.	Total	Estimated: Unreported	Illegal	Total	Accidental death	Grand total
1988/89	28(100)	0	0	28[c]	0	0	0	0	28
1989/90	48(100)	0	0	48[d]	0	0	0	0	48
1990/91	44(100)	0	0	44[e]	0	0	0	0	44
1991/92	56(100)	0	1	57[f]	0	0	0	0	57
1992/93	56(100)	0	0	56[g]	0	0	0	0	56

[a] Excludes permit hunt harvest.
[b] No estimates of unreported/illegal harvests have been made for this subunit.
[c] Does not include 3 bulls from an unspecified portion of Unit 17.
[d] Does not include 5 bulls from an unspecified portion of Unit 17.
[e] Does not include 3 bulls from an unspecified portion of Unit 17.
[f] Does not include 5 bulls from an unspecified portion of Unit 17.
[g] Does not include 3 bulls from an unspecified portion of Unit 17.

Table 7. Unit 17 moose antler sizes (percent) in the reported harvest, 1988-92.

Regulatory year	Antler size: <30"	30 - 50"	>50"	Largest antlers
1988/89	5	41	54	73
1989/90	10	40	50	76
1990/91	4	47	49	74
1991/92	4	33	63	72
1992/93	6	36	57	80

Table 8. Subunit 17B moose harvest data by permit hunt, 1988-92.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
983	1988/89	0[a]	--	--	--	0	0	0	0
	1989/90	0[a]	--	--	--	0	0	0	0
	1990/91	0[a]	--	--	--	0	0	0	0
	1991/92	318[b]	22	60	16	15(100)	0	1	16
	1992/93	277[b]	30	49	18	8(100)	0	0	8

[a] No registration hunts were held in these years. In 1988/89 and 1989/90 the August moose season was open to subsistence users only. In 1990/91 there was no August moose season in Unit 17.

[b] Registration permits were valid for both Subunits 17B and 17C. Permit data are for both areas combined, harvest data are specific to Subunit 17B.

Table 9. Subunit 17C moose harvest data by permit hunt, 1988-92.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
983	1988/89	0[a]	--	--	--	0	0	0	0
	1989/90	0[a]	--	--	--	0	0	0	0
	1990/91	0[a]	--	--	--	0	0	0	0
	1991/92	318[b]	22	60	16	28[c](100)	0	0	28
	1992/93	277[b]	30	49	18	31[d](100)	0	3	34

[a] No registration hunts were held in these years. In 1988/89 and 1989/90 the August moose season was open to subsistence users only. In 1990/91 there was no August moose season in Unit 17.

[b] Registration permits were valid for both Subunits 17B and 17C. Permit data are for both areas combined, harvest data are specific to Subunit 17B.

[c] Not included are 6 bulls from an unspecified portion of Unit 17.

[d] Not included are 8 bulls from an unspecified portion of Unit 17.

Table 10. Unit 17 moose hunter[a] residency and success, 1988-92.

Regulatory year	Successful: Local[b] resident	Successful: Nonlocal resident	Successful: Nonresident	Successful: Total (%)	Unsuccessful: Local[b] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Total(%)	Total hunters
1988/89	28	38	82	188(41)[b]	42	89	106	269(59)[b]	457
1989/90	62	47	59	175(40)[c]	86	76	97	263(60)[c]	438
1990/91	60	52	104	225(46)[d]	53	77	122	264(54)[d]	489
1991/92	68	72	67	218(40)[e]	95	96	131	328(60)[e]	546
1992/93	61	79	64	212(41)[f]	65	114	124	310(59)[f]	522

[a] Excludes hunters in permit hunts.
[b] Includes 40 successful and 26 unsuccessful hunters of unknown residency.
[c] Includes 7 successful and 4 unsuccessful hunters of unknown residency.
[d] Includes 9 successful and 12 unsuccessful hunters of unknown residency.
[e] Includes 11 successful and 6 unsuccessful hunters of unknown residency.
[f] Includes 8 successful and 7 unsuccessful hunters of unknown residency.

Table 11. Unit 17 moose harvest[a] chronology percent by time period, 1988-92.

Regulatory year	Harvest periods Aug. 10-20	Aug. 21-31	Sept. 1-10	Sept. 11-30	Sept. 21-30	Dec. 1-10	Dec. 11-20	Dec. 21-31	Unk.	*n*
1988/89[c]	0	9	26	55	1	1	2	2	5	188
1989/90[c]	1	5	33	49	2	1	3	3	5	175
1990/91	0	0	36	45	1	2	3	4	9	225
1991/92	0	5	30	51	1	1	3	4	5	218
1992/93	0	3	44	41	0	2	2	4	3	212

[a] Excludes permit hunt harvest.
[b] Total reported harvest
[c] Data for all regulatory years 1988/89 and 1989/90 are approximate due to data storage by week number rather than by day.

Table 12. Unit 17 moose harvest[a] percent by transport method, 1988-1992.

Regulatory year	Percent of harvest Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
1988/89	64	0	23	0	3	0	1	9	457
1989/90	57	0	35	1	3	0	1	3	438
1990/91	64	0	26	0	5	0	1	3	489
1991/92	61	0	31	0	4	0	1	3	546
1992/93	64	0	29	0	2	0	1	3	522

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit: 18 (42,000 Mi^2)
Geographical Description: Yukon-Kuskokwim Delta

BACKGROUND

Moose were thought to have begun immigrating onto the lower Yukon-Kuskokwim Delta during the mid-to-late 1940s, and have since colonized the riparian corridors of the Yukon and Kuskokwim Rivers in low to moderate numbers (Helmericks 1944, Alaska Dept. of Fish and Game 1976). Further expansion of range and population numbers is limited by spring flooding, availability of winter habitat, and hunting pressure. Most of the Yukon-Kuskokwim Delta is lowland treeless tundra, which is unsuitable as moose winter habitat. Moose are confined during the winter to forested and willow riparian habitats along the major rivers.

Moose densities appear to be moderate and growing in the Yukon River drainage upriver from Pilot Station but very low in the remainder of the Yukon drainage and in the entire lower Kuskokwim River drainage. Although moose are now more common than in the past, overall densities are still extremely low relative to habitat availability.

Heavy hunting pressure has effectively limited moose population growth in many areas of Unit 18. Extensive habitat is available for colonization, and moose densities in adjacent Units 19A and 21E are much higher than in Unit 18.

MANAGEMENT DIRECTION

Management Goals and Objectives

1. Increase the moose population in Unit 18 by 10% annually while maintaining a population goal for the Yukon River population of 3,000 moose. A population goal for the Kuskokwim River drainage has not been set. The bull:cow ratio for both populations will be maintained at a minimum of 30 bulls:100 cows.

    1a. Conduct fall sex and age composition surveys and winter recruitment surveys of the Yukon river population annually.

    1b. Conduct fall and/or midwinter surveys of the major drainages of the Kuskokwim and of the main Kuskokwim River to assess the status and population size of the Kuskokwim River population.

2. Improve harvest reporting and compliance with hunting regulations.

3. Develop updated population objectives and a management plan in consultation with the public and other agencies.

METHODS

We operated a hunter check station during late August through September 1991 and 1992 at Paimiut Slough along the Yukon River near the border of Unit 18 and Subunit 21E. Hunting activity and harvests were monitored.

We completed a moose census using methods developed by Gasaway et al. (1986) during late February and early March 1992 to estimate the size of the moose population along the Yukon River between Pilot Station and old Paimiut village. Additional aerial surveys were conducted along the Yukon River corridor of Unit 18 during December 1992 and February 1993. A second moose census was conducted along the Kuskokwim River corridor between Kalskag and Kwethluk during March 1993.

A cooperative radiotelemetry study documenting seasonal movements of moose in the Yukon and Kuskokwim drainages was continued by the U.S. Fish and Wildlife Service (FWS) and the Department. Eleven of the original 14 cow moose radio-collared during 1990 between the Aniak River and the Kwethluk River remained active. Five of the original 4 cows and 5 bulls radio-collared during 1989 and 1990 in the Yukon portion of the study area remained active.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: We estimate the population in the Yukon drainage ranges between approximately 1000 to 1100 moose. The number of moose observed during winter surveys along the riparian corridor of the Yukon River, especially on islands located upriver of Marshall, appears to have increased during recent years. Sections of the Yukon River corridor from Paimiut village to Pilot Station were censused during spring 1992, and a portion of this census area was surveyed during late February and early March 1993. The total number of adult moose and short yearlings observed during both years increased from previous years (Table 1 and 3).

The Yukon census area consisted of 159 polygons (N). The sample size was 39 polygons (n), each ranging in size from 6.01 to 20.64 mi^2. A population estimate of 994 moose ($\pm$12.5% standard deviation at the 80% confidence interval) was calculated.

Moose densities were very low and possibly decreasing in the Kuskokwim drainage (Table 4). We believe the population numbers approximately 300 to 400 moose. A moose census was conducted between Kalskag and Kwethluk along the riparian corridor of the Kuskokwim

River during March 1993. The census area was made up of 41 polygons (N), and the sample consisted of 18 polygons (n), each ranging in size from 6.08 to 23.38 mi^2. A population estimate of 217 moose (27.6% standard deviation at the 80% confidence level) was calculated (Table 2).

Population Composition: No fall sex and age composition surveys were completed during this reporting period due to inadequate snow cover and poor aircraft availability. However, we did collect recruitment information from spring aerial surveys and censuses. On the Yukon River during the 1993 survey, 27% of the moose observed were short yearlings. On the Kuskokwim during the 1993 survey, 25% of the moose observed were short yearlings. These recruitment estimates were taken from very small samples. The sample size for the Yukon survey was 98 moose and 44 for the Kuskokwim survey.

The only age composition information collected in Unit 18 during the reporting period was from incisors of hunter-killed moose harvested in the Yukon drainage between Russian Mission and the Innoko River. Seventy-seven percent of the teeth collected were from male moose between 1 to 3 years of age. If this sample reflects the actual age composition of the local moose population, recruitment may have been favorable during the previous 3 years.

Distribution and Movements: Small numbers of moose migrate during late summer to coastal regions from the mouth of the Kuskokwim to Scammon Bay, Nelson Island and the lower Yukon Delta. The Yukon Delta Wildlife Refuge staff monitored the radiocollared moose in Unit 18 and portions of Unit 19A during the reporting period. The telemetry data indicate most moose were migratory over relatively short distances. Bulls tended to remain away from riparian zones during summer, fall, and early winter until snow depths pushed them closer to the river. Only one of the collared moose along the lower Yukon showed any signs of moving long distances. This particular bull moose was collared near Pilot Station during March 1990, and had been seen below Mountain Village during the spring of 1991. Little or no movement occurred among the remaining 5 collared moose resident along the Yukon River. In the Kuskokwim drainage, cow moose collared near Aniak had moved into the Russian and Horn Mountain area north of the Kuskokwim and east to the Holukuk River. Very little movement occurred among collared moose elsewhere in the drainage.

Some moose apparently retreat with the advent of winter and fall hunting pressure to the forested regions of the Yukon River. Other moose are found in alpine and subalpine regions of the Kilbuck and Andreafsky Mountains during summer, but descend to yards along the Aniak River, in forested tributaries of the Kuskokwim, and along the lowlands and islands of the Yukon-Kuskokwim during late winter. The Yukon lowlands between Holy Cross and Paimiut in neighboring Unit 21E now support large numbers of moose, particularly during winter. A 6-hour survey of the Paimiut and Holy Cross Cross portion of the Yukon River in Unit 21E yielded a total of 1034 moose observed on 14-16 March 1990. We believe these moose move downriver into Unit 18 between Paimiut and Russian Mission.

The density of moose at locations along the Yukon and Kuskokwim Rivers is related to the distance upriver from the mouths of these drainages. The further upriver on both drainages, the greater the number of moose. This is evident from both aerial survey and harvest data. We believe this distribution and density is probably related to the presence of more quality habitat and escape cover in the upriver, forested portions of these drainages.

Mortality

Harvest:
Season and Bag Limits.

Unit and Bag Limit	Resident Open Season (Subsistence and General Hunt)	Nonresident Open Season
Unit 18, that portion north and west of a line from Cape Romanzof to Kuzilvak Mountain, and then to Mountain Village, and west of, but not including, the Andreafsky River drainage.	No open season	No open season
Remainder of Unit 18	Sept. 1-Sept. 30 Dec. 20-Dec. 30	Sept. 1- Sept. 30
One bull		

Game Board Actions and Emergency Orders. During 1988, a regulatory proposal was adopted by the Alaska Board of Game to close the moose hunting season in the lower Yukon Delta downriver of Mountain Village to allow the moose population to become established. That population is being monitored to assess the impact of the season closure. Between the years of 1988 and 1991, less than 10 moose were observed between Mountain Village and Emmonak by FWS and Department staff, and lower Yukon residents. During recent aerial survey of approximately 2,500 mi^2 of the closed area (Table 5), only 28 moose were observed (8 bulls, 10 cows, and 10 calves). We plan to complete a census of this area during late winter 1994.

During the spring 1993 Alaska Board of Game meeting, a proposal was adopted to change the Unit 18 winter moose season from a 20-30 December season to a 10-day season opened by Emergency Order between the dates of 20 December 1993 and 20 January 1994. This proposal was submitted to make our regulations more consistent with Federal subsistence regulations, and to accommodate local hunters who desire an open season when weather and snow conditions are adequate for snowmachine travel.

Harvest:

Human Induced Mortality. Hunting remains the most significant source of moose mortality in Unit 18. During the 1991-92 open season, 175 hunters reported a harvest of 67 moose. For the 1992-93 season, 182 hunters reported a harvest of 76 moose. Although reported harvests had declined between 1981 and 1987, harvests increased markedly during the 1988-89 season to the third highest take of moose since the 1978-79 season. During the 1989-90 season, reported harvests again declined. However, reported harvest for the 1990-91 season rebounded to higher levels. Harvest increased during the 1991-92 and the 1992-93 season (Table 6). The number of hunters reporting in Unit 18 seems dependent upon hunter success in adjacent Units 19A, 19B, 21E, and 21A. Overall moose harvest in the Unit is slightly increasing, reflecting poorer economic conditions, increasing human populations, higher moose densities along the Yukon drainage, and increasing demand for moose.

Sixty-three bull moose were reportedly taken in Unit 18 during the September 1991 season, and 4 during the December 1991 season. Sixty-three bull moose were reportedly taken in Unit 18 during the September 1992 season, and 13 were taken during the December 1992 season. Two of the 13 bull moose taken during the winter season were harvested during the federal season that occurred during 31 December 1992 through 9 January 1993.

The moose population in Unit 18 is heavily utilized by local residents, and the combined reported and unreported harvest is estimated to exceed or equal 5-10% of the population annually on the Yukon, and may exceed the annual recruitment rate on the Kuskokwim. Estimated unreported harvest may equal or exceed the reported harvest in the Kuskokwim drainage. The estimated Unit harvest, including the unreported harvest, is approximately 100 to 200 moose annually. On the Yukon River, we believe that harvest reporting has improved dramatically in the last 7 years because of the presence of the Paimiut hunter check station, the acceptance of using harvest tickets, and the willingness of some hunters to harvest only bulls.

Many Unit 18 residents are aware that hunting opportunities are significantly better in adjacent Units 19A and 21E. Harvest reporting data collected since 1980 indicate that between 25% and 66% of successful hunters in Unit 19A have been Unit 18 residents. Seventy-four percent of individuals who hunted near the Holitna/Hoholitna River hunter check station in Unit 19A during fall 1992 were Unit 18 residents. Between 85% and 95% of the hunters checking in at the Paimiut hunter check station who reported hunting in Unit 21E were also Unit 18 residents. As a consequence, fall moose hunting activity in the central Kuskokwim region of Unit 19A and the Innoko and Iditarod region of Units 21E and 21A has become a controversial allocation issue between the residents of Units 18 and the upriver residents of Units 19A and 21E. The concern among upriver residents is that continued heavy influx of hunters from downriver communities in addition to harvest pressure of local residents may result in increasingly restrictive seasons and bag limits.

The reported harvest of moose in Unit 18, as reported in previous years, does not reflect the actual harvest, but only that of people who operate within the regulatory system. The percentage of local residents hunting in season with valid hunting licenses and harvest tickets is increasing, particularly during the fall. However, the magnitude of the harvest taken during the closed season probably has not declined significantly.

During the 1991-92 season, approximately 75% of the reported harvest occurred in the Yukon drainage, with the remainder in the Johnson and Kuskokwim River drainages (Table 7). During the 1992-93 season, 64% of the harvest (49 moose) was reportedly taken in the Yukon drainage upstream of Mountain Village. Thirty-three percent of the harvest (25 moose) were taken in the Kuskokwim drainage, and 3% (2 moose) were taken in the Johnson River drainage. In the Kuskokwim drainage, 20% of the harvest was taken from the Kwethluk/Kisaralik drainage, 8% from the upper Johnson River drainage, and the remaining 72% from the upper portions of the Kuskokwim drainage between Tuluksak and Lower Kalskag. In the Yukon drainage, 71% of the harvest was taken from the area between Marshall and Paimiut village, and 16% was from the Andreafsky drainage. Few moose were reportedly taken from the remainder of the Yukon drainage.

During September 1991 and 1992, Department staff operated the Paimiut check station for the sixth and seventh consecutive years, respectively, at the junction of Twelve-Mile Slough and Paimiut Slough on the Yukon River. The check station was located near the border of Units 18 and 21E. Voluntary participation with the check station has increased from previous years. During the fall 1991 and 1992 seasons, 287 and 200 hunters, respectively, stopped at the check station. As in previous years, nearly all hunters going through the check station were residents of Unit 18. Hunters were from 17 towns and villages, located primarily along the lower Yukon River.

We estimate that between 80 to 100 moose were harvested from an area extending from the upper Innoko River and Iditarod River in Unit 21E and 21A to Russian Mission in Unit 18. Most of these moose were brought through or processed near the check station. The moose examined at the check station were primarily young bulls in good condition.

During 1991, hunters reported that 60 moose taken in Unit 18 were predominantly young bulls with an average antler width of 38.5 inches. During 1992, hunters reported that 65 moose taken in Unit 18 had an average antler width of 38.0 inches. Tooth sectioning data indicated that 77% of the moose examined at the check station during fall 1991 and 1992 were between 1 and 3 years old.

Moose during the December season are concentrated on islands with large cottonwood stands and bushy willow fringes along the Yukon and the Kuskokwim Rivers and their tributaries. These moose are vulnerable to snowmachine hunting and harassment by snowmachine travelers. We believe much of the winter harvest is taken during the closed season and not reported.

Much of the habitat in Unit 18 is marginal for moose and cannot support large densities of moose and heavy harvests. However, areas along the Yukon and Kuskokwim River corridors have adequate browse and should support larger densities of moose. Moose along the river corridors and numerous forested tributaries in Unit 18 seem to be responding with high calf production and apparently are absorbing mortality from severe winters, floods, predation, regulated hunting, poaching, disease, competition, and accidental deaths. However, moose populations in the poorer habitat in Unit 18 may have low initial calf production and survival and probably cannot absorb significant natural and hunting mortality.

Hunter Residency and Success. As reported in past years, Alaska residents accounted for most of the hunting activity in Unit 18. Only 2 nonresidents hunted in Unit 18 during the 1991 and 1992 seasons. Hunter success rate based on those contacted at the Paimiut check station was 33% for the 1991 and 1992 seasons. Harvest report data for both years indicate that the overall Unit success rate was 25%, and hunters required an average of 6.5 days to harvest a moose.

Transport Methods. During the reporting period, boats were the most frequently used mode of transportation by successful hunters in Unit 18 (74%). Other reported modes of transportation used by successful hunters were snowmachines (16%) and aircraft (4%). Six percent of all successful hunters did not report their mode of transportation.

Natural Mortality:

Little information is available indicating whether predation by bears or wolves was a significant source of moose mortality in Unit 18 during 1991 and 1992. Large numbers of black bears inhabit Unit 18 and grizzly bears are locally abundant in the upland portions of the Unit.

We estimate 75 to 100 wolves are in Unit 18. At least 2 wolf packs were resident in the Kilbuck Mountains, and several packs were sighted near Russian Mission and Paimiut Slough. The distribution of wolves reflects the distribution of moose, especially in the Yukon drainage. Caribou serve as an alternative prey species for wolves in the Kuskokwim drainage. Wolves may be slightly increasing in the Unit as ungulates increase, but overall numbers of wolves remained very low.

Grizzly bears probably outnumber moose in the Andreafsky and Kilbuck Mountains. Black bears are abundant along both the Kuskokwim and Yukon drainages in the forested portions and are very uncommon further downstream. Predation by bears, particularly on calves, may have a significant impact on moose population growth although quantitative data are lacking. Subsistence hunters often take black and grizzly bears near their camps, and may be locally depressing these populations through hunting.

Spring flooding of lowlands along the Yukon and Kuskokwim Rivers may follow winters characterized by heavy snowfall and severe temperatures as was seen during January 1989. We believe that many calves were lost to flooding during May and June of 1985. Many local people believe that the flood of 1989 was worse than in 1985. However, recruitment was better in the spring of 1990 and 1991 than in previous years. We do not have sufficient quantitative data to show an under representation of the 1985 cohort, but tooth sectioning data from hunter-harvested moose in Units 19A and 21E do reflect a low percentage of these particular age classes.

Habitat

Assessment: The islands and adjacent sloughs along the Yukon River corridor from Paimiut to Mountain Village appear to represent productive moose habitat. No overbrowsing is evident in this area. However, some overbrowsing is evident in the better winter yarding areas upstream of Paimiut on the Innoko River, and moose may migrate downriver into the better browsing areas between Paimiut and Pilot Station. The narrow bands of willows downriver from Mountain Village in the Yukon delta are overgrown and senescent, except for the expanse of willows towards Kusilvak Mountain and Kashunak River, and those islands flooded each spring. Because the Yukon Delta has many mouths fringed by willows and cottonwoods and yet supports very few moose, the availability of forage apparently is not a limiting factor. Lack of escape cover from hunters, predators and weather may be the most significant limiting factor affecting moose numbers in these low-density areas.

The riparian habitat along the Kuskokwim River in Unit 18 downstream of Kalskag represents good moose habitat. Between Lower Kalskag and Akiachak, the forest and brush along the Kuskokwim may provide sufficient escape cover for moose. Moose are sometimes seen by pilots in this area, standing in meadows surrounded by thick willow, spruce and cottonwood mixed forest. Downstream of Akiachak toward the mouth of the Kuskokwim, the riparian corridor narrows, and escape cover is lacking. Along the Kanektok, Goodnews, and Arolik Rivers, moose are rarely found in the forest fringes because cover and browse are very sparse.

Tributaries of the Kuskokwim bordered by spruce and cottonwood and interspersed with willow and alder extend onto the tundra along the Gweek and Johnson Rivers to the west and along the Tuluksak, Kisaralik, Kasigluk and Kwethluk Rivers to the east. Each of these tributaries supports a small, low-density moose population.

CONCLUSIONS AND RECOMMENDATIONS

Moose have colonized the Yukon-Kuskokwim Delta within the last 40 years, and are found in moderate densities along the Yukon River from Paimiut to Pilot Station, but remain at very low densities throughout the remainder of the Unit. Although much of Unit 18 is lowland tundra unsuitable as moose winter habitat, moose should be present in higher numbers because of the extensive habitat that is still 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 effectively limited moose population growth.

The illegal harvest, particularly of cows and calves, remains the most serious moose management problem in Unit 18. Although compliance is improving, a lack of alternative ungulate resources, a poorly developed cash economy, and high density of people and villages along the major rivers complicates moose management considerably.

Differing state and federal seasons for moose has also hampered our ability to effectively manage moose and enforce hunting regulations (Table 8). For example, the Federal Subsistence Board added 5 days to the existing state season on federal lands during the 1991-92 season, and during the 1992-93 season, 10 days were added. Because most of Unit 18 is classified as federal public lands, cooperative management goals and objectives need to be established between our 2 agencies to ensure moose are managed in a manner that promotes population growth and sustainable harvests in the future.

Recent actions by user groups within the Unit, especially along the lower Yukon, to shoulder some responsibility for the growth of local moose populations are welcome signs of increasing participation with existing management systems. However, some members of local Fish and Game Advisory Committees and the recently established Federal Subsistence Regional Advisory Council continue to submit or support proposals liberalizing moose seasons and harvest opportunities in Unit 18, regardless of the biological status of the moose population.

The growth of the Kilbuck caribou herd, and recent migrations of the Western Arctic caribou herd into the Unit may eventually lessen hunting pressure on the moose population. However, we anticipate that demand for moose will probably continue to exceed supply.

We recommend that continued monitoring and inventory of the moose population remain a priority in Unit 18, especially the continuation of mid-winter counts in the Yukon drainage, and intensive aerial surveys and composition counts in the Kuskokwim drainage. We should continue to attempt fall composition counts in the Yukon drainage. However, poor winter weather and snow conditions frequently hamper efforts to complete composition counts before bulls drop their antlers during late fall. We should continue to conduct censuses in both the Yukon and Kuskokwim drainages at intervals of 5 years or less. These censuses in conjunction with annual composition surveys will provide the Department with baseline demographic information needed to properly manage the moose population.

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Table 1. Lower Yukon moose survey, February-March 1992.

SU	Strat.	Area (mi^2)	Number of moose	Stand. Search	Intens. Search
1	2	10.29	36	5	5
2	2	15.00	16	6	7
4	2	16.20	2	1	1
5	2	9.11	21	10	11
6	3	6.53	49	9	11
8	3	13.27	78	11	13
12	2	7.51	9	0	0
19	3	12.96	119	28	28
20	2	16.15	7	2	2
22	3	10.35	33	11	12
23	2	8.98	1	0	1
25	1	9.61	1	1	1
29	2	11.25	4	1	1
30	3	9.99	26	17	17
49	2	12.92	7	4	4
50	3	12.43	33	7	9
52	2	5.16	17	3	5
53	4	7.59	5	2	2
55	4	9.03	2	0	0
63	2	6.65	30	2	3
64	2	8.91	24	0	0
66	4	7.59	2	1	1
74	1	7.06	0	0	0
79	4	9.03	2	0	0
94	2	6.19	6	0	0
95	4	6.01	1	0	1
105	4	10.07	0	0	0
111	3	11.97	51	10	12
119	2	7.79	3	0	0
120	2	13.78	14	6	6
121	1	12.09	2	2	2
129	1	10.48	0	0	0

Table 1. (continued)

SU	Strat.	Area (mi^2)	Number of moose	Stand. Search	Intens. Search
138	2	20.86	5	2	3
139	2	14.93	0	0	0
142	1	6.28	0	0	0
149	2	15.17	9	2	2
150	2	11.56	5	2	2
153	1	11.51	0	0	0
157	2	15.64	6	1	1

Par/Strat	Estimated population size				
	Low	Medium	High	Uplands	Total
N	64	33	7	55	159
Total area	617.90	373.60	77.50	489.40	1558.40
n	6	20	7	6	39
Area sur	57.03	233.83	77.50	49.32	417.68
Number seen	3	222	389	12	626
Density	0.0526	0.9494	5.0194	0.2433	0.6377

Estimate = 993.8 moose = Te

80% CI around Te = (869.6, 1118.0) is +/- 12.50%
90% CI around Te = (832.1, 1155.5) is +/- 16.27%
95% CI around Te = (798.1, 1189.6) is +/- 19.70%

Table 2. Estimated moose population size along the lower Kuskokwim River, Yukon Delta National Wildlife Refuge, Alaska, March 1993.

Parameters	Stratum Low	Stratum Medium	Total
N	25	16	41
Total Area km^2(mi^2)	1143.7 (441.6)	533.3 (205.9)	1677.0 (647.51)
n	7	11	18
Area Surveyed km^2 (mi^2)	275.2 (106.3)	368.8 (142.4)	644 (248.76)
Number Seen	2	47	49
Density moose/km^2 (mi^2)	0.0072 (0.0188)	0.1274 (0.3300)	0.1291 (0.3344)
TO	8.3	68.0	
V(TO)	58.88	106.10	
SCFo	1.000000	3.064463	
V(SCFo)	0.000000	0.1928744	
SCF df	9999	10	
To df	6	10	

Te = 216.6 V(TE) = 1925.443 df(Te) = 11
80% CI around Te = (156.7, 276.4) is +/- 27.62%
90 CI around Te = (137.7, 295.4) is +/- 36.39%
95% CI around Te = (120.0, 313.1) is +/- 44.60%

To = Estimated observable moose by strata.
df = Degrees of freedom.
SCFo = Observed sightability correction factor (SCF) estimate.
Te = Expanded population size estimate.
n = Sample size.
V( ) = Sampling variance of parameter in parentheses.

Table 3A. Lower Yukon moose surveys 1980-93: Mid-winter counts of moose observed along the Yukon River corridor, Unit 18.

Year	Pilot to Ohagamiut (lower river)	Ohagamiut to Russian Mission (middle river)	Russian Mission to Paimiut (upper river)
1980	-	11	49
1981	15	47	39
1982	17	27	37
1983	-	7	45
1984	-	22	63
1985	10	54	107
1986	-	11	-
1987	-	45	106
1988	30	106	209
1989	-	-	-
1990	63	73	337
1991	139	99	413
1992[a]			
1993			98[b]

[a] Census completed this year, total estimate was 993.8 moose.
[b] Only Survey Unit #19 (Figure 1) was sampled during February.

Table 3A (continued)

Number of short-yearlings observed:

Year	Pilot to Ohagamiut (lower river)	Ohagamiut to Russian Mission (middle river)	Russian Mission to Paimiut (upper river)
1980	-	5	11
1981	4	27	12
1982	9	16	15
1983	-	1	10
1984	-	7	20
1985	1	21	32
1986	-	5	-
1987	-	15	5
1988	8	21	54
1989	-	-	-
1990	9	9	72
1991	41	21	119
1992[a]			
1993			25[b]

[a] Total number estimated during census was 263.

[b] Only Survey Unit #19 (Figure 1) was sampled during February.

Table 3B. Kuskokwim moose survey, February 1992.

GMU	Survey area	Number of Adults	Number of Calves	Total
18	Lower Kwethluk	1	0	1
18	Upper Kwethluk	5	8	13
18	Lower Kiseralik	2	0	2
18	Upper Kiseralik	3	1	4
18	Both forks of Eek	1	1	2
18	Kuskokwim (Kalskag-Tuluksak)	32	4	36
18	Lower Kanektok	0	0	0
18	Upper Kanektok	0	0	0
Total		44(76%)	14(24%)	58(100%)

Table 3C. Yukon River Delta survey, December 1992.

Survey Unit	Bulls	Cows	Short-yearlings
918001[a]	0	0	0
918002[a]	0	0	0
918003[a]	0	1	2
918004[a]	0	1	1
918005[a]	0	1	1
918006[a]	1	1	1
918007[a]	0	1	0
918008[a]	0	0	0
918009[a]	0	0	0
918010[a]	0	0	0
918011[a]	0	0	0
918012[a]	4	0	0
918013[a]	0	3	1
918014[a]	0	1	2
918015[a]	1	0	0
918016[a]	0	1	2
918017[a]	2	0	0
Total	8	10	10

[a] See Figure 5 for location of survey units.

Table 4. Moose harvest reports for Game Management Unit 18 by regulatory year and season, 1978-1992.

Regulatory year Total	Fall[a]	Winter[b]	Unknown	
1978-79	42 (88%)	6 (12%)	0 (0%)	48
1979-80	11 (92%)	1 (08%)	0 (0%)	12
1980-81	45 (94%)	3 (06%)	0 (0%)	48
1981-82	72 (90%)	8 (10%)	0 (0%)	80
1982-83	54 (93%)	4 (07%)	0 (0%)	58
1983-84	61 (97%)	2 (03%)	0 (0%)	63
1984-85	63 (87%)	7 (10%)	2 (3%)	72
1985-86	43 (83%)	8 (15%)	1 (2%)	52
1986-87	54 (90%)	6 (10%)	0 (0%)	60
1987-88	40 (83%)	8 (17%)	0 (0%)	48
1988-89	67 (98%)	1 (02%)	0 (0%)	68
1989-90	31 (94%)	1 (03%)	1 (3%)	33
1990-91	55 (90%)	6 (10%)	0 (0%)	61
1991-92	63 (94%)	4 (06%)	0 (0)%	67
1992-93	63 (83%)	13 (17%)	0 (0%)	76

a Between 1977,82, the moose season was September 1-December 31 in all of GMU 18, except the Yukon River Delta; the delta season was September 1-20 beginning in 1982, until 1988, when a moose harvest moratorium was established on the delta. In 1985, the fall season was September 1-30 in the remainder of GMU 18. The bag limit in GMU 18 has been 1 bull throughout this time period.

b In 1982-85, the winter season was November 15-December 31 in GMU 18, excluding the Yukon River Delta. There was no winter season in the delta. In 1977-1985, only bulls were reported caught in the winter seasons. In 1985-88, the winter season was February 1-10. Unconfirmed harvest of cows was reported during 1985-86. Of the total 1986-87 moose harvest, 3.7 percent were cows. During the 1987-88 season, cow moose harvests accounted for between 2.1-10.4 percent of the annual harvest, depending on the sex of unknown animals. During the 1988-89 regulatory year, the winter season was December 20-30. During the 1992-93 season the Federal Refuge managers added 10 days to the State seaon from December 31, 1992 to January 9, 1993; the State's season was December 20 through December 30, 1992.

Table 5. Percentage of moose harvested by regulatory year and location in three major river drainages of GMU 18, 1981-92.

Regulatory year River	Percentage of moose harvested in drainage		
	Yukon River	Kuskokwim River	Johnson
1981-82	57	32	11
1982-83	58	36	6
1983-84	63	33	4
1984-85	62	32	6
1985-86	67	17	16
1986-87	66	34	0
1987-88	52	42	6
1988-89	81	19	0
1989-90	55	39	6
1990-91	80	15	5
1991-92	75	24	1
1992-93	64	33	3
Average	65	30	5

Table 6. Moose hunting regulations GMU 18, 1961-1993

Regulatory Year	Seasons	Total days	Bag Limits,Areas affected
1961-62	20 Aug.-30 Sept. 20 Nov.-10 Dec.	73	1 bull
1962-75	20 Aug.-31 Dec.	134	1 bull
1975-82[a]	1 Sept.-20 Sept. 1 Sept.-31 Dec.	20 122	1 bull; Yukon River Delta[b] 1 bull; remainder of GMU 18
1982-85	1 Sept.-20 Sept. 1 Sept.-30 Sept. 15 Nov.-31 Dec.	20 77	1 bull; Yukon River Delta redefined[c] 1 bull; remainder GMU 18
1985-88[d,e]	1 Sept.-20 Sept. 1 Sept.-30 Sept. 1 Feb.-10 Feb.	20 40	1 bull; Yukon River Delta[c] 1 bull; remainder GMU 18
1988-92[f]	CLOSED 1 Sept.-30 Sept. 20 Dec.-30 Dec.[g]	0 41	Yukon River Delta[c] 1 bull; remainder GMU 18
1993-94	CLOSED 1 Sept.-30 Sept. Winter Season TBA[h]	0 30+	Yukon River Delta[c] 1 bull; remainder GMU 18

Table 6 (continued)

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a The Alaska Board of Game established the Kalskag Controlled Use Area in 1977, incorporating a triangular-shaped region from Russian Mission upriver to the old Paimiut village site, south to Lower Kalskag, and northwest back to Russian Mission.

b That area north and west of a line from Cape Romanzof to Mountain Village, and west of and excluding the Andreafsky River drainage.

c That portion north and west of a line from Cape Romanzof to Kuzilvak Mountain, to Mountain Village, and west of and excluding the Andreafsky River drainage.

d In 1985-89, hunting regulations were divided into subsistence and general hunts.

e In 1987, residents of communities within GMU 18 and upper Kalskag were found to have customary and traditional uses of moose in GMU 18.

f In 1990, all hunts became general hunts and Federal Regulations took place. The 1990 Federal regulations were the same as the State regulations, except for the Kanektok and Goodnews River drainages, and only Unit 18 residents and residents of Upper Kalskag could hunt moose in GMU 18 under Federal regulations. In 1991 the Federal season was 15-24 December, which overlapped the State season.

g The fall season for the State and Federal lands is the same, the Federal winter season was 31 Dec.-9 Jan. (1992-93).

h The State winter season is To Be Announced by Emergency Order (20 Dec.-20 Jan.); the Federal winter season will also be a To Be Announced season by the Refuge Manager (1 Dec.-28 Feb.).

Table 7. Percentage of moose harvested by regulatory year and location in three major river drainages of Unit 18, 1981-92.

Regulatory year	Percentage of moose harvested by drainage		
	Yukon River	Kuskokwim River	Johnson River
1981	57	32	11
1982	58	36	6
1983	63	33	4
1984	62	32	6
1985	67	17	16
1986	66	34	0
1987	52	42	6
1988	81	19	0
1989	55	39	6
1990	80	15	5
1991	75	24	1
1992	64	33	3
Mean	65	30	5

Table 8. Moose hunting regulations in Unit 18, 1961-1993.

Regulatory Year	Seasons	Total days	Bag Limits, Areas affected
1961-62	20 Aug.-30 Sept. 20 Nov.-10 Dec.	73	1 bull
1962-75	20 Aug.-31 Dec.	134	1 bull
1975-82[a]	1 Sept.-20 Sept. 1 Sept.-31 Dec.	20 122	1 bull; Yukon River Delta[b] 1 bull; remainder of Unit 18
1982-85	1 Sept.-20 Sept. 1 Sept.-30 Sept. 15 Nov.-31 Dec.	20 77	1 bull; Yukon River Delta redefined[c] 1 bull; remainder Unit 18
1985-88[d,e]	1 Sept.-20 Sept. 1 Sept.-30 Sept. 1 Feb.-10 Feb.	20 40	1 bull; Yukon River Delta[c] 1 bull; remainder Unit 18
1988-92[f]	CLOSED 1 Sept.-30 Sept. 20 Dec.-30 Dec.[g]	0 41	Yukon River Delta[c] 1 bull; remainder Unit 18
1993-94	CLOSED 1 Sept.-30 Sept. Winter Season TBA[h]	0 30+	Yukon River Delta[c] 1 bull; remainder Unit 18

LOCATION

Game Management Unit: 19 (36,486 mi^2); 21A and 21E (23,270 mi^2)

Geographical Description: All of the drainages into the Kuskokwim River upstream from Lower Kalskag; Yukon River drainage from Paimiut upstream to, but not including, the Blackburn Creek drainage; the entire Innoko River drainage; and the Nowitna River drainage upstream from the confluence of the Little Mud and Nowitna Rivers.

BACKGROUND

Moose are a relatively recent faunal addition to western Interior Alaska. Their initial occurrence was apparently sometime after the turn of the century, and present populations are probably as high as they have ever been. 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 unit include predation, weather, and hunting. Hunting pressure is thought to be moderate except in a few easily accessible areas. Failure to report harvests, primarily by local residents, is a chronic problem.

Unit 19, as well as Subunits 21A and 21E, can be conveniently divided into two regions that have distinctive differences in moose habitat, user access, and hunting practices. Subunits 19A, 19D, and 21E are generally lower elevation areas that are accessible by boat. Hunters are generally local residents, living in either Unit 19, Unit 21, or adjacent Unit 18. Most hunt moose for food. Subunits 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 that have compounded the usual problems caused by annual variations in snow and weather conditions.

MANAGEMENT DIRECTION

Subunit boundaries within the area were designed to provide for two major uses of the resource. The lowland areas along the Kuskokwim River (Subunits 19A and 19D) and along the Yukon and lower Innoko Rivers (Subunit 21E) have been managed in an attempt to provide a sustained, relatively high harvest of moose. The higher elevation portions (Subunits 19B, 19C, and 21A) are managed largely for trophy quality animals. Because topography directly affects access, management of the area will continue to be based on these premises.

Management Goals and Objectives

- Develop statistically sound population estimates for select portions of the area by spring 1993.
- Annually assess population status and trend in portions of the area where harvest levels make significant impacts on moose populations.
- Maintain a Unit 19 reported harvest of at least 500 moose.
- Maintain an areawide reported hunter success rate of at least 45%.
- Maintain an annual average antler spread measurement of at least 48 inches in Subunits 19B, 19C, and 21A.
- Assess accuracy of harvest reporting in selected portions of the area.
- Encourage landowners to reduce fire suppression efforts on wildfires that do not threaten human life, property, or valuable resources, so that fire can fulfill its natural role in maintaining young, highly productive, and diverse habitats.

METHODS

Population composition surveys have continued in selected portions of the area using standard aerial survey techniques. A thorough census of the Holitna/Hoholitna Controlled Use Area was planned for fall 1992, but it was not undertaken because early deep snow conditions caused moose to move from areas where they are normally distributed during October/November and concentrate in winter habitat in the lowland riparian areas. A population estimation survey in the Lime Village Management Area was conducted during March 1992. Information received from harvest tickets was used to monitor hunter demographics and harvest parameters.

Using standardized Alaska Department Fish and Game transect methods, we have conducted browse utilization surveys annually on foot. An index of the overall importance of each species was made by 1) multiplying the median value for each browse use category in the survey by the number of plants in each category, 2) dividing by the total number of plants sampled in each area, and 3) multiplying by the frequency that the species occurred in the site sampled.

Late winter/spring aerial surveys were conducted in 1991 and 1992 to assess the effects of severe winter weather conditions on moose in Subunit 19D. Mortality rates and causes were assessed. During summer 1990, 1991, and 1992, calving rates and timing were aerially monitored in a selected area of 19D.

Surveys of portions of Unit 21E were completed by Bureau of Land Management (BLM) staff in January 1994.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Historical data from composition/trend surveys suggest that moderate moose numbers exist and that populations are largely stable. Population estimation surveys were conducted in the Lime Village Management Area portion of Subunits 19A and 19D.

Population Trend:

Long-term historical data, which can be used to depict population trends, are available from only two areas within Unit 19. However, annual changes in survey areas, timing, and conditions frustrate attempts to compare the data over time. In Subunit 19A, the lower reaches of the Holitna and/or Hoholitna Rivers (Table 1) have been surveyed 15 times since 1976. However, some of these surveys were conducted in late winter when moose distribution and observability are entirely different than conditions during early winter surveys. The only other survey area that has been repeatedly surveyed over a long period is in the Farewell (Bear Creek) Burn/Alaska Range Foothills area (Table 2). Sixteen surveys have been completed in that portion of Subunit 19C between 1976 and 1992.

In early winters of 1987 and 1988, six additional composition/trend count areas were established in Unit 19, as well as three count areas in Subunits 21A and 21E. This will significantly broaden our ability to assess moose population trends in the area if funding and weather patterns allow them to be surveyed annually. Unfortunately, snow conditions were poor during early winter 1991 and few surveys were completed.

In Subunit 19A, trend information is available only from the Holitna and Hoholitna River trend areas. The situation there should not be extrapolated to the remaining portions of the subunit. An additional survey area was established in 1988 in the Kiokluk/Chuilnuk Mountains, but has not been repeated.

Moose per hour figures from the Holitna/Hoholitna River count areas (Table 1) have increased dramatically since 1976 when the first fall surveys were completed. Four surveys completed between 1976 and 1984 averaged 39 moose/hour. Surveys completed during the 4-year period 1987-90 averaged 126 moose/hour. Standardization of the counts in 1987 to include early winter concentration areas partially explain the observed threefold increase. Because of standardization, future data should better reflect actual trends in the population. No counts were conducted in this area in 1991, but 1992 counts indicated continued slow growth of this population.

Bull:cow ratios from eight fall surveys between 1976 and 1990 in the Holitna drainage reveal a decline (49 to 26 in 1976 and 1990, respectively) and are assumed to be an accurate reflection of actual population trends. The ratio improved to 31 bulls:100 cows in 1992, possibly reflecting the poor hunting conditions during fall 1992 in this area. Calf:cow ratios have remained high in this area during the past 6 years and were 63:100 in 1992.

From these data, moose populations along the lower reaches of the Holitna and Hoholitna Rivers in Subunit 19A appear to be in good shape. Hunting pressure is intense, so the declines in bull:cow ratios are not surprising. Moose per hour figures indicate strong recruitment, and the total number of bulls available has increased dramatically. The area is composed largely of excellent moose habitat, leading to good calf production and annual recruitment.

Moose population composition data within Subunit 19B are available from two survey areas: Cairn Mountain/Sparrevohn Hills and upper Stony River. The Cairn Mountain/Sparrevohn Hills count area was surveyed five times between 1982 and 1990. Moose per hour figures increased from 16 to 41 during that period. Calves:100 cows also increased from 28 to 41. Observed bull:cow ratios have generally declined, but are still quite high (73:100 in 1990).

Like the Cairn/Sparrevohn count area, the upper Stony River count area was surveyed five times between 1982 and 1990. Moose/hour ($x = 69$), calves:100 cows ($x = 24:100$), and bulls:100 cows ($x = 45:100$) are all highly variable and show no distinct trends.

The Farewell Burn and Windy/Pingston count areas have been used to document moose population trends in Subunit 19C. The Farewell Burn count area (Table 2) has been surveyed 16 times during the period 1973-92. Moose per hour figures dropped from 94 to

31 between the 1974 and 1979 surveys. This drop was undoubtedly due in large part to the occurrence of the 1977 Bear Creek Burn. However, during the period 1983-89, moose per hour figures increased dramatically (22 to 194 in 1983 and 1989, respectively), even in the face of increased hunting pressure. This can be explained by the tremendous habitat enrichment which occurred on the area due to that same wildfire. As spruce reinvades the burn, willow growth will continue to decline. Habitat deterioration has probably influenced the 1990-92 declines in moose per hour data from the count area.

Bull:cow ratios have steadily declined in the count area, and yearling recruitment has remained low since 1990. Calf:cow ratios, however, have generally increased. Heavy hunting pressure has probably affected the bull:cow ratios. Classic successional changes following wildfire are evident. Immediately following the burn, moose densities declined severely. However, initial revegetation was composed of a high component of willow and encouraged increased moose densities. As the willow becomes more decadent and black spruce reinvades, moose densities begin to decline, although cows with calves tend to remain which contributes to the decline in moose per hour figures but steadily increasing calf:cow ratios.

The Windy Fork/Pingston Creek count area was surveyed five times between 1984 and 1990. Moose per hour figures have fluctuated widely at relatively high levels, as have calf:cow and bull:cow ratios. The trend count area thus far has not proved to be a good indicator of moose population trends in the area, as local snow conditions vary greatly and apparently affect moose abundance and composition on the site.

Subunit 19D also contains two composition/trend count areas, but both were established recently and have not provided sufficient long-term data upon which to base moose population trends. The White Mountains Count Area was established in 1988 and the Candle/Wilson Count Area in 1989. Both areas have 5 years of composition data. Moose densities are considerably lower in these portions of 19D than in areas surveyed in 19C with the lowest densities found in the Candle/Wilson count areas. Sample sizes are relatively small in these count areas, and population trends are difficult to determine. Bull:cow ratios appear to be declining in the White Mountains areas, calf:cow ratios are fairly stable (34:100 in 1993) and the number of moose seen per hour has been increasing since 1989 (Table 4). Bull:cow ratios are generally low in the Candle/Wilson areas as is yearling recruitment.

During 2-7 March 1992, a moose population estimation survey was conducted in a 1,240 mi^2 area within Subunits 19A and 19D near Lime Village. The area was stratified over a 3-day period in a Cessna 185. Stratification was complicated by minimal snowfall during the 1991-92 winter, allowing unrestricted moose mobility and by the fact that several thousand Mulchatna caribou were in the survey area resulting in impossible moose tracking conditions. Although unseasonably cold (to -50°F), completion of the survey was allowed because of recent snowfall, clear skies, and little wind.

Much of the survey area contained open black spruce taiga where visibility was good, so standard surveys (n = 47) were flown at an average of 4.3 min/mi^2. Intensive areas resurveyed (n = 29) to obtain sightability correction factors were flown at an average of about 13 min/mi^2. Overall observed moose density in the 1,240 mi^2 survey area was 0.57 moose/mi^2. Final estimates indicated a calculated estimate of 0.73 moose/mi^2 after sightability correction factors were included. Three density strata were used. The low density strata (739 mi^2) contained a mean of 0.31 moose/mi^2. Medium density areas (322 mi^2) contained 0.72 moose/mi^2, while high density areas (179 mi^2) had 1.39 moose/mi^2. Forty-seven sample units (37%) containing 474 mi^2 were sampled, and total moose in the area was estimated at 905 ± 16.6% (90% CI).

In addition to the standardized fall composition/trend counts conducted in Unit 19, winter aerial surveys were conducted at various times during 1989-91 along the Kuskokwim River south of McGrath in Subunit 19D. Snow depths greatly affect the wintering moose densities, so moose per hour comparisons among surveys are meaningless. Bull:cow ratios are not readily gathered, as most bulls have shed their antlers. Of particular importance, however, are observed calf percentages in the subpopulation. A February 1989 survey revealed 27% calves. In March 1990, 23% calves were noted. Five surveys were done during January-April 1991 during a period of particularly deep and crusted snow conditions. In January, calves composed 19% of the population. By February, calf percentages had declined to 16%, by March 13%, and by April 9%.

Overall, moose densities appear to be stable in Unit 19. Localized populations have recently experienced declines in total numbers or in the bull segment. Severe weather conditions during both 1989-90, 1990-91, and 1992-93 winters, with both high starvation mortality and heavy wolf predation, led to local declines, especially in the upper mainstream Kuskokwim River corridor of Subunit 19D. However, calf production and subsequent recruitment in those areas has apparently remained quite high.

In Subunit 21A, a trend count area was established in the Ophir area in 1980, but was not surveyed again until 1988 and 1990. In the American Creek area of the upper Innoko River an additional count area was surveyed in 1980 and 1988. Both areas have relatively low moose densities, and trend data are not available because of the limited work thus far completed. Near the confluence of the North Fork and the main Innoko Rivers another count area was surveyed four times between 1980 and 1990, and, like the upper Innoko count areas, trend data are of little value because of the lack of long-term information.

In Subunit 21E, a moose trend count area was established in 1987 near the confluence of the Innoko River and the Yukon River and was resurveyed in 1989 and 1990 (Table 3).

This is an extremely high-density area, with 758 moose being tallied during 3 hours of survey time in November 1990 (253 moose/hour). Calf:cow ratios have remained high (x = 46 calves:100 cows) and bull:cow ratios have apparently increased (19:100 to 28:100 in 1987 and 1990, respectively). Even with high hunting pressure along the Innoko River corridor, moose populations appear healthy.

Summer surveys (May-Aug) to assess calf production and survival were conducted during 1990, 1991, 1992, and 1993 (total sample sizes of 324, 164, 493, and 135 moose, respectively). Surprisingly, calf percentages varied minimally, with August values of 21.9%, 20.7%, 21.5%, and 23.1%, respectively. These 4 years followed relatively severe or "average" winters. Thus data for summer 1994, following a relatively mild winter, should prove interesting.

The BLM personnel conducted moose population stratification surveys in the areas west of the Yukon River from Paimiut to, and including, the Anvik River drainage during early winter 1993. Although final reports have not yet been produced, it appears that relatively high moose densities exist only in the vicinity of ice-scoured riparian areas along the Yukon River. Medium densities occurred in the upland vegetation types at the headwaters of the Bonasilla River and in lowland riparian areas of the Anvik River between Yellow River and Canyon Creek. Other areas had relatively low moose densities. No attempt was made to quantify moose numbers within density strata.

<u>Mortality</u>

<u>Harvest</u>:

Reported moose harvest in Subunit 19A has been relatively stable during the 5-year period 1986-90 with a mean of 137. Based on 1988 comparisons between check station and harvest ticket reports, only 45% of the actual harvest is reported via "mandatory" harvest report tickets. Thus, the actual harvest in Subunit 19A probably has exceeded 300 moose annually. Reported harvest in Subunits 19B and 19C are probably much more accurate and have averaged 140 and 113 moose, respectively. Because of shortened seasons and warm, mild fall weather, 1990 and 1991 harvests declined somewhat in comparison with previous years. In Subunit 19D, compliance with reporting requirements has also been poor, averaging 122 reported harvests of moose during the 1986-90 seasons. Overall, reported moose harvests for Unit 19 (Table 6) began a 3-year decline in the 1989-90 season. This was probably due to shortened season lengths, heavy mortality due to winter starvation and wolf predation, and unseasonably warm autumn weather during 1991.

In Subunit 21A, reported moose harvests have remained relatively constant during the period 1986-90 with a mean reported annual harvest of 142. Reporting rates are assumed to be high, with estimated harvest only about 10% higher than reported numbers. In

Subunit 21E, reported harvests have increased during the same time period, with 112 moose reported taken in 1986 and 184 reported in 1990. This increase is probably real, although reporting rates are probably increasing also and account for a portion of the observed increases. The combined harvest data for Subunits 21A and 21E are shown in Table 7.

Seasons and Bag Limits.

Subunit 19A

1986-1988	10 Aug.-25 Sept., 20 Nov.-31 Mar. = 179 days.
1989	Same season dates; no bag limit; either sex.
1990-1992	Same season dates. Tier II; harvest quota of 25.

Subunit 19A: Nonresidents, September only.

1986	1-25 Sept., 20-30 Nov., 1-10 Feb. = 47 days.
1987-1991	1-20 Sept., 20-30 Nov., 1-10 Feb. = 42 days.

Subunit 19B: All hunters.

1986-1989	1-30 Sept. = 30 days.
1990-1991	1-25 Sept. = 25 days.

Subunit 19C: All hunters.

1986-1989	1 Sept.-10 Oct. = 40 days.
1990-1991	1-25 Sept. = 25 days.

Subunit 19D (North Fork Portion of CUA): All hunters.

1986-1991	1-30 Sept. = 30 days.

Subunit 19D (Lower CUA Portion): Nonresidents, September only.

1986-1991	1-30 Sept., 1 Dec.-28 Feb. = 120 days.

Subunit 19D (Outside CUA Portion): Nonresidents, September only.

1986-1991	1-30 Sept., 1-15 Dec. = 45 days.

Subunit 21A: Nonresidents, September only.

1986-1991	5-30 Sept., 1-30 Nov. = 55 days.

Subunit 21E: Nonresidents, September only.

1986-1987	5-25 Sept., 1-10 Feb. = 31 days.
1988	5-25 Sept., 10-20 Feb. = 31 days.
1989-1990	5-25 Sept. = 21 days.
1991	5-25 Sept., 1-10 Feb. = 31 days.

Season dates during the past 6-year period have generally become more restrictive. In 1990, nonresident hunters were restricted to harvesting bull moose having antlers at least 50 inches in spread or with a minimum of three brow tines on at least one side. Brow tine limits were changed to a minimum of four on at least one side for the 1993-94 season in those areas of the interior where 50-inch regulations had been established.

Permit Hunts. Beginning with the 1990-91 season, a Tier II drawing permit was established for moose hunting in the Lime Village Management Area. During 1990, 10 permits were issued with a harvest quota of 25 either-sex moose. The bag limit was changed to 28 moose with a limit of two per permit for the 1993-94 regulatory year. Because no antlerless seasons were supported by a majority of advisory committees for this area, the bag limit was restricted to bulls only.

Hunter Residency and Success. Local residents continue to account for the major portion of the moose harvests in Subunits 19A, 19D, and 21E, while most hunters in Subunits 19B, 19C, and 21A were nonlocal Alaska residents or nonresidents (Tables 8 and 9). This segregation by residence location is caused largely by the accessibility of the respective areas. Access (Table 10) is largely by boat in Subunits 19A, 19D, and 21E, while aircraft provide most of the moose hunting access in Subunits 19B, 19C, and 21A.

In Subunit 19A during the 1990-91 season, 122 (48%) reporting hunters were from 1 of 13 villages in Unit 18. Fifty-four hunters (21%) representing seven villages were from Unit 19. Only 24 hunters (9%) were from other Alaska locations, while 34 (13%) hunters were nonresidents of the state (only two nonresident aliens). An additional 22 hunters (9%) failed to report their residence location.

Subunit 19B hunters were largely nonlocal. Only seven hunters (2%) were from Unit 19. Other Alaskan hunters numbered 144 (48%). Nonresidents also numbered 144 (48%). Only three hunters (1%) could not be assigned a residence location.

Similar to Subunit 19B, 19C hunters are generally not local residents. Only one Unit 19 resident reported hunting moose in Subunit 19C during the 1990-91 season. One hundred twenty-seven (50%) reporting hunters were from Alaska outside Unit 19, and 120 (48%) were not residents of the state. An additional four hunters (2%) were from unknown locations.

The majority of Subunit 19D hunters (n = 110, 48%) lived within the unit. Seventy-nine (35%) reporting hunters were from other Alaska locations, while 28 hunters (12%) were nonresidents or aliens. Twelve hunters (5%) came from unknown locations.

In Subunit 21A, like 19B and 19C, the majority of hunters are not from the local area. Nonresidents or aliens typically account for >70% of the moose hunters and are generally guided or outfitted hunters. Subunit 21E hunters, conversely, are largely subsistence hunters from either Unit 18 or Subunit 21E. The Paradise Controlled Use Area along the Yukon and lower Innoko Rivers in Subunit 21E largely restricts access to boats, effectively limiting participation by nonlocal hunters.

Hunter success rates are relatively consistent between subunits. In Subunit 19A, the reported success rate during 1990-91 was 54%. However, as noted above, reporting rates are poor, and successful hunters are more likely to report their hunt than unsuccessful hunters. Thus, the reported success rate is undoubtedly inflated. The other three subunits of Unit 19 had reported success rates between 33% and 35%. Unitwide, the reported moose hunter success rate of 38% during 1990-91 was the lowest on record.

Reported hunter success rates in Subunits 21A and 21E continue to be relatively high. As with the previous 4 years' data, the 1990-91 moose harvest ticket data indicate a 64% hunter success rate in Subunit 21A and a 78% success rate in 21E.

Harvest Chronology. Similar to previous years, the majority of the Unit 19 reported moose harvest occurs during September (n = 350, 87%). February harvests rank second among all months (n = 33, 8%), with other winter months contributing very little harvest. In Subunit 21A, virtually the entire legal harvest occurs during September, with the November hunts contributing very little to the harvest (in 1990, only two moose were reported). In Subunit 21E the harvest is likewise predominantly during September, with February seasons contributing <5% annually to the overall reported moose harvest.

Other Mortality:

Illegal harvests, defense of life or property kills, wounding loss, and funeral potlatch harvests probably account for an additional 100-150 moose deaths annually in Unit 19, and probably 50-75 additional kills in Subunits 21A and 21E. Of greater importance to the moose population, however, is predation mortality, and, during the 1989-90 and 1990-91 winters, high starvation mortality.

During the period 4 January through 5 May 1991, seven aerial surveys were conducted along the Kuskokwim River near McGrath in Subunit 19D. Surveys were designed to enumerate moose populations and determine extent, timing, and causes of mortality during this particularly severe winter. Because of deep and crusted snow conditions, moose were extremely concentrated along willow bars and islands of the Kuskokwim River. Very little moose sign was encountered except in these areas. Although not statistically defensible, the population in early January appeared to be composed of about 400 moose. Fifty-seven moose were found dead during the surveys (14% of estimated moose population), but this probably represents only a fraction of the actual mortality. Cause of death was determined for 43 of the moose, with wolf predation and starvation accounting for 20 and 23 of the mortalities, respectively. Of those which age class was determined, 22 were calves and 19 were yearlings or adults. Obviously, mortality was extremely high during winter 1990-91 and will probably affect the harvest for several years.

Habitat

Assessment and Enhancement:

Ongoing assessment efforts will continue to document browse utilization on heavily used winter ranges along the Kuskokwim River. Standard browse transects monitored in 1988 and 1990 will again be surveyed in summer 1992 and will be reported on in a later moose management report. Because winter 1991-92 has been relatively mild to date, results of 1992 summer browse assessment work promises to be most interesting in comparison with previous years of relative winter severity.

Habitat enhancement efforts have continued. Close cooperation with Alaska Department of Natural Resources fire management personnel has resulted in relatively high-acreage burns during both 1990 and 1991. Education efforts in schools and on radio programs have also continued in an effort to dispel myths concerning wildfires and attempt to allow more areas to burn.

CONCLUSIONS AND RECOMMENDATIONS

Because of two severe winters in succession (1989-90 and 1990-91), moose populations in many areas of Unit 19 have declined slightly, and those declines have been reflected in the harvest. Shortened moose seasons in portions of the unit have also contributed to the decline in harvest.

Moose populations in Subunits 21A and 21E have apparently not had to contend with winter conditions as severe as those encountered in Unit 19, and populations (as well as harvests) have not declined.

Increased emphasis should be expended toward education of hunters about the need for ethical hunting practices, following wounded moose, using harvest tickets, complying with harvest reporting requirements, disposing of garbage, and showing respect for private property.

Moose composition counts should be continued in established trend count areas. Census areas should be established in select portions of the area and populations assessed on a 5-year rotating schedule. Efforts must continue to encourage landowners to reduce suppression efforts on wildfires that do not threaten human life, property, or valuable resources, in accordance with provisions of the Alaska Interagency Fire Plan, so that fire can fulfill its natural role of maintaining young, highly productive, and diverse habitats. A burn prescription should be completed for a portion of the 1977 Bear Creek Burn and that area reburned when prescription parameters are met.

Future direction of management of the moose population in the area will depend largely on the ability to continue to harvest predator populations. Particularly during severe winters when moose are stressed due to dietary restrictions, wolf predation is responsible for heavy moose mortality. Continued ability to harvest wolves under same-day-airborne hunting tactics will enable moose populations to remain above critically low levels, thus avoiding a "predator pit" situation in the area.

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Table 1. Holitna/Hoholitna Count Area (Subunit 19A) fall aerial moose composition counts, 1987-94.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1987-88	22	4	72	50	36	84	140[a]	85
1988-89	31	16	56	103	30	240	343	95
1989-90	24	13	55	160	30	361	528[b]	163
1990-91	26	10	52	139	29	336	475	162
1991-92[c]	--	--	--	--	--	--	--	--
1992-93	31	15	63	172	32	360	542[d]	169
1993-94[c]	--	--	--	--	--	--	--	--

[a] Six unclassified moose.
[b] Seven unclassified moose.
[c] No survey.
[d] Ten unclassified moose.

Table 2. Farewell Burn Count Area (Subunit 19C) fall aerial moose composition counts, 1987-94.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1987-88	53	10	19	32	13	207	242[a]	115
1988-89	58	20	34	47	18	218	265	126
1989-90	47	15	22	55	13	361	416	194
1990-91	43	8	26	58	16	315	373	159
1991-92	44	8	29	59	17	293	352	156
1992-93	46	8	38	58	21	220	278	100
1993-94[b]	--	--	--	--	--	--	--	--

[a] Three unclassified moose.

[b] No survey.

Table 3. Holy Cross (Subunit 21E) fall aerial moose composition counts, 1987-94.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1987-88	19[a]	9	43	150	26	420	570	83
1988-89[b]	--	--	--	--	--	--	--	--
1989-90	31	12	45	148	25	432	584[c]	161
1990-91	29	7	51	211	28	536	758[d]	253
1991-92[b]	--	--	--	--	--	--	--	--
1992-93	26	5	22	67	14	412	483	163
1993-94[b]	--	--	--	--	--	--	--	--

[a] Total bulls:100 cows in 1987-88 may have been unrealistically low because surveys were done in late November/early December after some large bulls had already shed their antlers.

[b] No survey.

[c] Four unclassified moose.

[d] Eleven unclassified moose.

Table 4. White Mountains (Subunit 19D) fall aerial moose composition counts, 1987-94.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1987-88[a]	--	--	--	--	--	--	--	--
1988-89	189	27	17	5	11	84	89	40
1989-90	157	14	33	7	11	55	62	29
1990-91	96	6	46	15	19	63	78	34
1991-92[a]	--	--	--	--	--	--	--	--
1992-93	133	0	40	11	14	63	74	37
1993-94	50	11	34	9	18	39	48	60

[a] No survey.

Table 5. Candle/Wilson A, B, C, and D Count Area (Subunit 19D) fall aerial moose composition counts, 1988-94.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
A, B Count Area								
1988-89[a]	--	--	--	--	--	--	--	--
1989-90	14	6	34	17	23	56	73	34
1990-91	34	6	23	11	14	63	74	39
1991-92	20	0	31	14	20	53	67	37
1992-93	4	2	28	12	21	45	57	34
1993-94	14	9	28	6	20	24	30	12
C, D Count Area								
1988-89[a]	--	--	--	--	--	--	--	--
1989-90	25	5	70	14	35	25	39	41
1990-91	11	0	26	7	19	29	36	40
1991-92[a]	--	--	--	--	--	--	--	--
1992-93	17	4	26	6	18	27	33	22
1993-94	37	18	50	8	26	22	30	30

[a] No survey.

Table 6. Unit 19 moose harvest, 1986-93[a].

Regulatory year	Harvest by hunters: Reported M (%)	F (%)	Unk	Total	Estimated Unreported	Illegal	Total	Total
1986-87	454 (98)	8 (2)	2	464	153	unk	153	617
1987-88	530 (97)	17 (3)	2	549	181	unk	181	730
1988-89	615 (98)	15 (2)	7	637	210	unk	210	847
1989-90	546 (99)	7 (1)	6	559	184	unk	184	743
1990-91	383 (95)	20 (5)	1	404	133	unk	133	537
1991-92	461 (97)	13 (3)	2	476	157	unk	157	633
1992-93	485 (96)	22 (4)	3	510	168	unk	168	678

[a] Excludes permit hunt harvest.

Table 7. Subunits 21A and 21E moose harvest, 1986-93.

Regulatory year	Harvest by hunters: Reported M (%)	F (%)	Unk	Total	Estimated Unreported	Illegal	Total	Total
1986-87	227 (95)	11 (5)	0	238	79	unk	79	317
1987-88	251 (98)	6 (2)	0	257	85	unk	85	342
1988-89	306 (98)	6 (2)	5	317	105	unk	105	422
1989-90	277 (99)	1 (<1)	0	278	92	unk	92	370
1990-91	304 (99)	3 (1)	3	310	102	unk	102	412
1991-92	284 (99)	4 (1)	--	288	95	unk	95	383
1992-93	222 (99)	2 (<1)	--	224	74	unk	74	298

Table 8. Unit 19 moose hunter[a] residency and success, 1986-93.

Regulatory year	Successful: Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Unsuccessful: Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Total hunters
1986-87	89	191	119	47	446 (54)	101	183	77	15	376 (46)	822
1987-88	121	245	162	21	549 (54)	95	280	94	6	475 (46)	1,024
1988-89	110	285	188	54	637 (54)	132	271	105	28	536 (46)	1,173
1989-90	114	134	185	36	469 (45)	95	305	162	5	567 (55)	1,036
1990-91	81	189	111	23	404 (37)	94	329	232	20	675 (63)	1,079
1991-92	87	259	123	7	476 (47)	122	266	141	5	534 (53)	1,010
1992-93	100	256	113	41	510 (48)	123	257	149	18	547 (52)	1,057

[a] Excludes hunters in permit hunts.
[b] Local resident means those living in Unit 19.

Table 9. Subunits 21A and 21E moose hunter residency and success, 1986-93.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[a] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Local[a] resident	Nonlocal resident	Nonres.	Unk	Total(%)	
1986-87	43	135	45	15	238 (75)	10	63	7	0	80 (25)	318
1987-88	21	164	43	29	257 (68)	9	83	20	9	121 (32)	378
1988-89	13	177	69	58	317 (75)	2	62	28	16	108 (25)	425
1989-90	19	178	53	28	278 (73)	9	66	18	9	102 (27)	380
1990-91	40	203	52	15	310 (72)	13	80	25	3	121 (28)	431
1991-92	41	200	42	4	287 (64)	22	104	34	0	160 (36)	447
1992-93	20	152	35	19	226 (63)	8	91	26	5	130 (37)	356

[a] Local resident means those living in Subunits 21A or 21E.

Table 10. Unit 19 moose harvest[a] percent by transport method, 1986-93.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unk	*n*
1986-87	44	<1	44	2	3	<1	1	5	822
1987-88	38	<1	44	3	7	2	<1	5	1,024
1988-89	45	<1	43	2	5	1	<1	4	1,173
1989-90	47	<1	41	2	2	<1	<1	5	1,036
1990-91	53	1	35	2	4	<1	<1	4	1,079
1991-92	49	<1	41	3	4	<1	<1	1	1,010
1992-93	41	1	45	2	9	0	<1	2	1,057

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit: 20A (6,796 mi^2)

Geographical Description: Tanana Flats, Central Alaska Range

BACKGROUND

Moose are throughout the foothills of the Alaska Range and the Tanana Flats. Preferred moose habitat is composed of riparian willow, second growth forest, and subalpine shrub communities.

Moose numbers increased in Subunit 20A during the 1950s and reached high densities in the early 1960s. During the 1960s, habitat overutilization may have limited moose population growth (W. Gasaway, pers. commun.). During that period, the moose density may have exceeded 3 moose/mi^2. With an abundance of moose, wolf numbers also increased to high levels.

Annual moose harvests averaged 311 moose between 1963 and 1969 (McNay 1993). From 1969 to 1974, harvest increased to an average of 617 moose per year. Cow moose comprised 34% of the annual harvest from 1963 to 1974.

The moose population began a decline in the late 1960s, reaching its lowest point in the mid-1970s. Beginning in 1975, seasons and harvests were dramatically reduced and taking of cows was prohibited. In late winter 1976, a program to reduce wolf numbers was begun. During the first 4 years of these changes (1975-78), mean annual moose harvest was only 64 bulls. A detailed history of the moose population through 1978 was published by Gasaway *et al.* (1983).

Following wolf reduction efforts in Subunit 20A (1976-82) and Subunit 20B (1980-86), the moose population again increased. From 1979 to 1982, harvests averaged 226 bulls/year (McNay 1993). During the most recent 9 years (1984-91), the mean annual harvest increased to 369 bulls. Browse availability does not appear to have limited moose population growth in recent years.

Biologists documented the population increase with six population estimation surveys (censuses) (Gasaway *et al.* 1986) completed in Subunit 20A since 1976. These included censusing the entire subunit in 1978, the Tanana Flats in 1982, the foothills in 1984, the entire subunit in 1988, and the Central Tanana Flats and Western Foothills in 1991. Population estimates calculated from these censuses were 3,511 moose (1978), 7,663 moose (combined 1982 and 1984), 9,296 moose (1988), and 11,072 moose (1991) (McNay 1993).

Subunit 20A has been managed to provide a variety of hunting opportunities. The southwestern portion of the subunit currently includes the Wood River Controlled Use Area (no motorized access except aircraft), the Ferry Trail Management Area (harvest limited to bulls with spike-fork or 50 inch antlers), the Healy Lignite Management Area (bowhunting only), and the Yanert Controlled Use Area (no motorized access except aircraft, with harvest limited to bulls with spike-fork or 50-inch antlers) (Fig. 1). Approximately one-third of Subunit 20A is military land, including 1,003 mi^2 of Fort Wainwright Army property, 893 mi^2 of Fort Greely Army property, and 17 mi^2 of Clear Air Force Station property.

MANAGEMENT DIRECTION

Management Goals

- Protect, maintain and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.

Management Objectives

- Manage for a November population of between 10,000 and 12,000 adult (i.e., excluding calves) moose by 1995.
- Manage for at least 30 bulls:100 cows overall and at least 20 bulls:100 cows in the Tanana Flats, Western Foothills, and eastern foothills census areas.
- Maintain an annual harvest of no more than 300 bulls ^{3} 2 years of age and a total harvest of less than 400 bulls, until the population objective is reached.
- Allow the harvest of cow moose when the population is above the population objective of 10,000 adult moose.

METHODS

Weather during this reporting period was unusual. We collected data on snowfall and other weather from the National Weather Service to evaluate the potential impact on moose populations.

We have not conducted a moose survey in Subunit 20A to estimate population size since we completed censuses in the Central Tanana Flats and the Western Foothills in November 1991.

In November 1992, we were unable to complete most moose surveys because record snowfall in September resulted in the unprecedented retention of leaves on deciduous trees throughout much of Interior Alaska. The leaves and bent-over trees prevented adequate sightability of moose for surveys. However, on 16-17 November we completed composition surveys in the Walker Dome, Windy, and Japan Hills trend areas in the Western Foothills (141 mi^2) where sightability was adequate. We used standard survey techniques to thoroughly search the area and classify moose. Bulls were classified by antler spread; <30 inches, 30-39 inches, 40-49 inches, and ^{3} 50 inches.

In February 1993, due to growing concern about the effects of deep snow during early winter 1992-93, we conducted several reconnaissance-type surveys of moose. We searched the northern Tanana Flats and classified all moose we observed as calves or adults to estimate the percentage of calves. Areas were not searched systematically, but were highgraded because of the clumped distribution of moose.

On 5 May 1993, we conducted short-yearling (11-month-old calves) surveys (10.3 hours) in the northern Tanana Flats (319 mi^2) to determine overwinter survival of calves after the deep snow winter of 1992-93. We used standard techniques with transects to search the area. Bulls were identified by presence of nubs or velvet antlers. Short-yearlings were identified by their short faces, tendency to stay closer to the cow, and smaller body size.

From 21-28 May 1993, we completed two neonatal twinning rate surveys in the northern Tanana Flats. We conducted the first survey during the normal peak of calving (21-24 May) but because so few cows had calves (10%), we assumed calving was late and conducted a second survey in a portion of the same area 1 week later (28 May). Four pilot/observer teams completed the survey by searching assigned areas at approximately 500 ft above ground level but without adhering strictly to transects, so this survey did not represent a complete count.

From 18-28 November 1993, we completed two "superstrats" (superstratifications) in 2,691 mi^2 in Subunit 20A, one in the Central Tanana Flats (1,525 mi^2) and one in the Western Foothills (1,166 mi^2). We chose the superstrat technique to obtain data on moose composition and as an index to population trend. We did not have enough money and personnel to conduct a census, yet we wanted information over a broader area than trend counts provide. The superstrat technique provides an estimate of *observable* moose, not *total* moose, because no intensive surveys are done to calculate sightability correction factors (SCF). We stratified more intensively (33-57 sec/mi^2) than during a census (26 sec/mi^2). We compared data from this superstrat with data from the exact same area censused in 1991, which was a subset of the 1991 data. In 1993, we did not stratify or survey the Yanert drainage or six sample units south of Blair Lakes. Details of methods are outlined in Eagan (1994).

We estimated annual harvest from harvest report cards which were summarized in the Wildlife Information Data Base (WIDB) files provided to us in fall 1993. The WIDB files included harvest from 1984-92. We considered bulls with antler spreads less than 30 inches to be yearlings.

From 13-20 September 1992, we also conducted a hunter check station on the Tanana River at one of the primary boat launches (Chena Pump campground). Although we obtained harvest ticket numbers, we did not obtain a large enough sample size to estimate reporting rates (McNay 1990).

RESULTS AND DISCUSSION

Weather

Unusual weather influenced many aspects of moose population dynamics during the last few years and is worth summarizing. Winter of 1990-91 had the highest snowfall on record in Fairbanks (147.3 inches), exceeding the previous record in 1970-71 (145.7 inches) and was closely followed by 1992-93 (139.1 inches) (National Weather Service, pers. commun.). These record snowfalls are well over twice as high as the long-term average (68 inches). Based on a winter severity index that considers the duration of deep snow, however, the long winter of 1992-93 was slightly more severe (5.0) than 1970-71 (4.9), but still lagged behind 1990-91 (5.3) (Boertje *et al.* 1993).

Summer 1992 was probably the shortest on record. It was bracketed with snowfall in mid-May, then 24 inches of snowfall (3 times the previous record) and cold temperatures (13° colder than previous record) in September. The early cold temperatures resulted in the deciduous trees not completing abscission and instead retaining their foliage throughout the winter. Snowfall was highest through December, but by the end of January many ridgetops in the Alaska Range were blown free and the severity of the winter tapered off. In contrast, 1993 was likely the longest summer on record, with an early spring leafout, warm summer, and late fall.

Population Status and Trend

Population Size:

During our last censuses of the moose population in Subunit 20A in November 1991, McNay (1993) estimated that the population included 11,072 moose (4,989 in the Tanana Flats and 6,083 in the foothills). Of these, he estimated 8,788 were adults (3,893 in the Tanana Flats and 4,895 in the foothills). The overall subunit density was 2.2 moose (all ages) per mi^2.

Since those censuses, I believe that the moose population has declined, but do not know to what degree. In November 1993, our superstrats indicated that the number of *observable* moose declined by 23% in the Central Tanana Flats and 21% in the Western Foothills during this 2-year period. We could not calculate a decline in the *total* number of moose because in 1993 we did not do sightability plots to obtain a correction factor. We estimated that the 1,524 mi^2 portion of the Central Tanana Flats included 2,362 observable moose ± 13.6% (90% CI, 20 df), or 1.5 observable moose/mi^2 (Table 1). We estimated that the 1,163 mi^2 portion of the Western Foothills included 2,629 observable moose ± 15.3% (90% CI, 15 df), or 2.3 observable moose/mi^2.

Using this superstrat data, we calculated an expanded population estimate for 1993 using a range of plausible sightability correction factors (Table 2). The resulting expanded population estimates for 1993 overlapped with estimates for 1991 (Table 1), which means there may or may not have been a decline.

A survey in November 1992 also indicated that the moose population may have declined since 1991. In 1992, we observed fewer moose in all three trend areas we surveyed than in 1990 (Table 3). Sightability of moose in these areas was comparable between years and should not have contributed to fewer moose being seen in 1992. The decline may have been an artifact of moose not moving from the flats to the foothills because of deep snow. Changes in the number of moose seen in trend areas are difficult to interpret, however, because their relatively small size makes several factors, such as distribution, possible.

Population Composition:

If the population did decline significantly between 1991 and 1993, we expected to see evidence in composition counts of lower calf:cow ratios and yearling bull:cow ratios.

Calf:Cow Ratios. Despite the severe winters of 1990-91 and 1992-93, which could have affected 1991 and 1993 calf productivity and neonate survival, November calf:cow ratios were moderate in both the Central Tanana Flats (34:100 in 1991, 40:100 in 1993) and

Western Foothills (32:100 in 1991, 38:100 in 1993) (Table 4). The 1993 cohort probably benefitted from the early spring and late fall of 1993, which created a very long growing season. Calves made up 24% of the 1993 population in the Central Tanana Flats, and 23% in the Western Foothills.

In the trend count areas, calf:cow ratios have not varied much in the Japan Hills since 1987 (35-37:100), but have varied widely in other areas, ranging from 25:100 (1992) to 49-50:100 (1988, 1990) in Walker Dome, and 35:100 (1987) to 50-51:100 (1990, 1992) in Windy Creek (Table 3).

Survival of calves through winter 1992-93 was higher than we expected. In February 1993, 18-25% of the moose we surveyed on the Tanana Flats were calves. On 5 May 1993, we observed 29 short-yearlings:100 cows, with 19% short-yearlings in the sample. These values exceeded those collected during the most recent May surveys in 1987 (26:100, 16%) and 1990 (16:100, 12%), but were lower than from 1981-84 (31-33:100, 19-20%) (Table 5). If winter-kill had been severe, we would expect to see less than 5% short-yearlings in the surviving population (Boertje, pers. commun.)

Boertje (1993) noted that moose, in general, are very well adapted to deep snow. However, deep (>35 inches), soft snow endured for several months has caused significant declines in moose populations where moose density was high (3-4+ moose/mi^2 in large areas for several years prior to deep snow). Examples in recent decades were in Units 13, 14, 15, and 20A. Declines occur most notably from a loss of calves and old adults. In areas with excellent habitat and few wolves per moose (50-100 moose/wolf), moose populations have recovered quickly from declines caused by deep snow. Boertje noted that we have no documented cases in Alaska of low or moderate-density moose populations declining significantly due to deep snow.

The severe winter of 1992-93 may have affected parturition dates and rates. During the normal peak of calving (21-24 May), we conducted a twinning rate survey and counted 438 moose: 22 cows with single calves, 194 cows without calves, 92 yearlings (both sexes) and 108 bulls. Because so few (10%) cows had calves, we assumed calving was late and repeated the survey in a portion of the area 1 week later (28 May). By this later date, nearly 3 times as many cows had calves (29%). We counted 186 moose; 28 cows with single calves, 31 cows with yearlings but no calves, 37 cows without calves or yearlings, 1 lone calf, and 27 bulls. Therefore, calving was later than normal and the twinning rate was 0%.

Gestation length is somewhat flexible, and research indicates severe undernutrition may lengthen it (Schwartz and Hundertmark 1992). Pregnant cows fed ad libitum rations during the winter gained mass during winter and produced healthy calves during the normal period (25 May). Pregnant cows fed a diet typical of winter range (85% of ad libitum) lost mass through the winter and produced healthy calves slightly later (3 June).

Pregnant cows fed a diet typical of severe winter range (70% of ad libitum) also lost mass through winter but calved significantly later (21 June). The twins born during this latter case were very weak and died within 24 hours. I assume that during winter 1992-93 moose were on a diet typical of severe winter range, which may have been responsible for the later peak of calving. I do not know how much the moose diets were supplemented by access to bent-over treetops in 1992-93.

Twinning rates vary with range quality and may be a good indicator of carrying capacity (Schwartz 1992). In a research project on the Kenai Peninsula, body mass of primiparous cows at estrus was greater for those producing twins (Schwartz and Hundertmark 1992). Cows with a body mass less than 379 kg at estrus had single calves, whereas cows with a body mass more than 379 kg had twins. We did not observe any twins in either survey in May 1993. Perhaps the record snowfall and low temperatures in fall 1992 and early winter stressed cows enough to lower the twinning rate from the 10-22% twins found in earlier years (Table 6). Although twins were subsequently observed around Fairbanks, we do not believe the timing of our survey affected our twinning rates because gestation length is not different for single vs. twin litters (Schwartz 1992). Twinning rates on the Tanana Flats traditionally have been lower than in other areas of Alaska (McNay 1990).

Yearling Bull:Cow Ratios. In November 1991, yearling bull:cow ratios were very low in the Central Tanana Flats (4:100) and moderate in the Western Foothills (10:100) (Table 4). Calves may have survived the winter of 1990-91 better in the foothills because of lower snow depths and the presence of caribou that served as alternate prey for wolves.

In November 1993, yearling bull:cow ratios had increased slightly in both the Central Tanana Flats (8:100) and Western Foothills (12:100). Unlike most years, calves may have survived winter 1992-93 better in the flats than the foothills because the entire Delta caribou herd wintered on the Tanana Flats and surrounding foothills in Subunit 20B, providing alternative prey to wolves. Conversely, moose calves in the foothills probably experienced higher mortality from predation while the caribou were absent from that area.

Bull:Cow Ratios. In November 1991, we estimated the moose population in Subunit 20A included 28 bulls:100 cows overall (weighted by adult sample size), with 21:100 in the Central Tanana Flats and 32:100 in the Western Foothills. The low bull:cow ratio on the Tanana Flats was probably related to continued moderate harvest rates during 1989, 1990, and 1991 while yearling recruitment declined after severe winters (McNay 1993). In November 1993, the bull:cow ratio increased to 30:100 in the Central Tanana Flats and decreased slightly to 29:100 in the Western Foothills.

In November 1992, the small trend areas we surveyed (141 mi^2) also indicated that bull:cow ratios (32:100 combined) easily exceeded our management objective for at least 20:100 in each area (28:100, 31:100, and 36:100 in Windy, Walker Dome, and Japan Hills trend areas, respectively).

Antler Restricted Area. Since 1988, the bag limit in the southwestern portion of Subunit 20A has been limited to one bull with spike-fork or ^{3} 50 inch antlers (subsequently referred to as SF50). That regulation was adopted in response to declining bull:cow ratios (17-21:100) in this area where numerous trails provide motorized access. Bull:cow ratios subsequently increased in the two trend areas (Walker Dome and Windy) within the SF50 area (Table 3). However, because the bull:cow ratio also increased in the Japan Hills trend area outside the SF50 area, it is unclear whether or not the antler restriction was responsible for the increase.

Prior to the spring 1995 Board of Game (BOG) meeting, we plan to discuss keeping the current antler restriction in this area. The current restriction targets "inferior" yearlings (60% of yearlings) and "superior" prime-age bulls. If we want to select for large bulls, a spike-fork antler restriction would be most effective because a "SF50" regulation selects against large bulls by making them legal. Because a network of trails and roads provides easy access into the Ferry Trail Management Area, a restriction on the moose harvest will continue to be necessary. Several regulatory options include: 1) a short general season for any bull, 2) a long general season for spike or fork only, 3) a long permit season for any bull, or my preferred alternative 4) a combination of 2 and 3.

Distribution and Movements:

The moose population is distributed throughout Subunit 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 Subunit 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.* estimated that the 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 the foothills are probably much lower than during winter.

Mortality

Harvest:

Season and Bag Limit. Seasons and bag limits in Subunit 20A during regulatory years 1991 and 1992 were as follows:

Units and Bag Limits	Resident	Nonresident
Unit 20A, that portion in the	1 Sept.-20 Sept.	1 Sept.-20 Sept.

Ferry Trail Management Area and the Yanert Controlled Use Area: One bull with a spike-fork or 50-inch antlers.		
Remainder of Unit 20A: One bull.	1 Sept.-20 Sept.	1 Sept.-20 Sept.

In 1991 and 1992, 50-inch antlers were defined as antlers with at least a 50-inch spread or with at least three brow tines on at least one antler. In 1993, the bag limit was redefined as one bull with a spike-fork, antler configuration, 50-inch antler spread, or antlers with four or more brow tines on one side.

Game Board Actions and Emergency Orders. In fall 1992, the Joint Boards of Fisheries and Game established the Fairbanks Nonsubsistence Area, which, in Subunit 20A, roughly included all but the northwest quarter. The joint boards concluded (Finding 92-24-JB) that dependence upon subsistence is not a principal characteristic of the economy, culture, and way of life in this nonsubsistence area. No subsistence hunting or fishing regulations are permitted within a nonsubsistence area. However, in October 1993, a Superior Court judge declared the nonsubsistence area portion of the 1992 Subsistence Law invalid. The state is currently appealing the decision.

Following the joint board meeting, the BOG adopted the department's draft Area Specific Wolf Management Plan for Southcentral/Interior Alaska, which the department drafted after extensive public review. The plan outlined population and harvest objectives for big game species and zoned the entire area into 1 of 7 management zones, based on the intensity of human use and management. This action was later rescinded, so it will not be elaborated on in this report.

In fall 1992, the BOG removed the number of brow tines (three in Subunit 20A) from the definition of a 50-inch antler. Then in spring 1993, they redefined the bag limit in these antler restricted areas as one bull with a spike-fork or 50-inch antlers or antlers with four or more brow tines on one side.

In June 1993, after much public debate, the BOG approved a ground-based wolf control program in a portion of Subunit 20A to reduce predation on the declining Delta caribou herd and to determine whether ground-based control methods can effectively reduce wolf numbers temporarily to reverse declines in prey populations. This control program is proceeding during winter 1993-94. If a substantial number of wolves are removed from Subunit 20A, it will be necessary to monitor the moose population response to ensure that regulations are adjusted accordingly.

Harvest by Hunters. During this reporting period, we met our objective of maintaining an annual harvest of no more than 300 bulls 2 years or older in 1992 (194), but not 1991 (331). We met our objective for a total harvest of less than 400 bulls in both years (382 in 1991, 245 in 1992) (Table 7). Harvest in September 1992 was abnormally low because record snowfall shortened many moose hunts and access was very poor throughout the last half of the season. During the last half of the 1993 season, we contacted 63 hunters in 27 groups at the Chena Pump campground. Only 3-4% of the hunters had harvested moose.

From 1984 through 1991, the mean annual reported moose harvest in Subunit 20A was 369 bulls (range 302-420) (Table 8). If we adjust this reported harvest to account for approximately 17% unreported harvest (Gasaway *et al.* 1983), the resulting mean estimated harvest was 445 bulls.

In general, each year from 1984 through 1991, 1,000-1,300 hunters have spent 6,000-8,000 days hunting moose in Subunit 20A (Table 9). During the last 3 years, 60% of the harvest occurred on the Tanana Flats, 36% in the foothills, and 4% with unknown locations in Subunit 20A (Table 10).

Hunter Residency and Success. From 1984 through 1992, 81-88% of the successful moose hunters in Subunit 20A were Alaska residents, with most (61-77%) successful hunters being "local" residents (residents of Unit 20) (Table 8). Although nonresident hunters only took 30-60 bulls per year, their success rates were higher (35-54%) than for residents (23-31%) (Table 11).

Harvest Chronology. Moose harvest in Subunit 20A has traditionally been well distributed throughout the 20-day September season. In 1992, however, the number of bulls harvested during the last week of the season was relatively low (43 bulls) because of the record snowfall affecting access. During most years, the highest proportion of the harvest is taken during the last week of the season (14-20 September). During this latter period, success rates are higher because leaves have dropped, improving visibility, and bulls are more active as the breeding season approaches.

Transport Methods. During the last 9 years, in general, 30-40% of the successful moose hunters per year used airplanes, 25-31% used boats, 18-26% used ORVs or 3- or 4-wheelers, and 4-6% used horses (Table 12). Hunting by horseback is popular in the Yanert Controlled Use Area and in the Montana Creek drainage. The "boat" category on harvest reports includes a diversity of transportation types so we gathered more specific information at our check station in September 1992. Of the 27 groups of hunters we contacted, 55% used riverboats to access their moose hunting area, 33% used airboats, and 11% used canoes with outboards.

Other Mortality:

Using two independent methods of calculation, natural mortality among adult moose was estimated to be approximately 11% annually between 1984 and 1988 (McNay 1990). By comparison, natural mortality among adult moose was estimated to be 20% during the 3 years before the onset of wolf control in 1976 and 6% for the 3 years after removal commenced (Gasaway *et al.* 1983). Natural mortality was approximately 15% annually during the last few years (Boertje, pers. commun.).

Wolves are the primary predator of moose in Subunit 20A, with densities as high as 16 wolves/1,000 km^2 in fall 1991. Although this wolf density is very high, the corresponding moose:wolf ratio was about 40:1. Wolf predation probably has a greater impact on moose in the flats, where moose are usually the only year-round big game prey. Predation rates may have been higher than normal during winter 1992-93 as moose were concentrated along riparian areas, frequent travel routes for wolves. However, we did not have any evidence of a large-scale die-off of calves by spring 1993.

Black bears are known to be significant predators of moose in some areas. In one study in Unit 21B, black bears killed 40% of collared moose calves (Osborne *et al.* 1991). Black bears are common on the moose calving grounds on the Tanana Flats, but their predation rates are unknown.

The number of moose killed in accidents with motor vehicles and trains has been substantial in some years. For instance, 62 and 73 moose were killed by trains along the Subunit 20A/20C railbelt in 1989-90 and 1990-91, respectively (Table 13). Modifications in railroad activities, road designs, and fences may help minimize this mortality. Staff should work with Department of Transportation and the Alaska Railroad to recommend improvements when possible.

Habitat

There has been considerable discussion in recent years about the potential for Subunit 20A to support many more moose than the most recent peak of 11,700 in 1991. We are concerned about not exceeding the carrying capacity like we appeared to have done in the early 1970s. Several studies have been proposed to investigate the potential to increase the carrying capacity for moose with habitat manipulation.

In moose populations on good range or below carrying capacity, yearling ovulation and pregnancy occur (Schwartz 1992). For example, a 65% pregnancy rate among yearling cows indicates a population below K; a 41% yearling pregnancy rate indicates a population near K; and an 18% yearling pregnancy rate indicates a population above K. By radio-collaring short-yearling cows, we could estimate yearling pregnancy rates as indicators range quality or carrying capacity.

The Tanana Valley State Forest (TVSF) Management Plan is currently being revised. If future management of the TVSF results in a substantial increase in logging, browse conditions for moose may be enhanced. Although little of the TVSF is in Subunit 20A, many moose that migrate seasonally to Subunit 20A either winter on TVSF lands or move through them and would be affected by changes in forest management.

Nonregulatory Problems/Issues

The U.S. Air Force (USAF) is currently preparing an Environmental Impact Statement on a proposal to upgrade Alaskan Special Use Airspace to provide realistic air combat training environments for Major Flying Exercises, joint exercises, and routine theater operations. Portions of the plan that affect Subunit 20A include: 1) converting an existing Temporary Military Operations Area to a permanent Military Operations Area (MOA), 2) creating a new MOA, 3) conducting supersonic operations in the MOAs, and 4) increasing the number of major flying exercises. The effects on moose of the additional air traffic and supersonic noise are unknown, but should be fully considered and concerns relayed to the USAF.

CONCLUSIONS AND RECOMMENDATIONS

Our current management objectives for moose in Subunit 20A and my comments about our progress toward meeting them are as follows:

1. *Manage for a November population of 10,000-12,000 adult moose (i.e., excluding calves) by 1995.*

   Based on the decline (21-23%) in the number of *observable* moose in the flats and foothills between 1991 and 1993, we will not likely meet our population objective of 10,000 adult moose by 1995. In 1991, the population was estimated to include 8,788 adults and has probably declined. If the population currently includes about 8,000 adults, then we would need a 12% annual increase in the adult population for the next 2 years to reach our objective. If the population currently includes 7,000 adults, we would need a 20% annual increase for 2 years. If the population currently includes 6,000 adults, we would need a 30% annual increase for 2 years. Our ability to meet this objective depends largely on the current (unknown) population of adults, weather, and changes in predation rates due to the wolf control program.

   The strength of the superstrat technique is to provide unbiased composition data over a relatively large area. In addition, we can use the number of observable moose as an index to population trend, but we cannot calculate the total moose population because we lack an SCF and variance around it (both of which are necessary to calculate a total moose population estimate). The 1993 results have served to turn on the "yellow light," which should be turned into a "green" or a "red" light only after completing a survey designed to estimate density. I recommend that we complete a census in Subunit 20A in November 1994 to gather statistically significant data to compare with the 1991 census data.

In addition, if we plan to use superstrats as indices to population trend, we should consider standardizing and defining moose densities representative of each strata. This would reduce confusion when comparing data for consecutive years.

2. *Manage for at least 30 bulls:100 cows overall, and at least 20 bulls:100 in the Tanana Flats, Western Foothills, and Eastern Foothills census areas.*

   We are meeting our objectives for bull:cow ratios. I was glad to see the increase in the Central Tanana Flats from 1991 (21:100) to 1993 (30:100). Even though the 1993 bull:cow ratio in the Western Foothills (29:100) was slightly lower than in 1991 (32:100), we still met our objective of at least 20:100 in each area.

3. *Maintain an annual harvest of £300 bulls 2 years or older, and a total harvest of <400 bulls until the population objective is reached.*

   During this reporting period, we met our objective to maintain an annual harvest of no more than 300 bulls 2 years or older in 1992 (194) but not 1991 (331). We met our objective for a total harvest of less than 400 bulls in both years (382 in 1991, 245 in 1992). The substantial decrease in harvest in 1992 was probably due to record snowfall in September.

4. *Allow the harvest of cow moose when the population is above the population objective of 10,000 adult moose.*

   Not applicable at this time.

I recommend the following projects to increase our knowledge of moose population dynamics and their relationship to habitat conditions in Subunit 20A:

- Radiocollar short-yearling cows to determine yearling pregnancy rates. Schwartz (1992) stated that yearling pregnancy rates are an indicator of range condition and carrying capacity.

- Continue spring twinning rate surveys. Twinning rates vary with range quality and also may be a good indicator of carrying capacity (Schwartz 1992).

- Identify important wintering areas for moose and conduct browse transects in them.

- Monitor the four snowstakes snow survey courses we established in Subunit 20A in 1993 in cooperation with Soil Conservation Service.

- Develop specific objectives to monitor effects of increasing moose density on long-term moose population dynamics if the current wolf control program removes a large proportion of the wolves in Subunit 20A.

- Investigate the potential impacts of changes in USAF activities on moose in Subunit 20A and provide recommendations if necessary.

- Investigate the potential impacts of the TVSF Management Plan on moose that migrate annually to Subunit 20A and provide recommendations as necessary.

- Evaluate the feasibility of placing the Tanana Flats calving area in protective status to ensure that other activities do not compromise this major calving area for moose throughout the Fairbanks area.

Although I have no recommendations for changes in objectives at this time, I plan to review them with the public during the next reporting period to ensure that they reflect public desires. I will also be examining harvest and the effectiveness of the antler restrictions in the southwestern portion of the subunit.

Recommendations for changes in regulations will be made at the spring 1995 BOG meeting.

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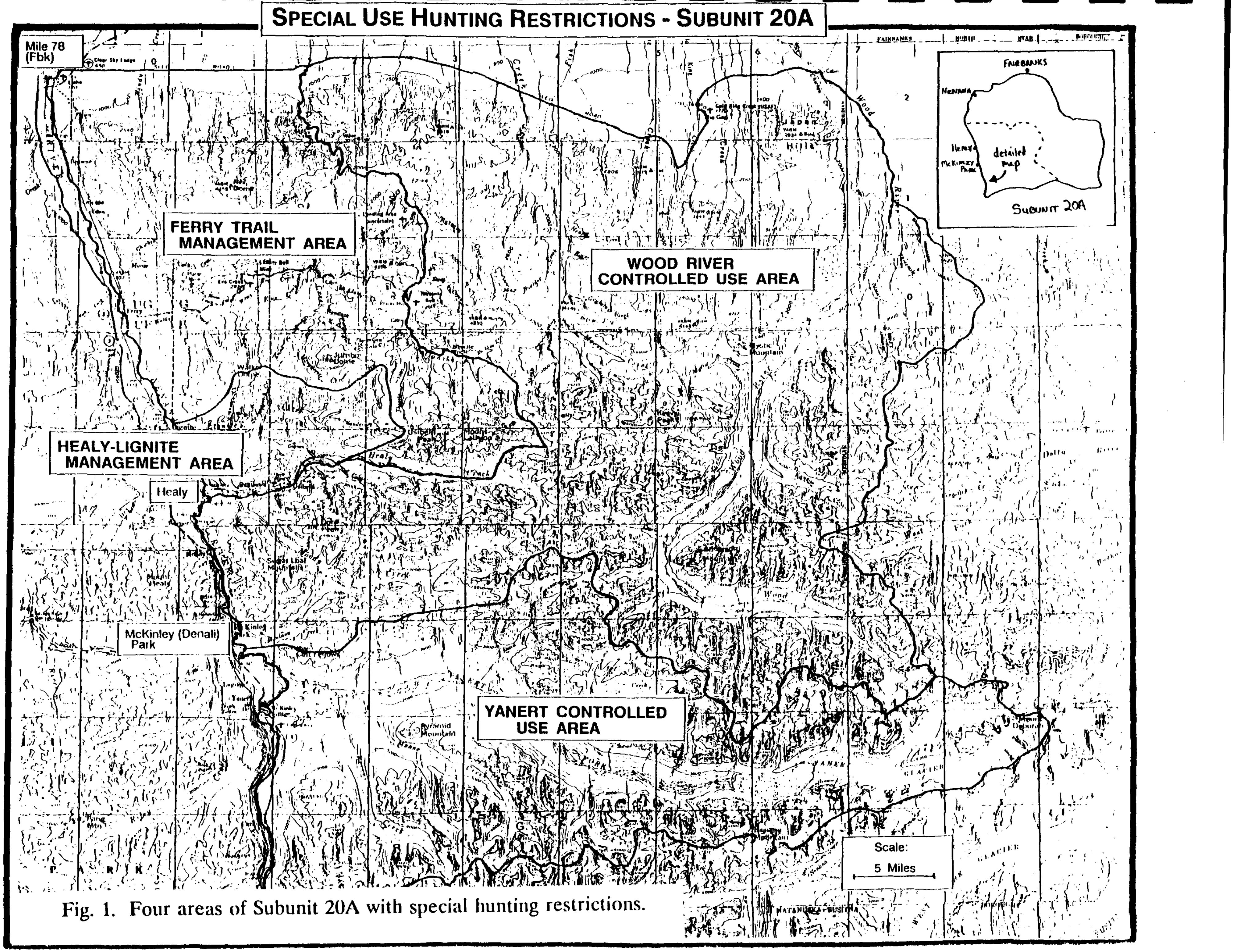

Fig. 1. Four areas of Subunit 20A with special hunting restrictions.

Table 1. Plausible range of expanded moose population estimates for portions of Subunit 20A, 1991 and 1993 (see text for explanation of 1993 values).

	Central Tanana Flats			Western Foothills		
Year	No. Moose (± 90% CI)	Range	Density (moose/mi^2)	No. Moose (± 90% CI)	Range	Density (moose/mi^2)
1993						
Observable Popn. Estim.(T_o)	2,362 ± 13.6%	2,040-2,684		2,629 ± 15.3%	2,226-3,032	
Range of SCFs[a]		1.04-1.39			1.04-1.29	
Expanded Popn. Estim.(T_e)		2,122-3,731	1.4-2.4		2,315-3,911	2.0-3.4
1991[b]						
Observable Popn. Estim.(T_o)	3,063 ± 9.3%	2,777-3,349		3,349 ± 15.9%	2,818-3,880	
Pooled SCF		1.10			1.25	
Expanded Popn. Estim.(T_e)[c]		3,268-4,412	2.1-2.9		3,017-4,511	2.6-3.9

[a] See Table 2.

[b] 1991 data only includes the subset corresponding to the same area completed in 1993.

[c] SCFs were not pooled for expanded population estimate.

Table 2. Range of sightability correction factors (SCF) measured during moose censuses in Subunit 20A, 1982-91.

Area	Year	SCF (90%CI)
Tanana Flats	1982	1.04 - 1.26
Tanana Flats	1988	1.04 - 1.18
Tanana Flats (Central)	1991	1.09 - 1.39
Foothills	1984	1.11 - 1.29
Foothills (Western)	1988	1.09 - 1.27
Foothills (Western)	1991	1.04 - 1.16

Table 3. Comparison of moose composition in three trend areas in Subunit 20(A) before and after the spike-fork/50-inch antler regulation was implemented in 1988. Parentheses indicate values when all sample units surveyed are included.

Trend area	Year	SF 50" regs?	Mi^2 surveyed	Bull: 100 cows	Yrlg. bull: 100 cows	Calves: 100 cows	% Calves	Total moose observed	Moose/ mi^2
Windy	1987[a]	N	76	21 (20)	6 (6)	35 (35)	22 (22)	255 (258)	3.4
	1990	Y	76	23	7	51	29	292	3.9
	1992	Y	78	28	3	50	28	107	1.4
Walker Dome	1988[b]	Y	66	17	12	49	30	125	1.9
	1990	Y	66	26	7	50	28	180	2.7
	1992	Y	66	31	16	25	16	105	1.6
	1993[c]	Y	43	31	21	35	21	119	2.8
Japan Hills	1987[d]	N	59 (87)	22 (29)	3 (6)	36 (40)	22 (23)	122 (205)	2.1 (2.3)
	1990[d]	N	59 (87)	24 (33)	6 (9)	37 (44)	23 (25)	158 (322)	2.7 (3.8)
	1992	N	59	36	1	35	20	137	2.3
	1993[e]	N	20	34	16	26	16	61	3.0

[a] Excludes data from sample unit 337 because it was not surveyed in 1990 or 1992. Data collected 12/3/87 and antler drop may have influenced bull:cow ratios.

[b] Excludes data from sample unit 140 and some observations in subunits 141 and 145 to make comparable areas to surveys in 1990 and 1992.

[c] Sample units 353 and 360 not surveyed.

[d] Excludes data from sample units 302 and 303 because they were not done in 1992 due to weather.

[e] Sample units 65, 66, 68, and 301-303 not surveyed.

Table 4. Subunit 20A fall aerial moose population estimation surveys, 1988 and 1991 (90% confidence limits in parentheses).

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Total calves	Percent calves	Adults	Total moose observed	Density moose /mi^2	Estimated population size	Survey area size(mi^2)
1988										
Entire Tanana Flats	27 (22-31)	7 (5-9)	46 (41-50)	1,176 (996-1,355)	25 (22-27)	3,616 (3,128-4,105)	1,562	1.66	4,792 (4,163-5,421)	2,880
Western Foothills (including Yanert)	32 (27-37)	11 (9-13)	41 (37-45)	679 (601-756)	23 (22-25)	2,229 (2,016-2,442)	1,298	2.05	2,908 (2,643-3,173)	1,418
Eastern Foothills	47 (40-53)	17 (14-19)	44 (41-47)	370 (316-423)	23 (22-24)	1,226 (1,075-1,377)	975	2.16	1,596 (1,397-1,796)	739
Central Tanana Flats[a]	30 (24-35)	8 (6-10)	44 (39-48)	863 (732-994)	23 (21-25)	2,889 (2,490-3,287)	1,378	2.33	3,752 (3,259-4,244)	1,610
1991										
Central Tanana Flats	22 (14-29)	5 (2-7)	35 (29-40)	859 (690-1,027)	22 (19-25)	3,047 (2,548-3,547)	949	2.42	3,906 (3,314-4,498)	1,610
Western Foothills (including Yanert)	32 (28-35)	10 (8-12)	32 (28-36)	766 (608-925)	20 (18-22)	3,161 (2,703-3,618)	1,531	2.77	3,927 (3,336-4,517)	1,418
1993										
Central Tanana Flats[b]	30 (22-37)	8 (6-11)	40 (36-44)	556 (456-657)	24	1,806 (1,511-2,101)	852	--[c]	--[c]	1,524
Western Foothills (excluding Yanert)	29 (18-40)	12 (7-17)	38 (34-42)	600 (488-711)	23	2,029 (1,624-2,435)	883	--[c]	--[c]	1,163

[a] In 1988, the Central Tanana Flats was surveyed; these data are a subset of the 1988 survey that compares directly with the 1991 Central Tanana Flats survey.

[b] Includes six fewer sample units than the Central Tanana Flats in 1988 and 1991.

[c] 1993 surveys done with superstratification technique; density and estimated population size data not comparable (see text).

Table 5. Results of short-yearling (11 month old) moose surveys in Subunit 20A, 1977-1993.

			Number of Moose												
		Survey		Cows			Lone			Total	Total	Yrlgs:	%	Bulls:
Date	Area[a]	Time (hrs)	Bulls	w/0	w/1[b]	w/2[b]	Yrlgs	Unk	Total	yrlgs	cows	100 cows	yrlgs	100 cows
5/17-21/77	1,2,3	8.1	43	103	38	2	18	0	280	60	159	38	21	15
5/9-11/77	1,2,3	13.1	52	173	55	7	1	0	357	70	235	30	20	15
5/9-10/79	1,2,3	14.0	65	194	61	6	2	0	401	75	261	29	19	16
5/9-15/80	1,2,3	7.7	67	107	37	9	8	1	280	63	150	42	23	24
5/11-12/81	1,2,3	11.2	52	165	53	7	4	0	348	71	225	32	20	23
No survey in 1982														
5/9-11/83	1,2,3	21.5	126	301	114	5	9	3	690	133	428	31	19	29
5/14-16/84	1,3AB	13.0	133	255	103	6	3	0	615	119	363	33	19	37
No surveys in 1985, 1986														
5/12-14/87	1ABCD	--	104	248	73	0	10	0	508	83	321	26	16	32
No surveys in 1988, 1989														
5/4/90	--[c]	2.0	37	85	16	0	0	0	154	16	101	16	10	37
No surveys in 1991, 1992														
5/5/93	1ABCDE	10.3	67	237	92	0	3	0	491	95	329	29	19	20

[a] Boundaries for each numbered/lettered area were not checked and are assumed to be consistent from year-to-year.

[b] With short-yearlings (11-month-olds).

[c] Boundaries of survey area included approximately 50 mi^2 of NE Tanana Flats in sample units 118, 119, most of 125, and all of the NE half of 120.

Table 6. Results of twinning rate surveys for moose in the Tanana Flats, 1987-93.

		Number of cows			
Year	Date	W/Single calf	W/Twins	Total	% Twins[a]
1987		45	5	50	10
1988		52	8	60	13
1989	20-24[b] May	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

[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 7. Antler spread of moose harvested in Subunit 20A, 1988-92[a].

	Antler spread					
Year	£ 30"[b]	31-40"	41-50"	> 50"	Unk	Total
1988	47	82	68	130	24	351
1989	92	100	79	81	19	371
1990	56	121	87	94	10	368
1991	38	99	122	110	13	382
1992[c]	44	54	58	82	7	245

[a] Data from WIDB files, fall 1993.

[b] Considered yearling bulls.

[c] Antler size categories <30", 30-39", 40-49", 50"+.

Table 8. Moose hunter success by residency, Subunit 20A, 1984-92.

	Successful					Unsuccessful							
Year	Local Res[a]	Other Res	Non Res	Unk Res	Total	Local Res[a]	Other Res	Non Res	Unk Res	Total	Total Hunters	Manager	Type
1984	292	45	53	2	392	680	72	59	10	821	1,213	State	Harvest ticket data
1985	279	40	41	2	362	729	102	27	11	869	1,231	State	Harvest ticket data
1986	305	59	51	5	420	736	101	55	5	897	1,317	State	Harvest ticket data
1987	216	41	43	2	302	639	102	32	7	780	1,082	State	Harvest ticket data
1988	235	61	52	3	351	528	106	49	3	686	1,037	State	Harvest ticket data
1989	273	46	53	1	373	612	85	58	11	766	1,139	State	Harvest ticket data
1990	257	43	61	9	370	651	122	52	15	840	1,210	State	Harvest ticket data
1991	264	62	48	8	382	566	148	48	10	772	1,154	State	Harvest ticket data
1992	150	51	32	13	246	549	113	59	15	736	982	State	Harvest ticket data

[a] Resident of Unit 20.

Table 9. Moose hunter effort and antler spread of bulls, Subunit 20A, 1984-92.

	Successful				Unsuccessful			Total				
Year	Hunters	Hunt Days	Average Days	Average Antler Spread	Hunters	Hunt Days	Average Days	Hunters	Hunt Days	Average Days	Manager	Type
1984	392	2,438	6.2	42.0	821	4,859	5.9	1,213	7,297	6.0	State	Harvest ticket data
1985	362	2,334	6.4	41.6	869	5,145	5.9	1,231	7,479	6.1	State	Harvest ticket data
1986	420	2,498	5.9	40.3	897	5,454	6.1	1,317	7,952	6.0	State	Harvest ticket data
1987	302	1,853	6.1	41.3	780	4,927	6.3	1,082	6,780	6.3	State	Harvest ticket data
1988	351	2,104	6.0	43.5	686	4,078	5.9	1,037	6,182	6.0	State	Harvest ticket data
1989	373	2,179	5.8	37.7	766	4,742	6.2	1,139	6,921	6.1	State	Harvest ticket data
1990	370	2,516	6.8	39.3	840	4,921	5.9	1,210	7,437	6.1	State	Harvest ticket data
1991	382	2,547	6.7	42.0	772	4,761	6.2	1,154	7,308	6.3	State	Harvest ticket data
1992	246	1,349	5.5	41.0	736	4,645	6.3	982	5,994	6.1	State	Harvest ticket data

Table 10. Distribution of moose harvested in Subunit 20A, 1990-92.

Location	Uniform coding units	Number of moose harvested			
		3-Year mean (1990-92)	1990	1991	1992
Tanana Flats					
W. of Wood R. drainage	(0100, 0101, 0201, 0301)	48	45	66	32
Wood R. drainage	(1/2 of 0400, 0401)	32	39	37	19
E. of Wood R. drainage and W. of Little Delta R. drainage	(0500-0504, 0506, 1/2 of 0507, 0185)	96	117	98	73
E. of and including Little Delta R. drainage	(0601, 0701, 0800, 0801)	23	22	25	23
Foothills					
W. of Tatlanika drainage, N. of Yanert drainage[a]	(0102-0105, 0200, 0202)	40	35	53	33
Tatlanika R., Wood R. and Dry Creek drainages	(0300, 0302, 1/2 of 0400, 0402-0405, 0505, 1/2 of 0507)	42	52	45	30
E. of Dry Creek drainage	(0600, 0602-0605, 0702, 0802, 0700)	27	27	34	19
Yanert R. drainage[a]	(0106-0109)	12	13	13	10
Total Tanana Flats		199 (60%)	223	226	147
Total Foothills		121 (36%)	127	145	92
Unknown in Subunit 20A)	(0000)	12 (4%)	18	11	7
Total Subunit 20A		332	368	382	246

[a] Bag limit restricted to spike-fork or ± 50-inch antlered bulls in the Yanert Controlled Use Area and Ferry Trail Management Area.

Table 11. Percentage of harvest and success rates by residency, Subunit 20A, 1988-92.

	% of harvest taken by:			Success Rates			
				Residents		Nonresidents	
	Alaska	Local					
Year	Resident	Resident[a]	Nonresident	No.	% Success	No.	% Success
1988	84	67	15	930	32	101	51
1989	85	73	14	1,016	31	111	48
1990	81	69	16	1,073	28	113	54
1991	85	69	13	1,040	31	96	50
1992	82	61	13	863	23	91	35

[a] Resident of Unit 20.

Table 12. Transportation types used by successful moose hunters in Subunit 20A, 1984-92.

Year	Percentage of successful hunters								Total no. successful hunters	Manager	Type
	Airplane	Horse/ dogteam	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk			
1984	34.7	6.1	28.6	7.1	0.0	10.7	8.7	4.1	392	State	Harvest ticket data
1985	36.5	6.6	30.7	6.6	0.0	11.3	3.3	5.0	362	State	Harvest ticket data
1986	38.8	6.0	26.7	6.7	0.0	11.4	5.2	5.2	420	State	Harvest ticket data
1987	32.8	4.6	25.2	11.3	0.0	12.3	6.6	7.3	302	State	Harvest ticket data
1988	37.9	5.1	24.8	8.8	0.0	12.0	5.1	6.3	351	State	Harvest ticket data
1989	29.2	5.1	36.7	9.4	0.0	10.2	5.9	3.5	373	State	Harvest ticket data
1990	37.0	6.2	31.4	9.5	0.0	8.6	4.3	3.0	370	State	Harvest ticket data
1991	33.5	5.5	28.8	14.1	0.0	9.9	5.0	3.1	382	State	Harvest ticket data
1992	32.9	3.7	26.8	15.9	1.6	10.2	7.3	1.6	246	State	Harvest ticket data

Table 13. Number of moose killed by nonhunting mortality in Subunits 20A or 20C, and reported to Fish and Wildlife Protection (Fairbanks), 1989-90 to 1993-94. Parentheses indicate number by end of December.

Regulatory Year	MVA	Train	Poach	DLP	Other	Total
1988-89		25 (10)				
1989-90	13 (3)	62 (14)	0	1 (0)	2 (0)	78 (17)
1990-91	15 (8)	73 (18)	0	1 (1)	3 (0)	92 (27)
1991-92	7 (3)	15 (1)	0	0	0	22 (4)
1992-93	10 (5)	38 (7)	0	0	0	48 (12)
1993-94[a]	-- (5)	-- (1)	-- (1)	-- (0)	-- (0)	(7)

[a] Preliminary data.

LOCATION

Game Management Unit: 20B (9,114 mi^2)

Geographical Description: Drainages into the north bank of the central Tanana River

BACKGROUND

As McNay (1993) summarized, moose numbers increased in Subunit 20B throughout the 1950s and early 1960s after extensive wildfires improved moose habitat and federal predator reduction programs reduced wolf predation on moose. Moose numbers declined following severe winters in 1965, 1970, and 1974. Increasing wolf predation and liberal either-sex hunting seasons contributed to the moose population decline. By 1976, moose densities were low and the hunting season had been reduced to 10 days in most of Subunit 20B. But moose populations again increased following wolf reduction programs in Subunits 20A (1976-82) and 20B (1980-86). Hunting seasons were extended from 10 days in 1981 to 20 days from 1983 to 1987. Reported harvests increased to approximately 300 bulls per year from 1983 to 1986. Harvests increased further from 377 bulls in 1987 and 1988 to 493 in 1992, despite a 5-day reduction in the season.

Demand for moose hunting opportunities is high and increasing in Subunit 20B. Extensive road systems and trails provide overland access, and numerous waterways such as the Tolovana, Tatalina, Chatanika, Goldstream, Salcha, and Chena Rivers provide boat access.

There are two permit moose hunts in Subunit 20B, one in the Minto Flats Management Area (MFMA) and one in the Fairbanks Management Area (FMA) (Fig. 1). The MFMA was established in 1979 to restrict harvest in a low density moose population and has been open to hunting only by registration or Tier II permit since then. In 1988, the Alaska Legislature established the Minto Flats State Game Refuge to ensure 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 500,000 acres of the Minto Flats area. The Minto Flats moose subpopulation was last surveyed in 1989.

The FMA was established in 1983 to provide moose hunting opportunities around the Fairbanks urban area by bow and arrow only. The area was closed to hunting in the late 1970s and early-1980s. Although boundaries of the FMA have changed several times, the FMA currently includes 217 mi^2, with about 50 mi^2 heavily inhabited by people, and 167 mi^2 of moose habitat. Since 1990, moose hunting in the FMA has been by registration permit only, with a requirement for permittees to have completed the International Bowhunter Education Program (IBEP) and a proficiency test. Even though harvest is generally low (less than 30 bulls per year), this hunt is very popular, with over 500 permits issued in 1993.

For management purposes Subunit 20B has been divided into three geographic zones: 20B West (3,955 mi^2), roughly west of a line from Fairbanks along the Elliott Highway to Washington Creek then north, 20B East (2,392 mi^2) including the Little Salcha and Salcha River drainages, and 20B Central (2,741 mi^2), the remainder. The 20B Central boundary is shifted westward in this report. Game Management Unit boundaries changed in 1981, increasing the size of Subunit 20B and creating Subunit 25C. Prior to 1981, the eastern and western portions of present-day Subunit 20B and all of Subunit 25C were considered part of Subunit 20C.

MANAGEMENT DIRECTION

Management Goals

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide for continued subsistence use of moose by Alaska residents who have customarily and traditionally used the population.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.
- Protect human life and property in human-moose interactions.

Management Objectives

- Manage for a population of 10,000 moose older than calves by 1993: 4,000 in Subunit 20B West and 6,000 distributed over Subunits 20B Central and 20B East.
- Manage for a minimum bull:cow ratio of 20:100 in each count area and an overall Subunit 20B bull:cow ratio of at least 30:100.
- Sustain an annual harvest of 300-400 bulls in Subunit 20B until the population objective is reached.

METHODS

Although weather is not normally discussed in these reports, weather during this reporting period was unusual and worth reporting. We obtained data on snowfall and other weather from the National Weather Service to evaluate the potential impact on moose populations.

We did not complete any population estimation surveys in Subunit 20B during this reporting period. We completed a survey of 51.9 mi^2 in the FMA (approximately 31% of moose habitat in the FMA) on 18 November 1993 to collect composition data. Standard survey techniques were used to avoid disturbing people; we did not always make low-level passes to classify moose. We compared these data with the subset of the area last surveyed in 1989 that corresponded to the same area.

Registration permits for hunting moose in the FMA were issued at the department office in Fairbanks. Tier II permits for moose hunting in the MFMA were issued by the department office in Anchorage but administered at the Fairbanks office.

We estimated harvest based on harvest report cards summarized in the Wildlife Information Database (WIDB) (distributed in fall 1993). This included data from report cards from the general season, the FMA registration hunt, and the MFMA Tier II permit hunt. One reminder letter was sent to nonreporting general season hunters through a statewide mail-out, and up to two reminder letters were sent to permit holders who failed to report. We considered bulls with antler spreads of <30 inches to be yearlings (results may differ from previous years because of using a cutoff of £30 inches). Results from the federal subsistence hunting season were not included in these results unless specifically noted.

The boundary between 20B West and 20B Central was the Elliott Highway from Fairbanks to Washington Creek and then north. However, because the Elliott Highway bisects Uniform Coding Units (UCUs), and several UCUs are more similar in habitat and hunting pressure to 20B Central, I moved the boundary westward so that 20B Central now includes the area east of Minto Flats and south of Washington Creek (Fig. 2).

We estimated mortality from poaching, and collisions with motor-vehicles and trains from Department of Public Safety records, Alaska Railroad records, and public reports of winter-killed moose along roadways and on private property. We created a computer database containing all substantiated reports of moose mortality.

Progress on development of the superstratification technique discussed in McNay (1993) is discussed in the Subunit 20A moose management report.

RESULTS AND DISCUSSION

Weather

Unusual weather likely influenced many aspects of moose population dynamics during the last few years and is worth summarizing. Winter of 1990-91 had the highest snowfall on record in Fairbanks (147.3 inches), exceeding the previous record in 1970-71 (145.7 inches) and was closely followed by 1992-93 (139.1 inches) (National Weather Service, pers. commun.). These record snowfalls are well over twice as high as the long-term average (68 inches). Based on a winter severity index that considers the duration of deep snow, however, the long winter of 1992-93 was slightly more severe (5.0) than 1970-71 (4.9), but still lagged behind 1990-91 (5.3) (Boertje *et al.* 1993).

Summer 1992 was probably the shortest on record. It was bracketed with snowfall in mid-May, then 24 inches of snowfall (3 times the previous record) and cold temperatures (13° colder than previous record) in September. The early cold temperatures resulted in the deciduous trees not completing abscission and instead retaining their foliage throughout the winter. Snowfall was highest through December, but by the end of January many ridgetops in the Alaska Range were blown free and the severity of the winter tapered off. In contrast, 1993 was likely the longest summer on record, with an early spring leafout, warm summer, and late fall.

Boertje (1993) noted that moose, in general, are very well adapted to deep snow. However, deep (>35 inches), soft snow endured for several months has caused significant declines in moose populations where moose density was high (3-4+ moose/mi^2 in large areas for several years prior to deep snow). Examples have occurred in recent decades in Units 13, 14, 15, and 20A. Declines occur most notably from a loss of calves and old adults. In areas with excellent habitat and few wolves per moose (50-100 moose/wolf), moose populations have recovered quickly from declines caused by deep snow. Boertje noted that we have no documentation in Alaska that low or moderate-density moose populations decline significantly in deep snow.

Population Status and Trend

Population Size:

The 1990 overall Subunit 20B moose population was estimated to include 9,800 moose (about 1.1 moose/mi^2): 3,400 in 20B West, 4,200 in 20B Central, and 2,200 in 20B East (McNay 1993). Excluding calves, this included approximately 7,600 adult moose: 2,500 in 20B West, 3,300 in 20B Central, and 1,800 in 20B East. At that time, the moose population was increasing and expected to reach the objective of 10,000 adult moose (excluding calves) by 1993. Because of changes in priorities, we have been unable to complete surveys planned to verify population status in Subunit 20B since then.

Of these 9,800 moose, approximately 150-200 (about 1 moose/mi^2) overwinter in the FMA, and approximately 1,600 (1.6 moose/mi^2) overwinter in the MFMA (1989).

Population Composition:

Bull:Cow Ratios. In 1990, McNay (1993) estimated that the overall Subunit 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 subunit. For instance, the less intensively harvested Salcha River and Minto Flats had 44:100 (1990) and 49:100 (1989), respectively. In contrast, the more intensively harvested Chena River had 28:100 (1990), and the most intensively harvested FMA had only 9-13:100 (1989, 1993).

During the last two surveys bull:cow ratios in the FMA (13:100 in 1989, 9:100 in 1993) have been far below our objective of at least 20:100 . Hunting pressure during the fall, prior to our surveys, is very high and most bulls killed are yearlings. Therefore, low yearling bull:cow ratios observed during the same surveys (10:100 in 1989, 4:100 in 1993) do not necessarily reflect poor calf recruitment from the previous year, but result in part from the high proportion of yearlings killed in September.

Calf:Cow Ratios. Fall calf recruitment was higher in Minto Flats (56:100 in 1989) than in the Chena (36:100 in 1990) and Salcha (35:100 in 1990) drainages. Short-yearling:cow ratios in May 1990 on the Minto Flats (36:100) suggested moderate overwinter survival of calves during winter 1989-90. The fall calf:cow ratio in the FMA was good in 1989 (42:100) and moderate in 1993 (30:100). The relatively small area surveyed makes inferences from these FMA data difficult.

Incidence of twinning was also much higher during November moose surveys in Minto Flats (20%) than in the Chena (3%) or Salcha drainages (5%).

Fall composition counts were not taken in Subunit 20B during fall 1991, but a census was conducted on the Tanana Flats in adjacent Subunit 20A. Although calf:cow ratios and yearling bull:cow ratios were lower in 1991 than in 1988, there was no evidence of widespread adult mortality or of a population decline resulting from the severe winter of 1990-91. With the exception of the immediate Fairbanks area, McNay (1993) did not believe winter 1990-91 resulted in significant winter-related mortality among Subunit 20B moose.

Distribution and Movements:

The moose population is distributed throughout Subunit 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 Subunit 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 moose. Therefore, the summer densities in Subunit 20B are probably much lower than during winter.

Mortality

Harvest:

Season and Bag Limit. Seasons and bag limits for moose hunting in Subunit 20B during regulatory years 1990-91 through 1993-94 are summarized in Table 1.

Game Board Actions and Emergency Orders. In fall 1992, the Joint Boards of Fisheries and Game established the Fairbanks Nonsubsistence Area, which, in Subunit 20B, roughly included my revised boundaries for 20B Central and East. The Joint Boards concluded (Finding 92-24-JB) that dependence upon subsistence is not a principal characteristic of the economy, culture, and way of life in this area. No subsistence hunting or fishing regulations are permitted within a nonsubsistence area. However, in October 1993, a Superior Court judge declared the nonsubsistence area portion of the 1992 Subsistence Law invalid. The state is currently appealing the decision.

Following the Joint Board meeting, the Board of Game (BOG) adopted the department's draft Area Specific Wolf Management Plan for Southcentral/Interior Alaska, which the department drafted after extensive public review. The plan outlined population and harvest objectives for big game species and zoned the entire area 7 management zones, based on the intensity of human use and management. This action was later rescinded, so it will not be elaborated on in this report.

In the MFMA, the department issued 150 Tier II permits per year from 1990-91 through 1992-93 to provide for an annual harvest quota of 50 bulls. However, harvests only ranged from 28-42 per year. In spring 1993, we calculated a new harvest quota of 100 bulls and recommended that the BOG authorize us to issue up to 250 permits. The BOG passed our recommendation and the department issued 200 permits in 1993-94.

Harvest by Hunters. The total reported harvest of moose in Subunit 20B (general and permit seasons combined) was within our harvest objective (300-400 bulls per year) from 1984-88 (305-377) (Table 2). However, harvests exceeded our objective from 1989 to 1991 (429-493). Harvest in 1992 (346) declined to within our objective, but was likely artificially low because of record snow in September. I expect harvests in the future to be closer to the 1987-91 mean of 423 bulls, which exceeds our objective. Additionally, if approximately 83% of the successful hunters reported (Gasaway *et al.* 1983), the actual mean harvest would be closer to 500 bulls.

The age distribution of the harvest is reflected by antler spread. In the general season area, the age distribution was relatively even, but skewed toward younger bulls (<40 inch antlers) (Table 3). In the FMA, where hunting pressure is high, most bulls harvested in 1991 and 1992 (61-75%) were yearlings (<30 inch antlers). In 1993, there were substantially fewer yearlings (42%) represented in the harvest. Very little of the harvest (10% or less) included bulls older than about 3 years. In the MFMA, where hunting pressure is relatively low, there was a more even distribution of the harvest among the four antler categories.

General Season. In the general season, reported harvests have ranged from 299-429 bulls per year since 1984. The 1992 harvest was only 71% of the 1987-91 mean of 391 bulls.

FMA. In the FMA, the demand for moose hunting continues to be very high. The number of hunters registering to hunt moose in the FMA has risen steadily from 333 (1991), to 452 (1992), to 546 (1993). Similarly, the number of permittees actually hunting increased from 260 to 316, to 363 during the same period. Conversely, the number of IBEP cards issued in the FMA decreased from 257 (1990) to 195 (1992), to 156 (1992) and indicates a high proportion of bowhunters have now completed the course. At some point, the demand for IBEP classes will somewhat stabilize as it deals primarily with newcomers to the area and new bowhunters.

The number of moose harvested in the FMA ranged from 23-28 bulls/year from 1990-92, then nearly doubled to 41 bulls in 1993. Only 2-6 bulls/year have been taken during the winter (21-27 Nov) season. Most harvested bulls have been yearlings, including 61% (17/28) in 1991, 75% (15/20) in 1992, and 42% (17/40) in 1993 (only includes bulls with antler information reported).

MFMA. Moose hunting in the MFMA has also been increasingly popular in recent years, with 361 eligible applicants for 150 Tier II permits in 1992 (41% received permits). When the Tier II hunt was established in 1990, the harvest quota was 50 bulls/year. This quota was approximately 3% of the population, would allow for 6% growth, and did not adversely affect bull:cow ratios. Reported harvest has been below that quota, but has steadily increased from 21 in 1990 to 42 in 1992 (31 through 17 Jan 1994). Usually, less than 8 moose per year are harvested in the winter season. However, the high harvest in 1992 was partly due to the high number of bulls (20) taken during the late season. Permittees in 1992 may have chosen to postpone their hunt until winter rather than hunting during the record snowfall and cold temperatures of September 1992.

Distribution of Harvest. Harvest distribution from the 1990 to 1992 general seasons is listed in Table 4. Because drainages vary widely in the area, I calculated a "harvest density" to compare drainages. This density does not consider differences in moose population sizes between areas and is somewhat clouded in areas that include parts of permit hunts. However, I have included mean harvest from permit hunts in the subtotals to compensate for this problem.

As expected, 20B Central had a higher harvest density (6 bulls/100 mi^2) than 20B West or Central (both 4/100). Based only on general season data, the highest harvest densities occur in the Moose Creek/French Creek area by Eielson Air Force Base (14/100) and the Bonanza Creek/Rosie Creek area west of Fairbanks (9/100). Approximately 20 bulls per year are taken from the Middle Fork of the Chena and Upper Salcha drainages combined. These two drainages had the lowest harvest densities (1 bull/100 mi^2) and can continue to support the 5-day longer season, compared to the remainder of the general season portion of the subunit.

<u>Hunter Residency and Success</u>. Since 1984, most (84-91% per year) of the moose hunters in the general season were local residents (residents of Unit 20) (Table 2). Participation by nonlocal residents and nonresidents was relatively low (3-9% and 4-8%, respectively).

Since 1987, approximately 5% of the MFMA permittees have been "nonlocals," or non residents of Unit 20. In 1992-93, most permittees were from the Fairbanks vicinity (69%), and the Minto, Nenana, Manley area (23%), with a few (8%) from the MatSu Valley, Anchorage area, or Kenai Peninsula (Table 5). The proportion of successful hunters from these three areas was 76%, 14%, and 10%, respectively.

Hunter success is generally lower in Subunit 20B than elsewhere in Unit 20. Since 1984, only 14-18% of the general season hunters per year have been successful (Table 6). Many Fairbanks residents obtain harvest tickets, but hunt only along the road system where hunting pressure is high and the number of bulls is limited. The FMA has even lower hunter success rates (7-11%), but has provided hunters with lots of hunting opportunity (2,437 hunter days in 1992) (Table 7). In the MFMA, success rates have been much higher (15-43% since 1987) than elsewhere in Subunit 20B, with the highest success in recent years (43% in 1991, 39% in 1992).

<u>Harvest Chronology</u>. As in other Interior areas, the declining availability of bull moose toward the latter part of the season is compensated by higher success rates resulting from leaf drop and increased activity of bulls in mid-September.

<u>Transport Methods</u>. Airplane access, which is a significant means of access in many other Interior subunits, has been used by less than 5% of the Subunit 20B general season successful hunters since 1984 (Table 8). Instead, highway vehicles were the primary method of transportation for 40-50% of the successful hunters. The use of highway vehicles, as expected, was pronounced in the FMA where 70% of successful hunters used highway vehicles as their primary transportation in 1992 (no transportation data before

then). In the MFMA, boats were the most common transportation except in 1992 when, due to record snow and cold in September, 45% of the successful hunters used snowmachines and only 38% used boats.

Other Mortality:

During the last 5 years, we have been collecting more systematic information on nonhunting mortality of moose because of its potential influence on harvest quotas and population trends. For instance, during 1990-91, which had the deepest snowfall on record, we documented 204 moose that died of human-related causes in Subunit 20B: 111 moose killed in motor vehicle accidents, 70 killed by trains, 19 killed in defense of life and property, and at least 4 poached (Table 9). In addition, we documented 52 other moose kills, many of which were starvation related.

The fall 1993 wolf population in Subunit 20B was estimated to include 150-225 wolves in 20-30 packs, and the wolf is probably the most important predator for moose in this subunit.

Habitat Assessment/Enhancement

Several proposed large-scale projects may affect moose habitat in Subunit 20B. The Division of Foresty (Department of Natural Resources) has proposed substantial increases in timber harvests in the Tanana Valley State Forest and on adjacent state lands classified for forest management, and some Native land owners have expressed interest in cooperative ventures with the state to enhance timber harvests. The proposed Fort Knox gold mine is located approximately 15 miles northeast of Fairbanks near Cleary Summit. The mine will be the largest ever opened in Alaska and will include an open pit mine and associated mill structures, waste rock dumps, a tailings dam, and a freshwater dam within the Fish Creek drainage.

Nonregulatory Management Problems/Needs

The U.S. Air Force (USAF) plans to change temporary military operating areas to permanent ones. In Subunit 20B, this would affect a large portion of the upper Chena and Salcha drainages. The effects on moose of the additional low-flying sorties and supersonic noise are unknown, but should be fully considered and concerns relayed to the USAF.

The number of moose killed in accidents with motor vehicles and trains has been substantial in some years. Staff should work with Department of Transportation (DOT) and the Alaska Railroad to modify road designs, add fences, clear right-of-ways, etc. to help minimize this mortality.

Within the Fairbanks urban area, we also receive a considerable number of complaints about human-moose conflicts, such as moose in gardens or yards, moose stomping dogs along dogsled trails, and moose "trapped" within the confines of the urban area.

CONCLUSIONS AND RECOMMENDATIONS

It is unlikely that the November 1993 Subunit 20B moose population included our objective of 10,000 adults. To have met this objective, the population would have had to grow at a mean annual rate of at least 9% since our last estimate in 1990. The annual growth rate between 1985 (5,700 adults) and 1990 (7,600 adults) was approximately 7% per year. Winters have been more severe since 1990. A significant increase in motor vehicle- and train-caused moose mortality occurred during the deep snow winters of 1989-90 and 1990-91. In addition, natural mortality from winter-induced starvation also increased in the immediate Fairbanks area. Moose population growth was probably suspended during 1990-91 because of high calf and yearling overwinter mortality, but McNay (1993) did not believe the adult segment of the Subunit 20B moose population was substantially affected. We recommend replacing this objective with one that reads, "To estimate the Subunit 20B moose population size by 1995, using revised boundaries for 20B East and 20B Central."

We are unable to determine whether we are meeting our objectives for bull:cow ratios throughout Subunit 20B because during this reporting period we only completed composition counts in the FMA. Bull:cow ratios in the FMA have been below our objective of at least 20:100 in each count area during the last two surveys (13:100 in 1989, 9:100 in 1990).

The FMA registration hunt continues to receive a high degree of interest and participation. During the next reporting period we plan to discuss moose management options with the public to determine whether the current objectives reflect their desires. First, does the public want the FMA moose population to increase, thereby providing more hunting and viewing opportunities? Or do they want the population to decrease, thereby reducing human-moose conflicts such as motor vehicle accidents or moose in gardens? Second, if the public wants us to increase the bull:cow ratio, are they interested in antler restrictions, cow seasons, or limited permit hunts? Because many bulls harvested in the FMA are transients, it is difficult to measure the effect of high-localized harvest on the larger population of moose. I recommend adding the following goals/objectives for the FMA:

- Determine a moose population size and composition that is acceptable to the public.
- Provide opportunities to hunt moose.
- Provide opportunities to view and photograph moose.
- Minimize human-moose conflicts.

Although the 1992-93 harvest was within our objective of 300-400 bulls per year (346), harvest exceeded this quota during the previous 3 years (429-493). Record snow and cold in September 1992 was probably responsible for the drop in harvest, but is not likely to limit harvest again soon. We will examine harvest data more thoroughly and make recommendations for changes in hunting regulations, if necessary, for the spring 1995 BOG meeting.

The next opportunity to recommend changes in seasons and bag limits for moose will be in spring 1995. McNay (1993) recommended the Subunit 20B general 1-15 September moose season be extended by 5 days if surveys confirm an increasing trend. I recommend surveys be conducted in November 1994 to determine population status in Subunit 20B.

Harvest in the upper Salcha drainage, where the season is 5 days longer than the surrounding area, will also be monitored to ensure that the longer season is still appropriate. Harvest jumped from 14 in 1990 to 27 in 1991.

Other questions that relate to moose in Subunit 20B and deserve attention the next reporting period include (not prioritized):

1. What are the likely effects of increased timber harvests on moose habitat?
2. What are the effects of a large-scale pit mine, such as Fort Knox, on the moose population and distribution. Possible projects may include censusing 20B Central, and radio-collaring moose wintering in the Fort Knox vicinity to establish baseline movement data to compare to postdevelopment movement.

3. How would changing the temporary military operating areas into permanent military operating areas affect moose populations? Possible projects include reviewing the literature regarding effects of low-flying supersonic aircraft on wildlife behavior and working with the USAF to document any effects.

4. How can we plan for moose wildlife in the Fairbanks urban area, while minimizing human-moose conflicts? Possible projects include:

   - Determine the feasibility of establishing wildlife corridors through Fairbanks to facilitate the migration of moose from the foothills to the Tanana Flats.
   - Report on the extent and location of moose mortality due to accidents with motor vehicles and trains.
   - Work with DOT to design roads to minimize moose-vehicle collisions and maximize the opportunity for moose to successfully migrate to and from their calving grounds.

- Prepare a public-awareness campaign to help people avoid conflicts with moose (motor vehicle accidents, moose in gardens, moose threatening dogs and humans on trails).

5. What are the movement patterns of moose residing in the FMA? Possible projects include radiocollaring bull moose in the FMA in fall to document where they are during our November moose surveys.

6. How productive are the female moose in Subunit 20B? Possible projects include determining in utero twinning rates from cows killed in motor vehicle accidents, conducting parturition surveys, and collaring short-yearling cows to determine age at first calving.

7. Is the Tier II season in the MFMA providing the maximum sustainable harvest?

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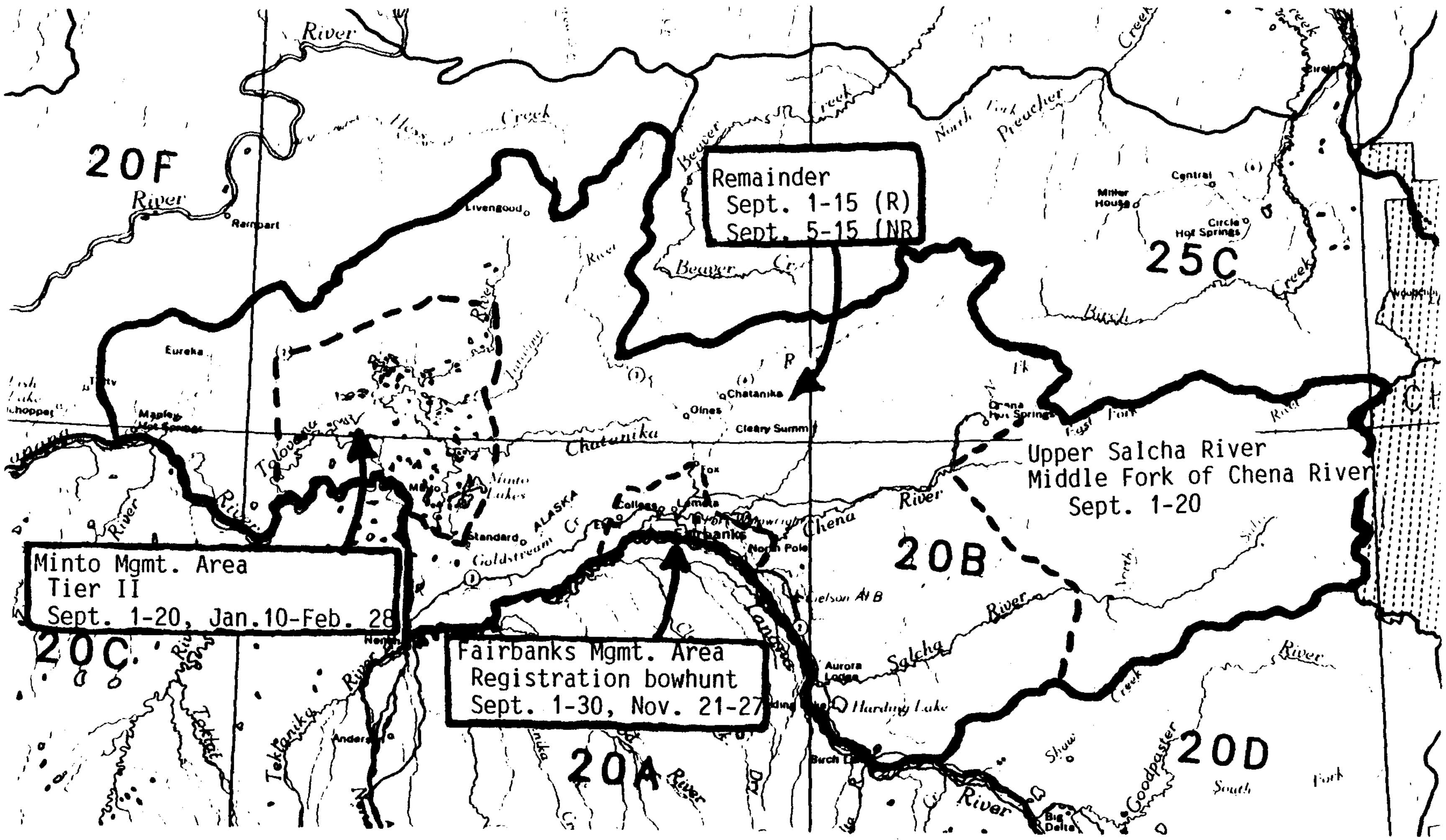

Fig. 1. Moose hunting seasons in Subunit 20B, 1990-91 through 1993-94.

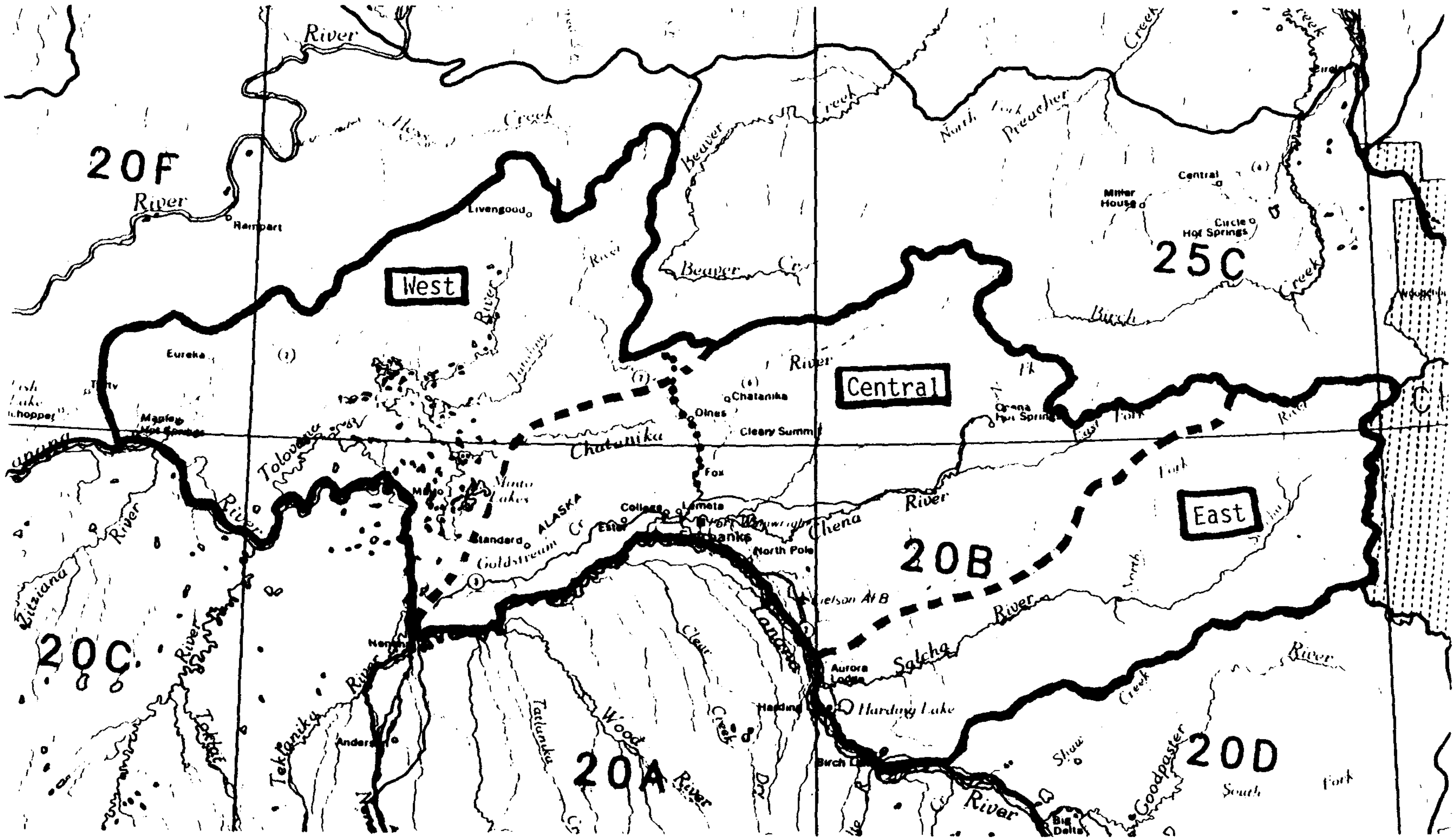

Fig. 2. Current boundaries of Subunit 20B West, 20B Central, and 20B East. (Dotted line indicates previous boundary between 20B Central and East).

Table 1. Moose hunting seasons in Subunit 20B, 1991-92 to 1993-94.

Regulatory year	Area	Resident	Nonresident	Bag Limit
1991-92, 1992-93, and 1993-94	Fairbanks Mgmt. Area	1-30 Sept., 21-27 Nov.	1-30 Sept., 21-27 Nov.	1 bull by bow and arrow only by registration permit
	Minto Flats Mgmt. Area	1-20 Sept., 10 Jan.-28 Feb.	None	1 bull by Tier II permit only. Up to 150 permits may be issued.[a]
	Middle Fork drainage of Chena River, and Salcha River drainage upstream from and including Goose Creek.	1-20 Sept.	1-20 Sept.	1 bull
	Remainder of Subunit 20B	1-15 Sept.	5-15 Sept.	1 bull

[a] In 1993-94, up to 250 permits could be issued and 200 permits were issued.

Table 2. Moose hunting success in Subunit 20B, 1984-92.

	Successful					Unsuccessful							
Year	Local Res	Other Res	Non Res	Unk Res	Total	Local Res	Other Res	Non Res	Unk Res	Total	Total Hunters	Manager	Type
All harvest sources combined													
1984	293	17	22	1	333	1,720	61	145	7	1,933	2,266	State	All harvest sources combined
1985	271	17	15	2	305	1,611	73	154	14	1,852	2,157	State	All harvest sources combined
1986	296	9	12	2	319	1,585	64	110	14	1,773	2,092	State	All harvest sources combined
1987	317	42	16	2	377	1,502	142	108	24	1,776	2,153	State	All harvest sources combined
1988	341	18	16	2	377	1,644	83	63	15	1,805	2,182	State	All harvest sources combined
1989	383	21	21	4	429	1,652	91	143	14	1,900	2,329	State	All harvest sources combined
1990	371	31	8	29	439	1,699	114	82	294	2,189	2,628	Combined	All harvest sources combined
1991	393	43	17	40	493	1,988	115	93	255	2,451	2,944	Combined	All harvest sources combined
1992	297	25	15	9	346	2,059	131	179	55	2,424	2,770	Combined	All harvest sources combined
Harvest tickets													
1984	286	17	22	1	326	1,708	59	145	6	1,918	2,244	State	Harvest ticket data
1985	265	17	15	2	299	1,599	73	154	14	1,840	2,139	State	Harvest ticket data
1986	288	9	12	2	311	1,534	64	110	14	1,722	2,033	State	Harvest ticket data
1987	301	42	16	2	361	1,463	142	108	24	1,737	2,098	State	Harvest ticket data
1988	324	17	16	2	359	1,596	83	63	15	1,757	2,116	State	Harvest ticket data
1989	372	21	21	4	418	1,590	91	143	14	1,838	2,256	State	Harvest ticket data
1990	343	31	8	5	387	1,646	107	82	36	1,871	2,258	State	Harvest ticket data
1991	359	41	17	12	429	1,943	110	93	24	2,170	2,599	State	Harvest ticket data
1992	229	24	15	9	277	1,726	114	166	53	2,059	2,336	State	Harvest ticket data
Minto Management Area													
1984	7	0	0	0	7	12	2	0	1	15	22	State	Registration permit hunt 0985
1985	6	0	0	0	6	12	0	0	0	12	18	State	Tier II permit hunt 0985

Table 2. Continued.

Year	Successful Local Res	Successful Other Res	Successful Non Res	Successful Unk Res	Successful Total	Unsuccessful Local Res	Unsuccessful Other Res	Unsuccessful Non Res	Unsuccessful Unk Res	Unsuccessful Total	Total Hunters	Manager	Type
1986	8	0	0	0	8	51	0	0	0	51	59	State	Registration permit hunt 0985
1987	16	0	0	0	16	39	0	0	0	39	55	State	Registration permit hunt 0985
1988	17	1	0	0	18	48	0	0	0	48	66	State	Registration permit hunt 0985
1989	11	0	0	0	11	62	0	0	0	62	73	State	Registration permit hunt 0985
1990	21	0	0	0	21	48	7	0	0	55	76	State	Tier II permit hunt 0985
1991	34	2	0	0	36	43	5	0	0	48	84	State	Tier II permit hunt 0985
1992	41	1	0	0	42	64	2	0	0	66	108	State	Tier II permit hunt 0985
1990	7	0	0	1	8	5	0	0	0	5	13	Federal	Registration permit hunt 0920
1991	0	0	0	0	0	1	0	0	0	1	1	Federal	Registration permit hunt 0920
1992	4	0	0	0	4	6	0	0	0	6	10	Federal	Registration permit hunt 0980
Fairbanks Management Area bowhunt													
1990	0	0	0	23	23	0	0	0	258	258[a]	281	State	Registration permit hunt 0986
1991	0	0	0	28	28	1	0	0	231	232	260	State	Registration permit hunt 0986
1992	23	0	0	0	23	263	15	13	2	293	316	State	Registration permit hunt 0986

[a] Hunters were required to obtain a separate permit for fall and winter seasons. Therefore, total unsuccessful includes duplicate counts of some individuals.

Table 3. Antler spread of moose harvested in Subunit 20B, 1988-92.

Hunt	Reg. Year	% of Moose Harvested by Antler Spread[a] < 30"	30-39"	40-49"	50"+	No. of moose[b]
General Season	1988	36	36	17	11	312
	1989	35	39	17	9	397
	1990	24	37	18	20	371
	1991	27	28	21	23	397
	1992	33	30	20	17	255
Fairbanks Mgmt. Area	1990	38	62	0	0	16
	1991	61	29	7	4	28
	1992	75	15	10	0	20
	1993[c]	42	48	10	0	40
Minto Mgmt. Area	1990	5	20	20	30	20
	1991	24	31	21	24	29
	1992	26	26	26	22	27
	1993[c]	14	39	18	29	28

[a] Percent of moose with known antler spread.

[b] Only includes moose with antler spreads reported.

[c] Preliminary data as of 26 January 1994.

Table 4. Distribution of moose harvested in the general season in Subunit 20B, 1990-92.[a]

Location	UCU[b]	Area (mi²)	Number of moose harvested 3-year mean (1990-92)	1990-91	1991-92	1992-93	Harvest density (harvest/100 mi²)
20B West							
Tolovana drainage	0201-0204, 281	1,363[c]	23	19	33	18	2[c]
Tatalina, Washington Cr., Chatanika (in flats)	0205-0207	757[c]	20	17	25	17	3[c]
Goldstream (in flats)	0210	217[c]	5	9	3	4	2[c]
Manley, Baker Cr.	0100s	746	25	23	36	17	3
Unknown 0200, Unknown Elliott Hwy.	0200, 0088	--	8	15	2	6	--
Subtotal 20B West		3,083	81 (114)[d]	83	99	62	3 (4)[d]
20B Central							
Chatanika R. (upper), Steese Hwy.	0209, 0286-0287	426	21	14	39	9	5
Chatanika R. (lower)	0208	353	19	30	14	12	5
Unknown Chatanika	0214	--	5	3	1	12	--
Goldstream (remainder)	0085, 0211-0213, 0285, 0487	444[c]	20	18	23	20	5[c]
Bonanza Cr./Rosie Cr.	0300s	127	12	13	14	9	9
Chena R. (middle fork)	0405	514	6	6	5	8	1
Chena R. (remainder)	0400-0404, 0406, 0486	1,573[c]	96	104	100	83	6[c]
Moose Cr., French Cr.	0500s	200	29	32	37	19	14
Subtotal 20B Central		3,637	208 (233)[d]	220	233	172	6 (6)[d]
20B East							
Salcha (lower), Little Salcha	0601-0602, 0684	893	43	41	60	27	5
Salcha (upper)	0603-0605	1,508	14	14	27	2	1
Unknown Salcha	0600	--	9	18	3	6	--
Subtotal 20B East		2,401	66	73	90	35	3
Unknown 20B	0000	--	6	11	1	7	--
Total Subunit 20B		~9,121	361 (419)[d]	387	423	276	4 (5)[d]

Table 5. Residency of Tier II Moose Hunt 985 (Minto Flats Management Area) permittees, 1990-91 through 1992-93 (data from Federal Subsistence Hunt not included).

Residence[a]	1990-91		1991-92		1992-93		1993-94[b]
	No. of permittees	Harvest	No. of permittees	Harvest	No. of permittees	Harvest	No. of permittees
Minto	60	3	39	9	11	3	51
Fairbanks vicinity	32	7	65	21	96	32	94
Nenana	27	6	15	3	19	3	26
Manley	10	0	11	1	5	0	4
Anchorage vicinity[c]	8	0	9	1	9	0	12
Other	3[d]	0	11	0	10[e]	4[f]	6
Total:	140	16	150	35	150	42	193

[a] Mailing address.

[b] Harvest data unavailable.

[c] Anchorage, Wasilla, Big Lake, Eagle River, Chugiak.

[d] Includes Central (2) and Tanacross/Northway (1).

[e] Includes Healy (2), Anderson (2), Cantwell, Denali, Valdez, Homer, Delta, and Seward.

[f] Includes Denali Park (1), Healy (2), and Anchor Point (1).

Table 6. Residency of moose hunters in Subunit 20B, 1984-92.

	Successful					Unsuccessful							
Year	Local Res	Other Res	Non Res	Unk Res	Total %	Local Res	Other Res	Non Res	Unk Res	Total %	Total Hunters	Manager	Type
All harvest sources combined													
1984	12.9	0.8	1.0	0.0	14.7	75.9	2.7	6.4	0.3	85.3	2,091	State	All harvest sources combined
1985	12.6	0.8	0.7	0.1	14.1	74.7	3.4	7.1	0.6	85.9	1,972	State	All harvest sources combined
1986	14.1	0.4	0.6	0.1	15.2	75.8	3.1	5.3	0.7	84.8	1,954	State	All harvest sources combined
1987	14.7	2.0	0.7	0.1	17.5	69.8	6.6	5.0	1.1	82.5	2,003	State	All harvest sources combined
1988	15.6	0.8	0.7	0.1	17.3	75.3	3.8	2.9	0.7	82.7	2,086	State	All harvest sources combined
1989	16.4	0.9	0.9	0.2	18.4	70.9	3.9	6.1	0.6	81.6	2,147	State	All harvest sources combined
1990	14.1	1.2	0.3	1.1	16.7	64.6	4.3	3.1	11.2	83.3	2,215	Combined	All harvest sources combined
1991	13.3	1.5	0.6	1.4	16.7	67.5	3.9	3.2	8.7	83.3	2,539	Combined	All harvest sources combined
1992	10.7	0.9	0.5	0.3	12.5	74.3	4.7	6.5	2.0	87.5	2,512	Combined	All harvest sources combined
Harvest tickets													
1984	12.7	0.8	1.0	0.0	14.5	76.1	2.6	6.5	0.3	85.5	2,070	State	Harvest ticket data
1985	12.4	0.8	0.7	0.1	14.0	74.8	3.4	7.2	0.7	86.0	1,954	State	Harvest ticket data
1986	14.2	0.4	0.6	0.1	15.3	75.5	3.1	5.4	0.7	84.7	1,895	State	Harvest ticket data
1987	14.3	2.0	0.8	0.1	17.2	69.7	6.8	5.1	1.1	82.8	1,948	State	Harvest ticket data
1988	15.3	0.8	0.8	0.1	17.0	75.4	3.9	3.0	0.7	83.0	2,020	State	Harvest ticket data
1989	16.5	0.9	0.9	0.2	18.5	70.5	4.0	6.3	0.6	81.5	2,074	State	Harvest ticket data
1990	15.2	1.4	0.4	0.2	17.1	72.9	4.7	3.6	1.6	82.9	2,127	State	Harvest ticket data
1991	13.8	1.6	0.7	0.5	16.5	74.8	4.2	3.6	0.9	83.5	2,453	State	Harvest ticket data
1992	9.8	1.0	0.6	0.4	11.9	73.9	4.9	7.1	2.3	88.1	2,093	State	Harvest ticket data
Minto Management Area													
1984	31.8	0.0	0.0	0.0	31.8	54.5	9.1	0.0	4.5	68.2	21	State	Registration permit hunt 0985
1985	33.3	0.0	0.0	0.0	33.3	66.7	0.0	0.0	0.0	66.7	18	State	Tier II permit hunt 0985

Table 6. Continued.

	Successful					Unsuccessful							
Year	Local Res	Other Res	Non Res	Unk Res	Total %	Local Res	Other Res	Non Res	Unk Res	Total %	Total Hunters	Manager	Type
1986	13.6	0.0	0.0	0.0	13.6	86.4	0.0	0.0	0.0	86.4	59	State	Registration permit hunt 0985
1987	29.1	0.0	0.0	0.0	29.1	70.9	0.0	0.0	0.0	70.9	55	State	Registration permit hunt 0985
1988	25.8	1.5	0.0	0.0	27.3	72.7	0.0	0.0	0.0	72.7	66	State	Registration permit hunt 0985
1989	15.1	0.0	0.0	0.0	15.1	84.9	0.0	0.0	0.0	84.9	73	State	Registration permit hunt 0985
1990	27.6	0.0	0.0	0.0	27.6	63.2	9.2	0.0	0.0	72.4	76	State	Tier II permit hunt 0985
1991	40.5	2.4	0.0	0.0	42.9	51.2	6.0	0.0	0.0	57.1	84	State	Tier II permit hunt 0985
1992	38.0	0.9	0.0	0.0	38.9	59.3	1.9	0.0	0.0	61.1	108	State	Tier II permit hunt 0985
1990	53.8	0.0	0.0	7.7	61.5	38.5	0.0	0.0	0.0	38.5	12	Federal	Registration permit hunt 0920
1991	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	1	Federal	Registration permit hunt 0920
1992	40.0	0.0	0.0	0.0	40.0	60.0	0.0	0.0	0.0	60.0	10	Federal	Registration permit hunt 0980
Fairbanks Management Area bowhunt													
1990	0.0	0.0	0.0	8.2	8.2	0.0	0.0	0.0	91.8	91.8	0	State	Registration permit hunt 0986
1991	0.0	0.0	0.0	10.8	10.8	0.4	0.0	0.0	88.8	89.2	1	State	Registration permit hunt 0986
1992	7.3	0.0	0.0	0.0	7.3	83.2	4.7	4.1	0.6	92.7	301	State	Registration permit hunt 0986

Table 7. Moose hunter effort and antler spread of harvested bulls, Subunit 20B, 1984-92.

	Successful				Unsuccessful			Total				
Year	Hunters	Hunt Days	Average Days	Average Antler Spread	Hunters	Hunt Days	Average Days	Hunters	Hunt Days	Average Days	Manager	Type
All harvest sources combined												
1984	333	1,523	4.6	37.3	1,933	11,400	5.9	2,266	12,923	5.7	State	All harvest sources combined
1985	305	1,765	5.8	36.6	1,852	10,773	5.8	2,157	12,538	5.8	State	All harvest sources combined
1986	319	1,662	5.2	36.9	1,773	10,632	6.0	2,092	12,294	5.9	State	All harvest sources combined
1987	377	2,029	5.4	36.9	1,776	10,698	6.0	2,153	12,727	5.9	State	All harvest sources combined
1988	377	1,896	5.0	34.5	1,805	10,173	5.6	2,182	12,069	5.5	State	All harvest sources combined
1989	429	2,046	4.8	32.6	1,900	11,072	5.8	2,329	13,118	5.6	State	All harvest sources combined
1990	439	2,254	5.1	36.8	2,189	11,924	5.4	2,628	14,178	5.4	Combined	All harvest sources combined
1991	493	2,488	5.0	36.7	2,451	14,439	5.9	2,944	16,927	5.7	Combined	All harvest sources combined
1992	346	1,674	4.8	34.5	2,424	15,205	6.3	2,770	16,879	6.1	Combined	All harvest sources combined
Harvest ticket data												
1984	326	1,510	4.6	37.2	1,918	11,331	5.9	2,244	12,841	5.7	State	Harvest ticket data
1985	299	1,710	5.7	36.6	1,840	10,706	5.8	2,139	12,416	5.8	State	Harvest ticket data
1986	311	1,618	5.2	36.9	1,722	10,403	6.0	2,033	12,021	5.9	State	Harvest ticket data
1987	361	1,951	5.4	36.8	1,737	10,541	6.1	2,098	12,492	6.0	State	Harvest ticket data
1988	359	1,831	5.1	34.0	1,757	9,997	5.7	2,116	11,828	5.6	State	Harvest ticket data
1989	418	2,002	4.8	32.4	1,838	10,767	5.9	2,256	12,769	5.7	State	Harvest ticket data
1990	387	1,924	5.0	36.7	1,871	10,323	5.5	2,258	12,247	5.4	State	Harvest ticket data
1991	429	2,132	5.0	37.3	2,170	13,064	6.0	2,599	15,196	5.8	State	Harvest ticket data
1992	277	1,295	4.7	34.8	2,059	12,370	6.0	2,336	13,665	5.8	State	Harvest ticket data
Minto Flats Management Area												
1984	7	13	1.9	42.3	15	69	4.6	22	82	3.7	State	Registration permit hunt 0985

Table 7. Continued.

Year	Successful Hunters	Successful Hunt Days	Successful Average Days	Successful Average Antler Spread	Unsuccessful Hunters	Unsuccessful Hunt Days	Unsuccessful Average Days	Total Hunters	Total Hunt Days	Total Average Days	Manager	Type
1985	6	55	9.2	0.0	12	67	5.6	18	122	6.8	State	Tier II permit hunt 0985
1986	8	44	5.5	39.7	51	229	4.5	59	273	4.6	State	Registration permit hunt 0985
1987	16	78	4.9	38.2	39	157	4.0	55	235	4.3	State	Registration permit hunt 0985
1988	18	65	3.6	45.6	48	176	3.7	66	241	3.7	State	Registration permit hunt 0985
1989	11	44	4.0	39.9	62	305	4.9	73	349	4.8	State	Registration permit hunt 0985
1990	21	76	3.6	45.2	55	222	4.0	76	298	3.9	State	Tier II permit hunt 0985
1991	36	155	4.3	40.0	48	276	5.8	84	431	5.1	State	Tier II permit hunt 0985
1992	42	195	4.6	41.5	66	510	7.7	108	705	6.5	State	Tier II permit hunt 0985
1990	8	61	7.6	0.0	5	12	2.4	13	73	5.6	Federal	Registration permit hunt 0920
1991	0	0	0.0	0.0	1	5	5.0	1	5	5.0	Federal	Registration permit hunt 0920
1992	4	28	7.0	30.0	6	44	7.3	10	72	7.2	Federal	Registration permit hunt 0980
Fairbanks Management Area												
1990	23	193	8.4	29.9	258	1,367	5.3	281	1,560	5.6	State	Registration permit hunt 0986
1991	28	201	7.2	25.3	232	1,094	4.7	260	1,295	5.0	State	Registration permit hunt 0986
1992	23	156	6.8	21.2	293	2,281	7.8	316	2,437	7.7	State	Registration permit hunt 0986

Table 8. Historical harvest percent by transportation type, Subunit 20B, 1984-92.

Year	Percentage of successful hunters								Total no. successful hunters	Manager	Type
	Airplane	Horse/ dogteam	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk			
All harvest sources											
1984	3.3	1.5	20.4	10.8	0.3	11.7	42.3	9.6	333	State	All harvest sources combined
1985	1.3	0.3	24.6	6.2	0.0	9.5	47.9	10.2	305	State	All harvest sources combined
1986	2.8	0.3	22.3	16.9	0.3	11.3	40.1	6.0	319	State	All harvest sources combined
1987	2.4	0.5	24.9	11.9	0.0	8.0	45.4	6.9	377	State	All harvest sources combined
1988	2.1	1.1	23.6	13.3	0.3	6.9	44.6	8.2	377	State	All harvest sources combined
1989	1.2	0.0	21.0	17.9	0.0	7.9	47.1	4.9	429	State	All harvest sources combined
1990	2.7	0.5	29.8	13.9	0.5	8.7	35.3	8.7	439	Combined	All harvest sources combined
1991	4.7	0.6	24.1	18.1	1.4	5.9	36.7	8.5	493	Combined	All harvest sources combined
1992	4.3	0.3	18.8	19.1	6.4	6.4	40.8	4.0	346	Combined	All harvest sources combined
Harvest ticket data											
1984	3.1	1.5	19.3	11.0	0.3	12.0	43.3	9.5	326	State	Harvest ticket data
1985	1.3	0.3	23.1	6.4	0.0	9.7	48.8	10.4	299	State	Harvest ticket data
1986	2.6	0.3	21.2	17.0	0.3	11.6	41.2	5.8	311	State	Harvest ticket data
1987	2.5	0.6	23.5	12.2	0.0	8.3	47.4	5.5	361	State	Harvest ticket data
1988	1.9	1.1	21.4	13.9	0.3	7.2	46.8	7.2	359	State	Harvest ticket data
1989	1.2	0.0	19.4	18.4	0.0	7.9	48.1	5.0	418	State	Harvest ticket data
1990	2.8	0.5	27.6	15.8	0.0	9.8	40.1	3.4	387	State	Harvest ticket data
1991	4.9	0.7	21.9	20.5	0.0	6.8	42.2	3.0	429	State	Harvest ticket data
1992	4.3	0.4	16.2	22.4	0.7	7.9	44.0	4.0	277	State	Harvest ticket data

Table 8. Continued.

	Percentage of successful hunters										
Year	Airplane	Horse/ dogteam	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk	Total no. successful hunters	Manager	Type
Minto Flats Management											
1984	14.3	0.0	71.4	0.0	0.0	0.0	0.0	14.3	7	State	Registration permit hunt 0985
1985	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	6	State	Tier II permit hunt 0985
1986	12.5	0.0	62.5	12.5	0.0	0.0	0.0	12.5	8	State	Registration permit hunt 0985
1987	0.0	0.0	56.3	6.3	0.0	0.0	0.0	37.5	16	State	Registration permit hunt 0985
1988	5.6	0.0	66.7	0.0	0.0	0.0	0.0	27.8	18	State	Registration permit hunt 0985
1989	0.0	0.0	81.8	0.0	0.0	9.1	9.1	0.0	11	State	Registration permit hunt 0985
1990	4.8	0.0	85.7	0.0	9.5	0.0	0.0	0.0	21	State	Tier II permit hunt 0985
1991	5.6	0.0	69.4	2.8	19.4	0.0	0.0	2.8	36	State	Tier II permit hunt 0985
1992	7.1	0.0	38.1	2.4	45.2	0.0	7.1	0.0	42	State	Tier II permit hunt 0985
1990	0.0	0.0	75.0	0.0	0.0	0.0	0.0	25.0	8	Federal	Registration permit hunt 0920
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	Federal	Registration permit hunt 0920
1992	0.0	0.0	75.0	0.0	25.0	0.0	0.0	0.0	4	Federal	Registration permit hunt 0980
Fairbanks Management Area											
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	23	State	Registration permit hunt 0986
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	28	State	Registration permit hunt 0986
1992	0.0	0.0	4.3	13.0	0.0	0.0	69.6	13.0	23	State	Registration permit hunt 0986

Table 9. Number of moose killed by nonhunting mortality in Subunit 20B and reported to Fish and Wildlife Protection (Fairbanks), 1989-90 to 1993-94. Parentheses indicate number by end of December.

Regulatory Year	MVA	Train	Poach	DLP	Other	Total
1989-90	69 (22)	28 (12)	1 (1)	0	2 (2)	100 (37)
1990-91	111 (46)	70 (14)	4 (2)	19 (0)	52 (1)	256 (63)
1991-92	55 (41)	10 (4)	1 (1)	0	6	72 (46)
1992-93	46 (28)	23 (4)	2 (2)	2 (0)	4 (1)	77 (35)
1993-94	-- (66)	-- (7)	-- (1)	-- (0)	-- (0)	-- (74)

[a] From Alaska Railroad records. Does not include animals classified as "missing" (not thought to be fatally hit).

LOCATION

Game Management Unit: 20C (11,822 mi^2), 20F (6,318 mi^2) and 25C (5,252 mi^2)

Geographical Description: Subunit 20C includes drainages into the west bank of the Nenana River and into the south bank of the Tanana River west of the Nenana River. Most of Denali National Park and Preserve (DNPP) is within Subunit 20C.

Subunit 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.

Subunit 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 Subunits 20C, 20F, and 25C have been low for many years. However, factors limiting growth of these moose populations are not well understood. Harvest is probably low relative to the population size, although unreported harvest may be substantial. Predation is suspected as a major limiting factor, but data on predator populations are lacking.

These areas contain large tracts of mature black spruce (poor quality moose habitat). However, many riparian areas, subalpine hills, and old burns appear to have suitable moose habitat capable of supporting more moose.

Trends in moose populations have also been difficult to identify. Approximately 26% (6,034 mi^2) of the area has been stratified to determine overall moose density and distribution. Surveys to determine density and composition were often inconclusive because of small sample sizes or poor survey conditions.

Moose within Denali National Park and Preserve (DNPP) have been studied more intensively than moose in the rest of the subunits. These studies include moose composition surveys and population estimation surveys (censuses) conducted by DNPP biologists since 1970 and a study of the movements and behavior of radio-collared moose.

Moose are an important source of food for many local rural residents. In addition, hunters throughout the Interior hunt moose in these subunits for food and/or trophies.

MANAGEMENT DIRECTION

The management objectives listed in the FY93 moose performance reports (Boudreau 1993*a,b*) for this area were to:

- Estimate hunting mortality and document nonhunting mortality when possible.
- Promote moose habitat enhancement by allowing natural fires to alter vegetation succession.
- Establish definitive moose population objectives in Subunit 20C and 20F by 1994.
- Establish an estimate of moose density in Subunits 20C and 20F by 1994.
- Establish an estimate of moose density in Subunit 25C by 1993.
- Provide for an annual harvest of 30-50 bull moose in Subunit 25C.
- Provide for an annual overall bull:cow ratio of 30:100 in Subunits 20C, 20F, and 25C.

METHODS

We estimated annual moose mortality with data from harvest report cards, reports to our office of nonhunting mortality of moose, records of moose-motor vehicle collisions (Fish and Wildlife Protection logsheets), and records of moose-train collisions (Alaska Railroad [ARR] summary sheets). The ARR travels through Subunit 20C between railroad mileposts 327 (Windy) and 371 (Ferry).

A permit was issued to the village of Tanana in June 1992 and June 1993 to provide for the taking of up to three moose/year for the Nuchalawoyya Potlatch.

Signs and handouts were placed in Manley Hot Springs to address concerns by residents of Manley Hot Springs about the moose population in the Fish Lake area. These signs reminded local hunters the area open during the 1-10 December hunt had been changed by action of the Board of Game (BOG) during the spring 1993 meeting.

Annual trends in moose composition and density were not documented during this reporting period. No surveys were completed. The last surveys were conducted between 25 October and 1 November 1991, when DNPP biologists completed population estimation surveys (Gasaway *et al.* 1986) in four separate areas: the East End (314 mi^2), Stampede (873 mi^2), Kantishna (620 mi^2), and Slope (878 mi^2).

We cooperated with the Bureau of Land Management (BLM) to radiocollar 17 moose (15 cows, 2 bulls) in April 1992 and 31 October-2 November 1993 on the north side of the Steese Highway and on the south side of the Steese Highway in the Birch Creek drainage, respectively, within Subunit 25C. The moose were radio-collared as part of a movement study being conducted by the BLM Steese White Mountain District. Radio-collared moose are relocated monthly by BLM staff.

To estimate unreported harvest, I used information from a 1987 Subsistence Division study to assess wild resource use in the village of Tanana. This study estimated residents of Tanana harvested 0.5 moose per household and approximately half of the hunting effort was spent in Subunits 20F and 20C (Case and Halpin 1987).

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

We estimate that 3,500-4,500 moose reside in Subunit 20C; 2,000 within Denali National Park (DNP) and 1,500-2,500 outside DNP (but including Denali National Preserve). These estimates assume an average density of 0.58 moose/mi^2 inside DNP (October 1991 census; T. Meier, pers. commun.) and 0.25 moose/mi^2 outside DNP.

We estimate that 1,000-2,000 moose reside in Subunit 20F. This assumes 0.25-0.50 moose/mi^2, with roughly 4,250 mi^2 of moose habitat (M. McNay, pers. commun.).

Population estimation surveys have not been conducted in Subunit 25C. Densities are believed low with a total estimated population of 500-2,000 moose. This low estimate is based on the fact that nearly half the subunit contains mountainous nonmoose habitat or open mountainous tundra interspersed by small drainages with localized good moose habitat. Attempts to complete a superstratification survey in Subunit 25C in 1991 and 1992 were unsuccessful (McNay 1993). The BLM had planned a superstratification survey for 1993, but did not have the funding the accomplish it.

Population Composition:

Composition survey data for recent years in Subunits 20C and 20F were previously summarized (Beasley 1990). The only additional data come from fall 1991 moose censuses in DNP (Table 1). High bull:cow ratios were indicated in the Kantishna and Slope areas in 1991 (125:100 and 108:100, respectively), but these results may have been due to bulls not having moved out of the high country yet (T. Meier, pers. commun.). Compared with the last census in 1986, densities were lower in the eastern area (1.4 moose/mi^2 in 1986 vs. 0.9 moose/mi^2 in 1991) but relatively unchanged in the other three censused areas.

H. Twitchell (pers. commun.) thought that DNP biologists would have funding for moose surveys during 1994 within DNPP in Subunit 20C.

Composition data for Subunit 25C were last collected in 1988 (Table 2) in the 57 mi^2 O'Brien Creek count area. Bull:cow ratios averaged 103 bulls:100 cows over the 3-year period 1986-88. Calf:cow ratios averaged 27 calves:100 cows.

Distribution and Movements:

Between 1984 and 1988, stratification surveys of over 6,000 mi^2 (approximately 26% of Subunits 20C, 20F, and 25C) confirmed the impression of overall low-density moose populations in these subunits. Seventy-three percent of the stratified area was considered "low density" (0.1-0.2 moose/mi^2), 21% "medium density" (0.2-1.2 moose/mi^2), and only 6% "high density" (2.3-3.6 moose/mi^2) (Beasley 1990).

In Subunit 20C, areas with medium or high densities of moose included the burn in the hills north of Minchumina and southwest of Wien Lake; the foothills of the Alaska Range in the southwestern portion of the subunit; the lower Kantishna River along the eastern floodplain; the low shrub area near Black Bear Lake; the area along the Tanana River; and the burn near Dune Lake.

Within DNP, surveys indicated a prevalence of bulls in the northwestern foothills of the Alaska Range and a relative scarcity of bulls in the flats to the north, indicating a posssible interchange of moose between these two areas (Meier 1986). However, according to data from radiocollared moose, most of the Eastern Park moose are residents with only a few venturing to the Toklat, Stampede, or Yanert areas (J. Dalle-Molle, pers. commun.).

In Subunit 20F, the highest densities of moose seen during the 1985 and 1988 stratification flights tended to be in the headwaters of the drainage of the Tozitna River and along the Yukon River, in the Fish Lake/Harpers Bend area, and near the mouth of the Tanana River.

In Subunit 25C moose are distributed throughout most of the subunit with the highest densities in the riparian zones of the major drainages. Radiotelemetry studies documented seasonal movement of moose to the Tanana Flats in Subunit 20A (Hobgood and Durtsche 1990). Radio-collared moose returned to wintering areas in Subunit 25C during the fall.

Mortality

Harvest:

Season and Bag Limit. During regulatory years 1992 and 1993 within Subunit 20C, moose hunting was open for all residents from 1 September to 20 September and for nonresidents from 5 September to 15 September with no antler restriction. In 1993 the Federal Subsistence Board created a 1-30 September moose season for local residents (Cantwell, Lake Minchumina, Nikolai, and Telida) on federal public lands within DNPP.

During regulatory year 1992 within Subunit 20F, the resident season was 1-15 September for the entire subunit and 1-10 December for that portion of Subunit 20F drained by the Yukon River downstream from the mouth of Hess Creek. There was no nonresident open season. The only change to Subunit 20F regulations for the 1993 regulatory year was the Board of Game's (BOG) clarification of the December season boundaries to include only that portion of Subunit 20F drained by the Yukon River, excluding the Tanana River drainage downstream of the drainage of Hess Creek. In addition in 1992, the federal government established a 1-25 September moose season for subsistence hunters on federal public lands in Subunit 20F (residents of Subunits 20F, Minto, Manley, and Stevens Village).

During regulatory years 1992 and 1993 within Subunit 25C, the resident season was 1-15 September and the nonresident season was 5-15 September for one bull. Table 3 summarizes changes in the hunting seasons since 1984.

Game Board Actions and Emergency Orders. In its March 1993 meeting, the BOG adopted an amended proposal that clarified the boundary of the December season within Subunit 20F. This clarification changed the northern boundary from the mouth of Hess Creek to the drainage of Hess Creek, and clarified the southern boundary as to exclude that portion of 20F draining into the Tanana River which was never intended to be open during the December season.
The Denali Park Subsistence Resource Commission sent a resolution to the state BOG regarding the creation of a winter moose season within DNPP lands for consideration at their fall 1993 meeting. The BOG took no action since this was actually a proposal to be taken up by the Federal Subsistence Board at their next meeting.

Hunter Harvest. In 1991, 142 moose were reported killed by 376 hunters in Subunit 20C; 37 moose were reported killed by 155 hunters in Subunit 20F; and 46 moose were reported killed by 164 hunters in Subunit 25C (Fig. 1). These reported harvests represented 6-9%, 2-4%, and 2-9% of the estimated moose populations in those areas, respectively. In 1992, 66 moose were reported killed by 311 hunters in Subunit 20C; 27 moose were reported killed by 134 hunters in Subunit 20F, including 4 moose reported taken during the December season; and 39 moose were reported killed by 206 hunters in Subunit 25C (Fig. 1). These reported harvests represented 3-5%, 1-3%, and 2-8% of the estimated moose populations in those areas, respectively. Data from the 1993 season are not yet available.

Nuchalawoyya Potlatch. In spring 1989, the board authorized the department to issue permits to take up to three moose/year for the Nuchalawoyya Potlatch in June. Under this regulation, the potlatch was canceled and no moose were taken during 1991; two cows were taken in June 1992; and the potlatch was canceled and no moose were taken in 1993.

Federal Permit Hunt 990. In 1992 the Federal Subsistence Board created a 1-25 September moose season on federal public land in Subunit 20F for qualifying local subsistence users by federal registration permit. The federal public land is located within the Dalton Highway Corridor. During the 1992 season three permits were issued, but none of the permittees were successful. In 1993 no permits were issued for the hunt. The BLM will recommend to the Federal Subsistence Board the registration hunt be dropped from the regulations due to lack of participation (Ray Corning, FWS, pers. commun.).

The amount of unreported kills in Subunits 20C, 20F, and 25C is not easily estimated. Harvest report card returns from Tanana, Rampart, Manley, Livengood, Central, Circle, and Circle Hot Springs within these subunits are negligible. In 1992, 41 hunters from Tanana, Rampart, Manley, and Central reported hunting in either Subunit 20C, 20F, or 25C; 11 were successful. No harvest report cards were received from the other communities. Subsistence Division research information from the village of Tanana illustrates the magnitude of the nonreporting problem. Only 10-20% of the actual harvest is reported in Tanana. I will calculate a total estimate for all three subunits for the next report period.

Hunter Residency and Success. During the last 5 years, less than 4% of the hunters reporting in Subunits 20C, 20F, and 25C have been nonresidents (Table 4). The 5-year average success rate for hunters was 34% (533/1,556) in Subunit 20C, 26% (161/617) in Subunit 20F, and 25% (198/801) in Subunit 25C. Most successful hunters were "nonlocal" hunters, primarily from the Fairbanks area (Table 5). During 1992 within Subunit 20C, 64% (42/66) of the successful hunters were from communities other than Nenana, Tanana, Manley Hot Springs, Healy, Clear, Anderson, Lake Minchumina, or Denali Park. In Subunit 20F, 74% (20/27) of the successful hunters were from communities other than Tanana, Manley Hot Springs, or Rampart. In Subunit 25C, 97% (38/39) of successful hunters were from communities other than Central, Circle, or Circle Hot Springs.

Harvest Chronology. In 1992 in Subunit 20C, the moose harvest was evenly distributed throughout the season with increases on the weekends. In Subunit 20F, most of the September harvest was early in the season with a small mid-season weekend peak, otherwise the harvest was uniformly low (Fig. 2). During the December season in Subunit 20F the moose harvest was evenly distributed throughout the season. In Subunit 25C the harvest increased steadily through the first weekend and thereafter was evenly distributed until the end of the season.

Transport Methods. In Subunit 20C, successful hunters used boats and airplanes for transportation most often. Boat use ranged from 32% to 44% and airplane use ranged from 20% to 32% over the last 5 years. Extensive river systems, many lakes and gravel bars make these transport methods most versatile.

In Subunit 20F, boats are the primary mode of transportation for successful hunters with use ranging from 44% to 63% over the last 5 years.

In Subunit 25C, successful moose hunters used highway vehicles and 3- or 4-wheelers most often. This is due to good road access along the Steese Highway and the extensive trail/mining road system throughout the subunit (Table 6).

Other Mortality:

Trains caused 76% (188/247) of the reported nonhunting mortality over the last 5 years. Motor vehicles were the second greatest nonhunting mortality source at 18% (45/247). This data is from Subunits 20C and 20A (Table 7). Nonhunting mortality in Subunits 20F and 25C is probably negligible because there is no railroad through Subunits 20F and 25C and reports of vehicles hitting moose are rare. Nonhunting mortality accounted for 22% (247/1139) of known mortality over the past 5 years in the three subunits.

Habitat

The BLM is reclaiming mine tailings within the White Mountains National Recreation Area in Subunit 25C. Native willows are being planted to enhance the revegetation process and increase moose browse.

Summaries of the recent fire history within these subunits were unavailable at the time of this report.

Nonregulatory Management Problems/Needs

Harvest reporting in these subunits is poor. We need to contact more people in these remote areas to emphasize the importance and benefits of reporting harvest. It would be especially helpful to contact young people in the village schools.

Fire is an integral part of interior ecosystems and essential to good moose habitat. The department should continue to coordinate wildlife needs with fire suppression activities and encourage more controlled burns to enhance habitat.

Collisions with trains are a significant mortality factor for moose in some areas. Efforts to reduce these mortalities should continue.

CONCLUSIONS AND RECOMMENDATIONS

Low-density populations of moose are in Subunits 20C, 20F, and 25C. Hunting pressure is relatively low. Current regulations are addressing our management objectives and no regulatory changes are recommended at this time. However, several changes in the objectives are needed.

The objective of establishing population objectives for Subunit 20C and 20F by 1992 was not met. Fiscal limitations and demands on more intensively utilized areas have delayed census activities in these areas. I want to revise the objective to establish definitive moose population objectives for Subunits 20C, 20F, and 25C by the year 2000.

We did not meet the objective to estimate moose density in Subunit 25C by 1992. This was due to bad survey conditions caused by the unusually early snowfall in 1992 and work demands in more intensively used areas in 1993. I would like to revise the objective to estimate moose densities in all three subunits, using the superstratification method by 1998.

We did meet part of the harvest objective for Subunit 25C to provide an annual harvest of 30-50 bull moose, but the overall bull:cow ratio part of the objective was not measurable. Until densities are known and population objectives are established, there is no basis to make specific harvest and population composition objectives. Meanwhile, I suggest we provide a sustained nominal harvest from this low-density population until we gather data sufficient to develop more specific guidelines.

Hunter harvest reporting is poor from rural villages within Subunits 20C, 20F, and 25C. To increase reporting in rural areas, more contact is needed with rural residents, especially the young people in the school systems.

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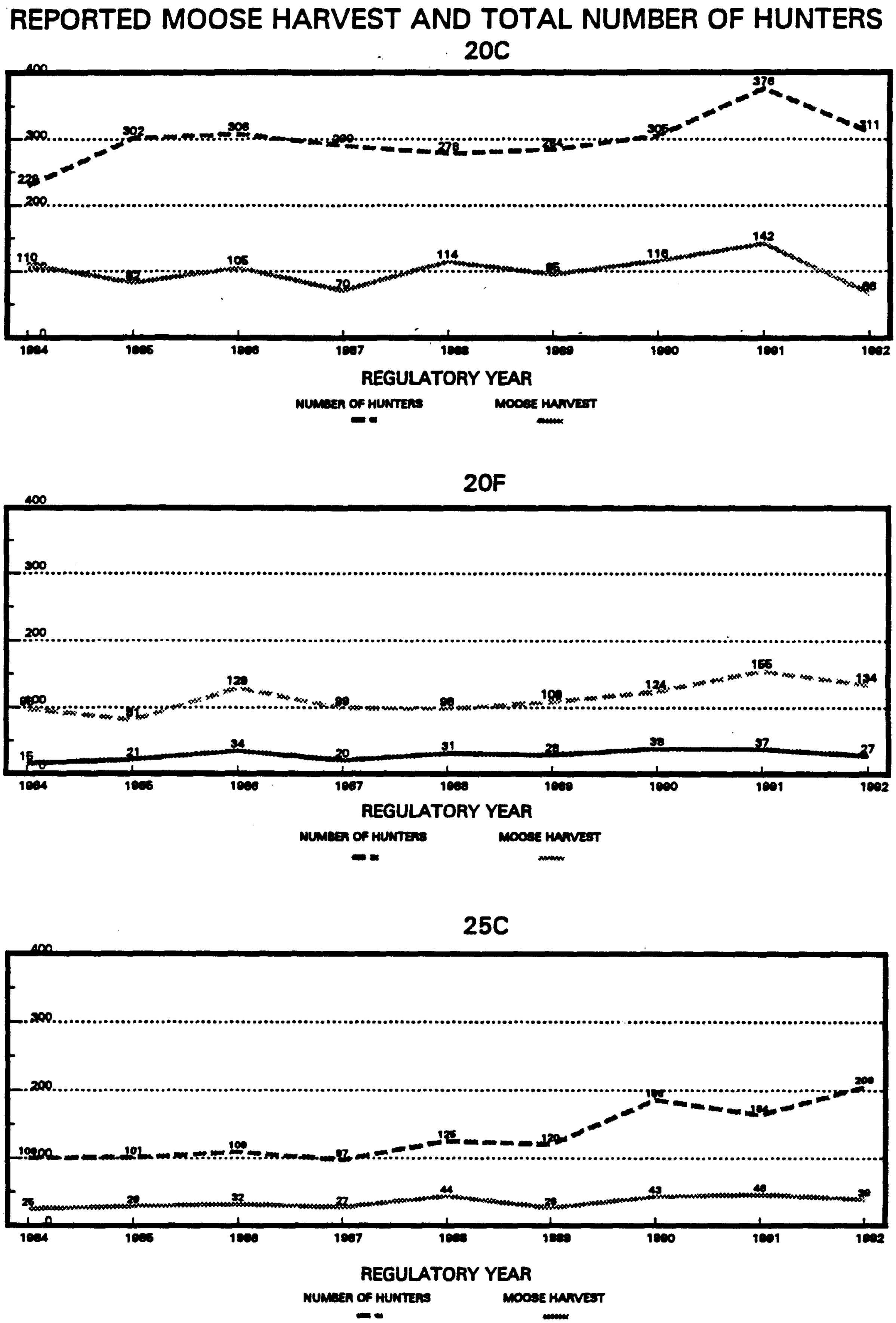

Figure 1. Annual moose harvest and hunting pressure 1984-92.

CHRONOLOGY OF THE REPORTED HARVEST

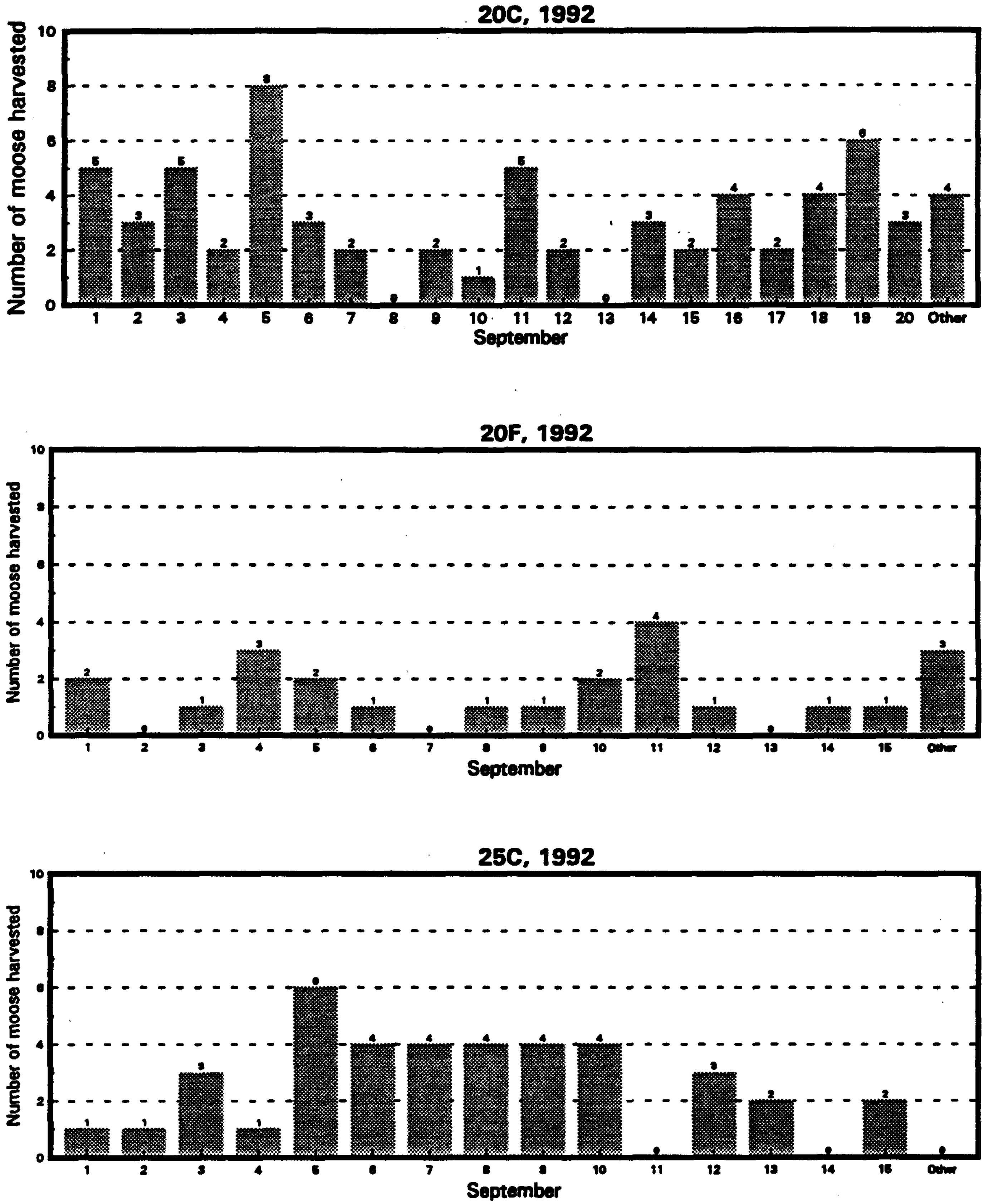

Figure 2. Chronology of reported moose harvest, 1992.

Table 1. Preliminary results of Subunit 20C fall aerial moose censuses in Denali National Park, 25 October-1 November 1991[a] (range of estimates with 90% confidence limits in parentheses).

Location (mi²)	Bulls: 100 Cows	Calves: 100 Cows	Total calves	Percent calves	Adults	Total Survey moose observed	Corrected Density (moose /mi²)	Estimated population size	area size
East End[b]	49	14	20	9	212	232	0.9	272 (229-315)	313.7
Stampede	69 (51-87)	26 (21-31)	25	13	169	194	0.3	302 (241-363)	873.0
Kantishna	125 (54-196)	11 (7-15)	17	8	203	220	0.6	395 (326-464)	619.8
Slope	108 (99-117)	35 (27-43)	67	15	394	461	0.7	594 (499-689)	877.6

[a] T. Meier, pers. commun., April 1992. Small mathematical errors were corrected from his data.
[b] All sample units censused; no variance.

Table 2. Subunit 25C, O'Brien Creek Count Area fall aerial moose composition counts, 1986-93.

Regulatory year	Bulls: 100 Cows size(mi^2)	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total Survey moose observed	Moose /mi^2	area
1986-87	103	13	21	8	9	77	85	1.49	57.0
1987-88	77	11	28	13	14	83	96	1.68	57.0
1988-89	129	37	33	16	13	112	128	2.25	57.0
1989-90	--	--	--	--	--	--	--	--	--
1990-91	--	--	--	--	--	--	--	--	--
1991-92	--	--	--	--	--	--	--	--	--
1992-93	--	--	--	--	--	--	--	--	--

Table 3. Moose hunting seasons for Subunits 20C, 20F, and 25C, 1984-94. Bag limit was one bull in all years except 1990 (see footnote).

Regulatory year Allowed[b]	Subunit 20C		Subunit 20F		Subunit 25C	
	Season[a]	Hunters Allowed[b]	Season	Hunters Allowed[b]	Season	Hunters
1984-85	1-20 Sept.	A	1-15 Sept.	A	5-15 Sept.	A
			1-10 Nov.	A		
1985-86	1-20 Sept.	A	1-15 Sept.	A	5-15 Sept.	A
			1-10 Nov.	S		
1986-87	1-20 Sept.	A	1-15 Sept.	A	5-15 Sept.	A
			1-10 Nov.	SR		
1987-88, 1988-89,	1-15 Sept.	RN	1-15 Sept.	A	5-15 Sept.	A
and 1989-90	1-20 Sept.	S	1-10 Dec.	S		
1990-91	1-15 Sept.	R	1-15 Sept.	R	1-15 Sept.	R
	5-15 Sept.	N[c]	1-10 Dec.	R (Tier II)	5-15 Sept.	N[c]
1991-92	1-20 Sept.	R	1-15 Sept.	R	1-15 Sept.	R
	5-15 Sept.	N	1-10 Dec.[d]	R	5-15 Sept.	N
			1-25 Sept.	FS[e]		
1992-93	1-20 Sept.	R	1-15 Sept.	R	1-15 Sept.	R
	5-15 Sept.	N	1-10 Dec.[f]	R	5-15 Sept.	N
	1-30 Sept.	FS[g]	1-25 Sept.	FS[e]		
1993-94					1-15 Sept.	R
					5-15 Sept.	N

[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 ³ 50-inch antler spread.
[d] Only that portion of Subunit 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 Subunit 20F on federal public lands.
[f] Only that portion of Subunit 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 Subunit 20C on federal public lands within DNPP.

Table 4. Number of successful and unsuccessful moose hunters by Alaska residency, Subunits 20C and 20F, 1986-93.

Reg. year	Successful hunters Total Resident hunters				Unsuccessful hunters Resident				
		Nonresident	Unk	Total (%)		Nonresident	Unk	Total (%)	
Subunit 20C:									
1986-87	98	3	4	105 (34)	196	4	3	203 (66)	308
1987-88	65	3	2	70 (24)	203	6	11	220 (76)	290
1988-89	84	6	24	114 (41)	114	8	42	164 (59)	278
1989-90	88	5	2	95 (33)	174	11	4	189 (67)	284
1990-91	108	4	4	116 (38)	178	6	5	189 (62)	305
1991-92	131	9	2	142 (37)	229	2	3	234 (63)	376
1992-93	56[a]	5	5	66 (21)	228	9	8	245 (79)	311
Subunit 20F:									
1986-87	33	1	0	34 (26)	92	2	1	95 (74)	129
1987-88	19	0	1	20 (20)	69	3	7	79 (80)	99
1988-89	25	0	6	31 (32)	49	3	15	67 (68)	98
1989-90	25	3	0	28 (26)	78	3	0	81 (74)	109
1990-91[b]	38[c]	0	0	38 (31)	84	0	2	86 (69)	124
1991-92	36	1	0	37 (24)	109	3	6	118 (76)	155
1992-93	25	0	2	27 (20)	104	1	2	107 (80)	134
Subunit 25C:									
1986-87	32	0	0	32 (29)	75	1	1	77 (71)	109
1987-88	22	3	2	27 (28)	66	3	1	70 (72)	97
1988-89	43	0	1	44 (35)	77	3	1	81 (65)	125
1989-90	24	2	0	26 (22)	89	3	2	94 (78)	120
1990-91	38	4	1	43 (23)	129	7	7	143 (77)	186
1991-92	43	3	0	46 (28)	108	7	3	118 (72)	164
1992-93	32[d]	7	0	39 (19)	161	5	1	167 (81)	206

[a] 37% were "local" residents (Nenana, Tanana, Manley Hot Springs, Healy, Clear, Anderson, Lake Minchumina, and Denali Park).
[b] Excludes hunters in permit hunts.
[c] 26% were "local" residents (Tanana, Rampart, Manley Hot Springs).
[d] 36 were "local" residents (Central, Circle, Circle Hot Springs).

Table 5. Residency of successful moose hunters in Subunits 20C and 20F, 1992-93.

Subunit	Town	No. Successful Hunters	
20C	"Nonlocal"		
	Fairbanks, North Pole, Salcha, Two Rivers	19	
	Wasilla, Anchorage, Palmer	12	
	Nonresidents	5	
	Other residents/unknown	6	
	Subtotal	42	(63%)
	"Local"		
	Denali Park	1	
	Nenana	10	
	Tanana	0	
	Manley Hot Springs	3	
	Healy/Clear/Anderson	10	
	Lake Minchumina	0	
	Subtotal	24	(37%)
20F	"Nonlocal"		
	Fairbanks, North Pole, Ft. Wainwright, Eielson, Ester	11	
	Healy	1	
	Anchorage	1	
	Other residents, unknown	7	
	Subtotal	20	(74%)
	"Local"		
	Tanana	4	
	Manley Hot Springs	2	
	Rampart	1	
	Subtotal	7	(26%)
25C	"Nonlocal"	24	
	Fairbanks, North Pole, Ft. Wainwright	5	
	Anchorage, Chugiak	7	
	Nonresidents	2	
	Other residents, unknown	38	(97%)
	Subtotal		
	"Local"		
	Central	1	
	Circle	0	
	Circle Hot Springs	0	
	Subtotal	1	(3%)

Table 6. Subunit 20C and 20F moose harvest[a] percent by transport method, 1986-93.

Regulatory year	Percent of harvest								
	Airplane	Horse/ Dogsled	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown/ other	*n*
Subunit 20C:									
1986-87	28	1	34	25[b]	0	-[b]	7	7	105
1987-88	27	1	43	20[b]	0	-[b]	6	3	70
1988-89	23	2	44	-[b]	0	-[b]	8	6	114
1989-90	20	2	37	14	0	14	11	3	95
1990-91	24	0	41	11	0	11	9	3	116
1991-92	23	0	39	20	0	7	8	3	142
1992-93	32	0	32	12	6	8	10	0	66
Subunit 20F:									
1986-87	9	3	38	26[b]	0	-[b]	18	6	34
1987-88	15	0	30	5[b]	0	-[b]	20	35	20
1988-89	6	0	55	19[b]	0	-[b]	13	6	31
1989-90	14	0	50	0	0	11	21	4	28
1990-91	11	0	63	16	0	0	11	0	38
1991-92	8	3	57	11	3	3	14	3	37
1992-93	7	4	44	7	15	0	19	4	27
Subunit 25C:									
1986-87	9	3	25	16	0	19	22	6	32
1987-88	11	4	37	15	0	7	19	7	27
1988-89	7	0	14	21	0	2	52	5	44
1989-90	4	4	23	27	0	12	31	0	26
1990-91	2	0	9	35	0	14	37	2	43
1991-92	11	0	22	44	0	0	20	4	46
1992-93	18	0	13	33	0	8	26	3	39

[a] Excludes permit hunt harvest. Data through 1988-89 are from FY89 moose survey-inventory.
[b] 3- or 4-wheeler and ORV combined.

Table 7. Number of moose killed by nonhunting mortality in Subunits 20A or 20C, and reported to Fish and Wildlife Protection (Fairbanks), 1989-90 to 1993-94. Parentheses indicate number by end of December.

Regulatory Year	MVA[a]	Train	Poach	DLP[b]	Other	Total
1989-90	13 (3)	62 (14)	0	1 (0)	2 (0)	78 (17)
1990-91	15 (8)	73 (18)	0	1 (1)	3 (0)	92 (27)
1991-92	7 (3)	15 (1)	0	0	0	22 (4)
1992-93	10 (5)	38 (7)	0	0	0	48 (12)
1993-94	-- (5)	-- (1)	-- (1)	-- (0)	-- (0)	(7)

[a] Motorize Vehicle Accident

[b] Defense of Life or Property

LOCATION

Game Management Unit: 20D (5,720 mi^2)

Geographical Description: Central Tanana Valley near Delta Junction

BACKGROUND

Subunit 20D was created in 1971 from the portion of Subunit 20C south of the Tanana River between the Johnson and Delta Rivers. From 1962 to 1970, the moose hunting season in the area that is currently Subunit 20D consisted of a 70- to 72-day bull season and a 1- to 8-day antlerless moose season. Fifty-one percent to 74% of the harvest from 1964 to 1970 came from the highly accessible areas near Delta Junction (Clearwater Lake, Donnelly Dome, and the Delta farming area). However, several severe winters in the mid-1960s and early 1970s killed many moose throughout this subunit and other portions of Interior Alaska and set the stage for predation and hunting to aggravate already widespread population declines. The moose hunting season was closed because the depressed moose population could no longer support the harvest that would result from even the most restrictive seasons (McIlroy 1974). Recruitment of yearling moose to the population had remained poor, causing the continued bulls-only hunting to depress the bull:cow ratio to only 4:100 in the more accessible portions of the subunit.

Despite restrictions on hunting, the moose population in Subunit 20D continued to decline because of chronically high moose mortality due to other causes. In 1973, the moose population in the area south of the Tanana River and between the Johnson and Delta Rivers was estimated to number only 600. When limited moose hunting was resumed in 1974, it was under a registration permit system designed to keep harvest minimal. The population decline in the western portion of the subunit was gradually reversed by wolf control efforts in adjacent Subunit 20A (1976-82) and in western Subunit 20D (1980-83), coupled with continued hunting restrictions and mild winters.

In 1978, the subunit was enlarged by moving the eastern boundary from the Johnson River to the Robertson River. It was further enlarged in 1981 to include all drainages north of the Tanana River from the mouth of the Robertson River to Banner Creek.

In 1983 the remaining closed area around Delta Junction was formally named the Delta Junction Management Area (DJMA). The name of the DJMA was changed to the Delta Junction Closed Area (DJCA) in 1990.

For convenience, Subunit 20D has been unofficially subdivided into four areas for moose management purposes: southwestern Subunit 20D, which includes the area south of the

Tanana River from the Johnson River to the Delta River; southeastern Subunit 20D, which includes the area south of the Tanana River from the Robertson River to the Johnson River; northwestern Subunit 20D, which includes the area north of the Tanana River from Banner Creek to and including the Volkmar River; and northeastern Subunit 20D, which includes the area north of the Tanana River and east of the Volkmar River.

Since restrictive hunting seasons during the mid-1970s and early 1980s, hunting opportunities have been expanded in southwestern Subunit 20D by first eliminating the registration permit requirement and then lengthening the season. Antler restrictions were implemented in 1988 to stabilize increasing harvest and improve age structure in the bull segment of the population. The DJCA remains closed to moose hunting, but this is due to local preference rather than biological necessity. In southeastern Subunit 20D, the seasons were also increased. In the northern portion of Subunit 20D hunting seasons have been shorter than in the southern portions of the subunit due to smaller numbers of moose.

MANAGEMENT DIRECTION

Management Goals and Objectives

- Manage for a total posthunting season population of 7,000 moose with 3,000 in northern Subunit 20D, 2,500 in southwestern Subunit 20D, and 1,500 in southeastern Subunit 20D.

- Manage for a posthunting season bull:cow ratio of no less than 30 bulls:100 cows.

- Manage for a November calf:cow ratio of no less than 30 calves:100 cows.

- Increase the bull age structure in southwestern Subunit 20D so that by 1993 at least 20% of the bulls observed after the hunting season have an antler spread of 50 inches or larger.

- Manage for at least 20% hunter success as long as moose populations are stable or increasing.

METHODS

Aerial composition surveys were flown in a Robinson R22 helicopter at an altitude of 300-500 feet above ground level and an airspeed of approximately 50-70 mph. A low pass was flown over moose to determine sex and age, to look for additional moose, and in some areas to estimate antler spread and the number of antler brow tines for bulls. Yearling bulls were identified by spiked or forked antlers or by a lack of brow development on palmated antlers. Older bulls with an antler spread less than 50 inches were classified as medium bulls. Bulls with an antler spread of 50 inches or more were classified as large bulls.

Density of moose and unbiased composition data were collected in trend count areas (TCA). The TCAs were subdivided into sample units (SU) with each SU having a mean area of approximately 12 mi^2. One SU was surveyed at a time, with a search intensity of approximately 4-8 minutes/mi^2.

Estimates of sex and age composition were calculated by flying transect or contour surveys in specified areas. Sex and age composition data collected during these surveys may be biased because different segments of the moose population have varying observer sightability during aerial surveys.

RESULTS AND DISCUSSION

Population Status and Trend

The number of moose in southern Subunit 20D is medium to high and stable. The number of moose in northern Subunit 20D is low and stable to decreasing.

Southwestern Subunit 20D:

The moose population is stable in this area. Because the population is stable, no progress was made toward the management objective of increasing the population to 2,500 moose.

Moose density and trend data were collected in the Donnelly TCA in 1992 and 1993. A density of 3.0 moose/mi^2 was counted during November 1992 and 4.4 moose/mi^2 in 1993 (Table 1). The 1993 survey resulted in a substantial increase in moose density in the Donnelly TCA. However, I believe the increase was due in part to atypical moose distribution when the survey was flown rather than being solely a result of population increase.

The Delta Agricultural Project TCA was surveyed in 1993 to assess the effect of the Conservation Reserve Program (CRP) on moose density and distribution, and the potential impacts of changes in the CRP program mandated by the Agricultural Stabilization and Conservation Service (ASCS). Therefore, the 1993 survey covered a larger area than previously surveyed and is not directly comparable to earlier surveys. The Delta Agricultural Project TCA resulted in a density of 1.8 moose/mi^2 compared to 1.5 moose/mi^2 in a smaller portion of the Delta Agricultural Project in 1989 (Table 2).

Southeastern Subunit 20D:

The moose population is stable in this area. However, I had difficulty collecting moose survey data to make an assessment during this reporting period. Because the population is probably stable, no progress was made toward achieving the management objective of increasing the number of moose to 1,500.

Moose density and trend data were collected in the Knob Ridge TCA during 1992, but the survey was not completed due to poor weather (Table 3). A survey was not flown in this area in 1993 due to poor weather and lack of funds. Therefore, neither density of moose nor population trends were estimated for the Knob Ridge TCA during 1992 or 1993.

Moose/hour data were collected in the Robertson River drainage during 1992 and resulted in 28 moose/hr observed (Table 4). Bad weather prevented the survey from being completed in 1993.

Northwestern Subunit 20D:

The moose population is probably stable or declining in northwestern Subunit 20D. Therefore, no progress was made toward the management objective of increasing the moose population to 3,000.

Moose density and trend data were collected in the Central Creek TCA in 1992 and 1993. The Central Creek TCA was reduced in size in 1992 to compensate for increased survey expenses and reduced funds. Therefore, 1992 and 1993 density and trend data are not directly comparable with earlier data. Moose density ranged from 2.8 moose/mi^2 in 1992 to 3.1 moose/mi^2 in 1993 (Table 5). Based on the following composition data, I believe the number of moose in this area is decreasing.

Northeastern Subunit 20D:

No moose surveys were flown during this reporting period.

Population Composition:

Southwestern Subunit 20D. Data collected in the Donnelly TCA indicated calf survival to 6 months of age increased to 44 calves:100 cows during 1992 and calves composed 26% of moose classified. In 1993, calf survival declined, only 24 calves:100 cows were observed, and calves comprised only 16% of the herd. Calf survival in 1993 was below the management objective and is the lowest calf survival recorded since 1986 (Table 1).

Calf survival also declined below the management objective in the Delta Agricultural Project TCA during 1993 with only 25 calves:100 cows (Table 2). A pack of wolves became established in the Delta Agricultural Project during fall 1993 and probably contributed to reduced calf survival in this area.

Moose survival to 18 months of age increased during 1992 and 1993 to 10 and 11 yearling bulls:100 cows, respectively, in the Donnelly TCA (Table 1), but was low with only 6 yearling bulls:100 cows during 1993 in the Delta Agricultural Project (Table 2). Antler restrictions during the hunting season result in many yearling bulls being harvested by hunters in southwestern Subunit 20D, so the observed ratio of yearling bulls:100 cows misrepresents actual recruitment of yearling moose more than for areas without harvest directed toward yearling bulls.

The bull:cow ratio increased during 1992 and 1993 to 27 and 26 bulls:100 cows in the Donnelly TCA, which is slightly below the management objective (Table 1). Ratios of 18 and 16 bulls:100 cows were observed in 1990 and 1991. Although the actual number of bulls in the Donnelly TCA increased in 1992 and 1993 to equal or exceed the number of bulls before antler restrictions, there has been little change in the age structure of the bull segment of the population. During 1993, yearling, medium, and large bulls were present in proportions similar to the population prior to antler restrictions (Table 6).

Bull:cow ratios in the Delta Agricultural Project TCA declined to 18 bulls:100 cows in 1993, compared with 34 and 24 bulls:100 cows in 1989 and 1991, respectively (Table 2).

Southeastern Subunit 20D. Calf survival to 6 months of age was below the objective in the Knob Ridge TCA during 1992 with only 16 calves:100 cows. Calves comprised only 10% of the moose (Table 3). However, an incomplete survey and poor survey conditions may have biased the data. It should be noted that a large pack of 13 wolves was in this area during 1992-93 and may have contributed to increased calf mortality. Calf survival met the management objective in the Robertson River drainage during 1992 with 38 calves:100 cows and calves comprised 23% of the herd (Table 4). Calf survival data collected in southeastern Subunit 20D during 1993 was too insufficient to analyze.

Moose survival to 18 months of age was 12 and 11 yearling bulls:100 cows during 1992 in the Knob Ridge and Robertson River areas, respectively (Tables 3 and 4).
Bull:cow ratios met the objective in the Knob Ridge area with 38 bulls:100 cows observed during the 1992 incomplete survey and the Robertson River area was slightly below the objective with 28 bulls:100 cows (Tables 3 and 4).

Northwestern Subunit 20D. Calf survival to 6 months of age continued to be poor and below the management objective in the Central Creek TCA during 1992 with only 4 calves:100 cows (Table 5). Calf survival improved significantly in 1993 to 21 calves:100 cows. Percent calves in the herd was low in 1992 with only 3% calves, but improved in 1993 to 16% calves.

Survival of moose to 18 months of age was also poor both years with 8 and 5 yearling bulls:100 cows in 1992 and 1993, respectively (Table 5).

Bull:cow ratios decreased from 69 bulls:100 cows in 1991 to 53 and 46 bulls:100 cows in 1992 and 1993, respectively, but met the management objective (Table 5).

Northeastern Subunit 20D. No sex and age composition data were collected in this area during 1992 or 1993.

Distribution and Movements:

No data were collected on moose distribution or movements during this reporting period, because the U.S. Army withdrew funding for an ongoing cooperative moose movement study.

Mortality

Harvest:

Season and Bag Limit. Table 7 lists moose hunting seasons in Subunit 20D during the 1991-92, 1992-93, and 1993-94 regulatory years.

Game Board Actions and Emergency Orders. The Alaska Board of Game (BOG) made the following changes to moose regulations during this reporting period: 1) the BOG increased the moose hunting season in all of northern Subunit 20D to 1-15 September effective for the 1993 season, and 2) the BOG changed the definition of a 50-inch bull in southwestern Subunit 20D to a bull having an antler spread of at least 50 inches or at least four brow tines on at least one antler effective for the 1993 season.

Human-induced Mortality:

Estimated moose mortality from all human causes during 1991-92 totaled 193 moose (Table 8). This total included 144 moose reported killed by hunters during the general hunting season, an estimated 25 unreported hunter kills, an illegal harvest of 11 moose, and 13 road kills (Table 8). Most illegal kills and road kills occurred in southwestern Subunit 20D. Hunters had a 22% success rate in Subunit 20D during the 1991 general hunting season which exceeded the minimum harvest management objective (Table 9).

Estimated moose mortality from all human causes during 1992-93 totaled 205 moose. This total included 143 moose reported killed by hunters during the general hunting season, an estimated unreported harvest of 25 moose, 5 killed illegally, 32 road kills (Table 8), and 1 moose killed during a Tier II permit hunt (Table 10). Most illegal kills and road kills came from southwestern Subunit 20D. This is the highest estimated mortality for

Subunit 20D since at least 1986-87. Hunters had a 20% success rate in Subunit 20D during the 1992 general hunting season which met the minimum harvest management objective (Table 9).

Southwestern Subunit 20D. Reported harvest totaled 54 moose during the 1991 general hunting season and 59 moose in 1992 (Table 11). Harvest has ranged from 54 to 60 moose since antler restrictions were adopted in this area during the 1988 hunting season. Hunter success was 16% in 1991 and 18% in 1992.

Hunter success is lowest in southwestern Subunit 20D of any portion of Subunit 20D because the number of hunters is increasing but the harvest is staying fairly constant. After an initial drop in the number of hunters during 1988, the first year of antler restrictions, the number of hunters has increased to 331 in 1991 and 329 in 1992 (Table 11).

Southeastern Subunit 20D. Both the harvest of moose and the number of hunters have remained low in this subunit. Fifty-one hunters killed 12 moose during the 1991 general hunting season and 49 hunters killed 12 moose in 1992 (Table 11). Hunters in this area had a 24% success rate in 1991 and 1992.

Low numbers of hunters and harvest in this area are partially caused by motorized vehicle access restrictions in the Macomb Plateau Controlled Use Area. Access restrictions make moose hunting difficult south of the Alaska Highway; however, access is good along the Tanana and Robertson Rivers.

Northwestern Subunit 20D. The number of moose killed in northwestern Subunit 20D has increased the last 2 years, along with the number of hunters. Two hundred thirty-one hunters killed 66 moose during the 1991 general season, and 257 hunters killed 58 moose during the 1992 general season (Table 11). This is the most hunters reported for this area since 1985. Hunters had a 29% success rate in 1991 and a 23% success rate in 1992.
The moose harvest and hunter success remains fairly high in this area despite a probably declining moose population because many of the people who continue to hunt north of the Tanana River have hunted the area for a long time. These hunters are familiar with the area and efficient at harvesting moose. I also believe that migratory moose that winter in southwestern Subunit 20D are contributing significantly to the harvest coming from areas north of the Tanana River.

Northeastern Subunit 20D. Number of hunters and harvest was low in this area with 26 hunters harvesting 9 moose in the 1991 general season. During the 1992 season, 34 hunters harvested 5 moose (Table 11). Hunters had a 35% success rate in 1991 and a 15% success rate in 1992.

This area is difficult to access during the hunting season except along the Tanana River, a few small creeks flowing into the Tanana River, and a few ridgetop airstrips. Poor access plus low moose numbers result in low hunter effort and harvest.

Hunter Residency. Most moose hunters in Subunit 20D are Alaskan residents and residents of the subunit. During the 1991 general hunting season, 82% of successful hunters and 86% of the unsuccessful hunters were residents of the subunit. Only 3% of successful hunters and 3% of unsuccessful hunters were nonresidents (Table 9).

During the 1992 general season, 75% of successful hunters and 80% of unsuccessful hunters were residents of the subunit. Six percent of successful hunters and 6% of unsuccessful hunters were nonresidents (Table 9).

Hunter Effort. During the 1991 general hunting season, successful hunters hunted a mean of 5.6 days compared with a mean of 6.3 days for all unsuccessful hunters (Table 12).

During the 1992 general hunting season, successful hunters hunted a mean of 5.0 days and unsuccessful hunters hunted a mean of 6.2 days (Table 12).

Effort by successful hunters increased in southwestern Subunit 20D from 3.8 days in 1986 to 6.0 days in 1991, but declined during 1992 to 4.7 days (Table 12). Antler restrictions in this area since the 1988 season contributed to the increase in hunter effort by forcing hunters to search longer for a legal bull moose. Even though hunter effort increased, it is not substantially different from mean days hunted for the entire subunit.

Permit Hunts. Tier II permit hunt number 987T was conducted during the 1991-92 hunting season from 1 January to 15 February 1992. Fifteen permits were issued with a harvest quota of five bulls. Five hunters reported hunting but no moose were killed (Table 10).

Tier II permit hunt number 987T was conducted during the 1992-93 hunting season from 1 January to 15 February 1993. Fifteen permits were issued with a harvest quota of five bulls. Eleven hunters reported hunting and one moose was killed (Table 10).

Harvest Chronology. During the 1991 general hunting season, 60% of the reported harvest occurred during the first 5 days of the season from 1-5 September. Harvest during the next two 5-day periods was 23% and 16%, respectively (Table 13).

Harvest patterns were similar in 1992, with 52% of moose harvested from 1-5 September, 31% from 6-10 September, and 18% harvested from 11-15 September (Table 13).

Transport Methods. Highway vehicles, three- or four-wheelers, and boats are the most commonly used mode of transportation used by successful hunters in Subunit 20D.

Highway vehicles, three- or four-wheelers, and boats were used by 72% of successful hunters during the 1991 season and 80% of successful hunters during the 1990 season (Table 14).

Natural Mortality:

No estimates of natural mortality were calculated during 1991-92 or 1992-93. However, predation by wolves, grizzly bears, and black bears is believed significant in Subunit 20D. Predation is thought to be limiting moose population growth in the northern half of Subunit 20D and recently reducing calf survival in portions of southern Subunit 20D.

Winters 1991-92 and 1992-93 were relatively mild. Snow depths were not deep enough to result in increased overwinter mortality of moose in the Delta Junction area (Table 15).

Habitat

Assessment:

No habitat assessment was done during this reporting period.

Enhancement:

No habitat enhancement took place during this reporting period.

CONCLUSIONS AND RECOMMENDATIONS

No progress was made toward increasing the number of moose to meet population objectives in Subunit 20D. Harvest objectives are being met in the subunit, although harvest in southwestern Subunit 20D is below the harvest objective. Calf:cow ratios are being met in some portions of Subunit 20D but not in others. Because of political constraints on predator reductions, I have no plans to initiate management actions to increase calf survival in those areas that are below the management objective. Bull:cow ratios are being met throughout the subunit, except in southwestern Subunit 20D where bull:cow ratios are below the management objective but have increased during this reporting period. I plan to maintain antler restrictions in southwestern Subunit 20D to further increase bull:cow ratios. The objective to have 20% large bulls in southwestern Subunit 20D by 1993 was not met. I will reevaluate this objective in the future.

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Table 1. Subunit 20D, Donnelly Trend Count Area fall aerial moose composition counts, 1986-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1986-87	30	12	40	83	24	270	353	3.4
1987-88	31	15	44	81	25	242	323	--
1988-89	29	12	47	92	27	251	343	3.2
1989-90	27	12	27	62	18	290	352	3.4
1990-91[a]	18	6	31	64	21	240	311	--
1991-92	16	4	32	73	22	260	333	3.1
1992-93	27	10	44	83	26	239	322	3.0
1993-94	26	11	24	75	16	389	464	4.4

[a] Incomplete survey.

Table 2. Delta Agricultural Project Trend Count Area fall aerial moose composition counts, 1989-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1989-90[a]	34	14	41	46	25	145	191	1.5
1990-91[a]	--	--	--	--	--	--	--	--
1991-92[b]	24	2	42	21	25	62	83	--
1992-93[a]	--	--	--	--	--	--	--	--
1993-94[a]	18	6	25	33	18	154	187	1.8

[a] Survey areas vary.

[b] Incomplete survey.

Table 3. Knob Ridge Trend Count Area fall aerial moose composition counts, 1986-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1986-87[a]	46	4	12	9	7	144	153	2.0
1987-88[b]	--	--	--	--	--	--	--	--
1988-89	42	11	26	23	15	126	149	2.0
1989-90	41	8	35	25	20	100	125	1.4
1990-91	39	8	39	36	22	129	165	1.9
1991-92	33	4	31	32	19	138	170	2.0
1992-93[c]	38	12	16	11	10	94	105	--
1993-94[b]	--	--	--	--	--	--	--	--

[a] TCA has slightly different boundaries than later years.

[b] No survey conducted.

[c] Incomplete survey.

Table 4. Robertson River fall aerial contour moose composition counts, 1986-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1986-87	60	15	24	22	13	106	128	41
1987-88[a]	--	--	--	--	--	--	--	--
1988-89	45	11	43	34	23	116	150	33
1989-90	37	5	14	13	9	129	142	27
1990-91	37	8	29	21	17	100	121	25
1991-92	31	4	35	30	21	113	143	33
1992-93	28	11	38	33	23	111	144	28
1993-94[b]	45	9	18	2	11	17	19	--

[a] No survey conducted.

[b] Incomplete survey.

Table 5. Central Creek Trend Count Area fall aerial moose composition counts, 1986-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1986-87[a]	--	--	--	--	--	--	--	--
1987-88[a]	--	--	--	--	--	--	--	--
1988-89	44	6	13	12	8	138	150	2.5
1989-90	36	4	20	18	13	121	139	2.3
1990-91	63	4	10	9	6	145	154	2.6
1991-92	69	6	15	9	8	105	114	1.9
1992-93[b]	53	8	4	3	3	115	118	2.8
1993-94	46	5	21	16	13	91	127	3.1

[a] No survey conducted.

[b] TCA boundaries altered.

Table 6. Age structure of bulls in the Donnelly Trend Count Area of southwestern Subunit 20D based on antler morphology and estimated antler spread of bulls observed during aerial surveys, 1987-93. Values in parentheses are percentages.

	Antler Spread in Inches			
Year	Yearling ≤30.0	Medium 30.0-49.9	Large ≥50.0	Total Bulls
1987[a]	27 (47)	24 (42)	5 (9)	56
1988[b]	24 (43)	26 (46)	7 (13)	57
1989	27 (44)	25 (41)	9 (15)	61
1990[c]	13 (36)	20 (56)	3 (8)	36
1991	9 (26)	21 (60)	5 (14)	35
1992	18 (35)	24 (47)	9 (18)	51
1993[d]	34 (42)	38 (47)	9 (11)	81

[a] Hunting season bag limit = 1 bull.

[b] Hunting season bag limit = 1 bull with spike-fork or 50-inch antlers or 3 brow tines on one side.

[c] Incomplete survey.

[d] Hunting season bag limit = 1 bull with spike-fork or 50-inch antler spread or 4 brow tines on one side.

Table 7. Moose hunting seasons in Subunit 20D during the 1991-92, 1992-93, and 1993-94 hunting seasons.

Year	Area	Season		Bag Limit
1991-92 and 1992-93	Southwestern	Subsis./Res.:	1-15 Sept.	1 bull with spike-fork or 50" antlers[a]
		Nonresident:	5-15 Sept.	1 bull with 50" antlers[a]
	Southeastern	Subsis./Res.:	1-15 Sept.	1 bull
			1 Jan.-15 Feb.	1 bull by Tier II permit
		Nonresident:	no season	
	Northern West of Alyeska Pipeline	Subsis./Res.:	1-15 Sept.	1 bull
		Nonresident:	5-15 Sept.	1 bull
	Northern Remainder	Subsis./Res.:	1-10 Sept.	1 bull
		Nonresident:	1-10 Sept.	1 bull
1993-94	Southwestern	Subsis./Res.:	1-15 Sept.	1 bull with spike-fork or 50" antlers[b]
		Nonresident:	5-15 Sept.	1 bull with 50" antlers[b]
	Southeastern	Subsis./Res.:	1-15 Sept.	1 bull
			1 Jan.-15 Feb.	1 bull by Tier II permit
		Nonresident:	no season	
	Northern	Subsis./Res.:	1-15 Sept.	1 bull
		Nonresident:	1-15 Sept.	1 bull

[a] 50" antlers defined as having a spread of at least 50 inches or at least 3 brow tines on one side.

[b] 50" antlers defined as having a spread of at least 50 inches or at least 4 brow tines on one side.

Table 8. Subunit 20D moose harvest[a] and accidental death, 1986-93.

Regulatory year	Harvest by Hunters: Reported M (%)	F (%)	Unk	Total	Estimated Unreported[b]	Illegal	Total	Accidental death Road	Train[c]	Total	Total
1986-87	130	0	0	130	23	4	27	15	0	15	172
1987-88	126	0	0	126	22	10	32	26	0	26	184
1988-89	126	0	0	126	22	13	35	27	0	27	188
1989-90	127	0	0	127	22	9	31	16	0	16	174
1990-91	117	1	0	118	21	4	25	11	0	11	154
1991-92	143	1	0	144	25	11	36	13	0	13	193
1992-93	142	0	1	143	25	5	30	32	0	32	205

[a] Excludes permit hunt harvest.

[b] Based on 17.7% unreported harvest estimated by Gasaway *et al.* (1992).

[c] Not applicable in Subunit 20D.

Table 9. Subunit 20D moose hunter[a] residency and success, 1986-93.

Regulatory year	Successful: Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Unsuccessful: Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Total hunters
1986-87	121	15	1	1	138 (23)	409	45	12	0	466 (77)	604
1987-88	96	13	7	10	126 (21)	375	24	17	31	447 (79)	591
1988-89	93	13	9	11	126 (23)	333	36	31	29	429 (77)	555
1989-90	96	18	8	5	127 (20)	404	57	23	9	493 (80)	620
1990-91	98	10	4	6	118 (22)	351	51	24	4	430 (78)	548
1991-92	118	21	4	1	144 (22)	443	51	13	7	514 (78)	658
1992-93	107	25	8	3	143 (20)	462	61	37	14	574 (80)	717

[a] Excludes hunters in permit hunts.

[b] Local means reside in Subunit 20D.

Table 10. Subunit 20D moose harvest data by permit hunt, 1989-93.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
988	1989-90	15	27	91	9	100	0	0	1
987T	1990-91	15	20	86	14	100	0	0	1
987T	1991-92	15	67	100	0	0	0	0	0
987T	1992-93	15	27	91	9	1	0	0	1

Table 11. Annual reported harvest of moose and number of hunters during the general open season in southwestern, southeastern, northwestern, and northeastern Subunit 20D from 1984 to 1992.

Regulatory	Moose Harvest						Number of Hunters					
year	SW	SE	NW	NE	Unk	Total	SW	SE	NW	NE	Unk	Total
1984	39[a]	9[b]	40[c]	14[c]	0	102	236[a]	47[b]	294[c]	48[c]	10	635
1985	48[d]	8[b]	60[d]	14[d]	0	130	236[d]	37[b]	272[d]	50[d]	9	604
1986	76[d]	10[b]	40[d]	10[d]	1	137	250[d]	45[b]	232[d]	57[d]	12	596
1987	66[d]	8[b]	43[d]	9[d]	0	126	296[d]	35[b]	208[d]	35[d]	17	591
1988	60[e]	12[b]	39[d]	12[d]	3	126	244[e]	45[b]	201[d]	37[d]	28	555
1989	60[e]	11[b]	41[d]	10[d]	5	127	303[e]	47[b]	191[d]	39[d]	40	620
1990	58[f]	9[c]	40[g]	7[d]	4	118[a]	270[f]	29[c]	195[g]	26[d]	28	548
1991	54[f]	12[c]	66[g]	9[d]	3	144	331[f]	51[c]	231[g]	26[d]	19	658
1992	59[f]	12[c]	58[g]	5[d]	9	143	329[f]	49[c]	257[g]	34[d]	48	717

[a] Season 1-6 Sept.; 1 bull.

[b] Season 1-20 Sept.; 1 bull.

[c] Season 1-15 Sept.; 1 bull.

[d] Season 1-10 Sept.; 1 bull.

[e] Season 1-15 Sept.; 1 bull with spike-fork or 50-inch antlers or 3 brow tines on one antler.

[f] Subsis./Res. Season 1-15 Sept.; 1 bull with spike-fork or 50-inch antlers or 3 brow tines on one antler.
Nonres. Season 5-15 Sept.; 1 bull with 50-inch antlers or 3 brow tines on one antler.

[g] West of pipeline; season 1-15 Sept.; 1 bull, nonres. season 5-15 Sept.; 1 bull with 50-inch antlers or 3 brow tines on one side.
Remainder area 1-10 Sept.; 1 bull.

Table 12. Mean days hunted for successful and unsuccessful hunters in southwestern, southeastern, northwestern, and northeastern Subunit 20D from 1986-87 to 1990-93.

Regulatory	Successful					Unsuccessful				
year	SW	SE	NW	NE	20D Combined	SW	SE	NW	NE	20DCombined
1986-87	3.8	3.0	5.3	4.1	3.9	5.5	10.5	6.1	7.0	6.0
1987-88	4.4	7.3	4.8	3.9	4.7	5.3	7.5	6.7	6.5	6.1
1988-89	4.6	6.2	5.3	4.5	5.0	5.9	6.3	5.8	6.5	6.0
1989-90	4.7	4.5	4.1	5.1	4.6	9.7	5.7	5.9	5.3	5.9
1990-91	4.9	6.6	3.9	6.5	4.7	3.5	5.6	5.8	6.3	5.9
1991-92	6.0	4.9	5.5	4.2	5.6	5.9	7.0	6.8	5.6	6.3
1992-93	4.7	5.7	5.4	4.9	5.0	5.9	5.1	6.8	5.2	6.2

Table 13. Subunit 20D moose harvest[a] chronology percent by time period, 1990-92.

Regulatory	Harvest periods				
year	9/1-9/5	9/6-9/10	9/11-9/15	Unk	*n*
1990-91	57	20	23	0	109
1991-92	60	23	16	10	144
1992-93	52	31	18	8	143

[a] Excludes permit hunt harvest.

Table 14. Subunit 20D moose harvest[a] percent by transport method, 1987-92.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk	*n*
1987-88	8	2	27	20	0	8	29	6	126
1988-89	10	2	24	18	0	9	29	9	126
1989-90	10	3	29	13	0	12	29	3	127
1990-91	7	0	25	20	0	12	33	3	118
1991-92	13	3	23	25	0	8	24	3	144
1992-93	8	1	26	18	0.1	8	36	1	143

[a] Excludes permit hunt harvest.

Table 15. Total snow depth and snow water equivalent (SWE) for four sites in Subunit 20D during spring (Mar-Apr) 1992-93 as measured by the Soil Conservation Service.

Location	1992		1993		Mean 1961-90	
	Snowpack	SWE	Snowpack	SWE	Snowpack	SWE
Ft. Greely	22"	4.6"	12"	2.4"	16"	3.3"
Granite Creek	21"	3.8"	21"	4.2"	17"	3.4"
Gerstle River	20"	3.7"	18"	3.3"	17"	3.2"
Shaw Creek	20"	3.9"	20"	4.8"	15"	2.9"

LOCATION

Game Management Unit: 20E (11,000 mi^2)

Geographical 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 Subunit 20E increased to a minimum of 12,000 moose. The population declined rapidly between 1965 and 1976 reaching a low of 2,200 moose. Since 1976, the moose population in Subunit 20E has remained at low densities (0.2-0.5 moose/mi^2). Gasaway *et al.* (1992) evaluated the roles that predation, nutrition, snow, harvest, and disease played in the decline and in limiting the moose population at low densities. They determined that predation was the primary factor and that other variables had little to no impact.

In response to declining moose and caribou populations, the Alaska Department of Fish and Game initiated more intensive predator management. Between 1981 and 1983, the wolf population was reduced by 54% in a 3,800 mi^2 area of Subunit 20E. In 1981 grizzly bear hunting regulations were liberalized, causing moderate harvest increases in portions of the subunit and area-specific declines.

Between 1981 and 1988, the moose population increased by 4-5% per year. The increase was probably due to the combined effects of favorable climatic conditions, the wolf reduction program, elevated public harvest of grizzly bears and wolves, and an increase in the area's caribou population which served as alternate prey for predators and hunters.

Subunit 20E has been popular among local hunters as well as hunters from Fairbanks and Southeast Alaska. Historically, harvest has been low in relation to the moose population and has been largely restricted to the Taylor Highway corridor and the Mosquito Fork drainage. During the last population high, the hunting season was long and the bag limit was one moose. As moose numbers began to decline, harvests were reduced by shortening the season length in 1973 and by eliminating cow seasons in 1974. However, the population continued to decline unitwide, and in 1977 moose hunting in Subunit 20E (then a portion of Subunit 20C) was terminated. A 10-day bulls-only season was opened in 1982 and continued until 1991. Despite the increase in hunting opportunity, hunter success has been 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 and thereby assure perpetuation of the population and its capability of providing:

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

Management Objectives

- Increase the moose population from an estimated 2,000-3,000 to 8,000-10,000 with an annual harvestable surplus of at least 3% by the year 2000 in the remainder of Subunit 20E.
- Increase the overall hunter success rate to at least 35%, while increasing hunter participation from 200 to 800 hunters by the year 2000 in the remainder of Subunit 20E.
- Maintain a posthunting ratio of at least 40 bulls:100 cows in all areas.

METHODS

Population Census:

We conducted moose population estimation surveys (Gasaway *et al.* 1986) in southwestern Subunit 20E (Mosquito Flats) in 1981, 1988, and 1992 and in southeastern Subunit 20E (Ladue River) in 1992. I calculated population growth rates by comparing the 1992 Mosquito Flats superstratification results with identical portions of the 1981 and 1988 census areas. I also compared population density and trend between the 1992 Mosquito Flats and Ladue River study areas. The two study areas differ in habitat quality, grizzly bear densities, human use, and proposed management directions.

Composition Surveys:

Sex and age composition was estimated in October and November 1991 and 1993, using aerial contour and transect surveys. All moose observed were classified as large bulls (antlers ^{3}50 inches), medium bulls (antlers larger than yearlings but <50 inches), yearling bulls (spike, cerviform, or small palmate-antlered), cows without calves, cows with one calf, cows with two calves, lone calves, or unidentified moose.

Predator Influence:

I used the predator-prey model developed by McNay (1993) to predict the response of the Subunit 20E moose population under different predator management programs. The input data I used for the model was collected through Subunit 20E survey and inventory activities and intensive Interior Alaska predator-prey studies.

Harvest:

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

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

During fall 1981 and 1988, censuses were conducted in a 2,978-mi^2 (7,700 km^2) area in southwestern Subunit 20E. We estimated population sizes of 601 ± 17.1% (90% C.I.) in 1981 and 1,149 ± 13.2% (90% C.I.) in 1988. Mean densities were 0.23 and 0.39 moose/mi^2 during 1981 and 1988, respectively. Based on census results, the estimated annual finite rate of growth between 1981 and 1988 was 1.09.

In 1992, we censused a 912 mi^2 portion of the 1981 and 1988 study area. In this area (referred to as the Mosquito Flats Study Area [MFSA]), we estimated a population size of 406 ± 24% (90% C.I.) moose and a density of 0.44 moose/mi^2. Using the boundaries of the MFSA, the estimated population size and density for 1981 was 355 and 0.39 moose/mi^2, and 601 and 0.66 moose/mi^2 for 1988. The annual rate of increase between 1981 and 1988 was 1.08, and between 1988 and 1992 it was 0.91. Based on census data, the moose population in Subunit 20E increased through the 1980s until 1988. Between 1988 and 1992, the population declined at least in the southwestern portion of the subunit.

In the Ladue River Study Area (LRSA), the 1992 estimated moose population was 652 ± 21% (90% C.I.). The mean density was 0.89 moose/mi^2, 2.0 times the density found in the adjacent MFSA. The LRSA was not censused during 1981 or 1988 and we do not know how this area's population size and trend compared to the MFSA during the 1980s.

The total 1992 population estimate for Subunit 20E was 5,075 moose. The estimated density was 0.46 moose/mi^2. To reach the minimum management objective of 8,000 moose by the year 2000, the population must increase at the annual rate of 1.08, equal to the growth rate observed between 1981 and 1988.

There has been much public and scientific debate whether predator management is biologically justifiable to elevate moose population in the Upper Tanana/Fortymile River Valleys. Gasaway *et al.* (1992) reported that the Subunit 20E moose population was being maintained at a low density dynamic equilibrium by wolf and grizzly bear predation. They determined that predator management was necessary to increase the moose population and maintain it at a higher abundance level. In response, opponents of wolf control have argued that a wolf control program in Subunit 20E would not work because grizzly bear predation is the primary limiting factor on the moose population. They based their conclusions on the results of the wolf control program conducted in Subunit 20E between 1981 and 1983. Unfortunately, this program was terminated prematurely due to political decisions; therefore, the results are nebulous and difficult to interpret. In an attempt to better predict the outcome of a wolf control program on the subunit's moose population, I entered the current population status and trend data for moose and their predators into a predator-prey model (McNay 1993).

The model predicts that under the current management program, the moose population in Subunit 20E will remain stable. If a 5-year wolf control program were conducted, a minimum removal of 50% of the wolf population would be necessary to cause a noticeable increase. If 80% of the wolves were removed, the moose population was estimated to increase 12% annually (Fig. 1). Under the more intensive wolf removal program, the population could increase to 10,000 moose by year 2000 and meet our population objective.

Population Composition:

During 1992 standard contour surveys were not completed; howeve, composition ratios were estimated from the MFSA and LRSA superstratification data. Calf, yearling bull, and bull:cow ratios were higher in the LRSA compared to the MFSA (Table 1). The higher bull:cow ratio in the LRSA was probably related to the low historic harvest rates due to minimal access into the area. Causes of the substantial difference in calf and yearling survival between the two study areas are not known. The past 5-year average, based on survey data from traditional count areas located within the MFSA and LRSA was 24.4 calves and 14.0 yearling bulls:100 cows in the MFSA compared to 25.3 calves and 11.7 yearling bulls:100 cows in the LRSA.

Between 4 November and 17 November 1993, traditional fall moose composition surveys were conducted in Subunit 20E (Table 2). The bull:cow and calf:cow ratios were 63:100 and 28:100, respectively. Between 1988 and 1992, the subunit's bull:cow ratio declined, but was still at a level indicative of a lightly harvested population and well above the minimum population objective of 40:100. The declining bull:cow ratio was directly related to moderate to high harvest rates in the more accessible portions of the subunit (Mosquito Flats, Mt. Fairplay, and Nine Mile Trail).

In Subunit 20E, the average calf:cow ratios increased from 12.7:100 between 1973 and 1982 to 19.3:100 between 1982 and 1988, and then to 28.7 between 1989 and 1993. Between 1982 and 1989, grizzly bear harvests were high and caused an estimated 30% reduction in the bear population in the central portion of Subunit 20E (Gardner in press). Since grizzly bears were the predominant predator on moose calves in this subunit (Gasaway *et al.* 1992), the increase in calf survival was attributed to a decline in the subunit's grizzly bear population (Boertje and Kelleyhouse 1993). In contrast, the grizzly bear population throughout the remainder of the unit was lightly harvested and probably remained stable. If grizzly bears were the primary factor in limiting moose calf survival, there should be a difference in calf recruitment between the area which received high bear harvest and an area that received little bear harvest and presumably still supported a more natural density of bears. I presented this analysis in Gardner (1993) and the result was no significant difference between the two areas.

I do not have alternate hypotheses for the comparable moose calf survival in the low and high bear harvest areas. Two possibilities are: 1) the effects of the bear harvest extend further than I assumed and 2) the burn in a portion of the control area was large enough to decrease hunting efficiency of predators.

Distribution and Movements:

Moose were well distributed throughout Subunit 20E. While resident moose remained in the Mosquito Flats area, most others moved seasonally from lowland summer habitat to upland rutting areas, where they remained until winter conditions caused them to move back to lower elevations. In fall 1988 and 1992, early deep snowfall (>22 inches) caused moose to move to lower elevations earlier than in previous years.

Mortality

Harvest:

Season and Bag Limit.

	Resident	Nonresident
That portion drained by the Ladue, Sixtymile, and Fortymile Rivers (all forks) from 9 1/2 to 145 mile Taylor Highway, including the Boundary Cutoff road.		
Resident Hunters: One bull.	1-15 Sept.	
Nonresident Hunters: One bull with 50" antlers.		5-15 Sept.
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: One bull.	5-25 Sept.	
Nonresident Hunters: one bull with 50" antlers.		5-25 Sept.

Game Board Actions and Emergency Orders. There were no changes in the moose seasons and bag limits for Subunit 20E during the report period.

During November 1992, the Board of Game (BOG) adopted a wolf management plan that incorporated the major population objectives for Subunit 20E moose and the Fortymile caribou herd. To meet these objectives, the plan called for a 70-80% reduction of the wolf population within most of the western half of Subunit 20E. Implementation of the plan was to begin after 1 January 1993, but in December 1992 the plan was postponed by Governor Hickel to allow for greater public input. In January 1993, in response to public dissatisfaction, the BOG rescinded the plan. In June 1993, the BOG decided it was in the best interest of the state to conduct only one wolf control program at a time. The BOG opted to initiate a wolf control program in Subunit 20A and, therefore, did not adopt the Upper Tanana/Fortymile Plan. The board's decision in conjunction with the current predator and moose population status and trends in Subunit 20E will prevent our meeting the moose management objectives.

Hunter Harvest. Total reported harvest in Subunit 20E during the fall 1992 season was 69 bulls (Table 2) or about 1% of the estimated population. The average reported harvest for the last 5 years was 60. The preliminary harvest estimate for fall 1993 is 115, the highest recorded harvest for Subunit 20E. Probable causes of the higher 1993 harvest are: 1) the new regulation adopted throughout southcentral Alaska restricting harvest to bulls with spike/fork or antlers >50 inches caused a displacement of hunters into the area and 2) the Fortymile caribou season was open concurrently with the moose season attracting hunters interested in hunting both species.

Of the 69 moose harvested in 1992, 29 (42%) and 19 (28%) moose were taken in the Mosquito Fork and Dennison Fork drainages, respectively. In northern Subunit 20E, 9 (13%) were taken along the Yukon, Charley, and Seventymile Rivers (7, 1, and 1, respectively). The harvest of the remaining 12 moose was spread out fairly equally over the main stem of the Fortymile River, the North Fork, and along the Ladue River.

The mean antler spread of bulls taken in Subunit 20E was 47.5 inches, exceeding the 5-year mean of 46.1 inches. The 1992 average antler spread was the highest recorded since 1987. Seven bulls (10.1%) were judged to have been yearlings (antlers <30 inches), 23 (33.3%) were 2-4 years old (antler spread 30.0-49.9 inches), and 36 (52.2%) were mature bulls (antler spread ^{3}50 inches). Of the mature bulls, 13 (36.1%) had antler spreads >60 inches. Antler spreads were estimated for 281 and 282 bulls observed during posthunting aerial surveys in 1991 and 1993, respectively. The age composition was 16-22% yearlings, 41-46% 2- to 4-year-olds, and 36-37% mature bulls. Based on 1992 harvest results, hunters were either selecting for larger bulls, or large antlered bulls were more vulnerable to harvest. Because the moose density is low in Subunit 20E and most hunters are primarily looking for meat, I doubt many hunters were selective.

Hunter Residency and Success. Of the 69 bulls harvested in 1992, 15 (21.7%) were taken by residents of Units 12 and 20E (Table 3) including 5 taken by residents of Chicken and Eagle. Nonlocal residents reported taking 45 moose in Subunit 20E. Of these, 16 were from Southcentral Alaska, 9 from Southeast Alaska, and 10 from Interior Alaska. Nonresident hunters had been prohibited from hunting moose in Subunit 20E between 1984 and 1991. During the 2 years of open hunting, nonresidents have accounted for 3% and 6% of the harvest.

During 1992, 289 hunters reported hunting moose in Subunit 20E, which is lower than the 5-year average of 330. Hunter success was 24% exceeding the 5-year average of 18.2%. The success rate of the local residents was 22% compared with a 25% success rate for nonlocals. Local resident success has averaged 23.1% the past 5 years. Currently, both the number of hunters and the harvest success rate are below the management objectives.

Harvest Chronology. Since the moose hunting season in most of Subunit 20E between 1986 and 1991 was limited to 10 days, analysis of harvest chronology was of limited value. Most hunting pressure and harvest occurred during the first week of the season (Table 4). However, in 1991 and in 1993, more hunters took advantage of the longer season offered in the northern portion of the subunit.

Transport Methods. In Subunit 20E during the past 5 years, most moose hunters used highway vehicles (37.5%); fewer hunters used 4-wheelers (24.4%), boats (15.3%), aircraft (13.6%), and other ORVs (9.1%). Hunters using highway vehicles had the lowest success rate (12.1%), while hunters using offroad vehicles and airplanes had the highest success rates with 30.4% and 29.7% success, respectively. Hunters using 4-wheelers have a success rate of only 14.8%. However, during the past 2 years the number of successful hunters using 3- or 4-wheelers has increased substantially (Table 5). I believe the cause of the increased success was that hunters using 3- or 4-wheelers have begun using several trails that offered access into moose concentration areas.

The increasing number and success rate of hunters who use 3- or 4-wheelers have become concerns. Because Subunit 20E supports a low density moose population, once hunters access moose concentration areas, harvest rates will increase and cause a decline in the bull:cow ratio. This scenario occurs more commonly in areas accessible by 3- or 4-wheelers, as hunters using this type of transportation tend to concentrate more than hunters who use other transportation types.

Other Mortality:

Predation by wolves and grizzly bears is the greatest source of mortality for moose in Subunit 20E and is presently maintaining the population at a low density (0.46 moose/mi^2). Using the model presented by McNay (1993), I estimated that 28% of the postcalving moose population is being killed by wolves and grizzly bears and about 1% is harvested by humans.

Habitat

Assessment:

Presently in Subunit 20E, the availability of browse is not limiting moose population growth. Recent browse studies indicate most of the preferred browse plants are not being utilized, and use of the current year's growth has been less than 5% (Boertje *et al.* 1985). Over 10% of the subunit, primarily the southeast portion, has burned within the last 25 years offering excellent browse. However, much of western Subunit 20E supports climax forest and does not offer substantial moose browse.

Enhancement:

Implementation of the Alaska Interagency Fire Management Plan is expected to restore a near-natural wildfire regime to over 60% of Subunit 20E. Under the plan, much state and federal land was accorded limited fire protection. Unfortunately, nearly all land selected by Native corporations was accorded modified or full-suppression status. Vegetation communities in these areas will continue to degrade to the detriment of moose and other wildlife species that fare best in a fire-shaped environment.

CONCLUSIONS AND RECOMMENDATIONS

Between 1981 and 1988, the moose population in Subunit 20E increased 5-9% annually reaching a density of 0.33 to 0.49 moose/mi^2. Between 1988 and 1992, the population had stabilized or slightly declined. Recent research has shown that wolf and grizzly bear predation was the primary factor limiting the subunit's moose population. The combination of wolf and bear predation is taking about 28% of the postcalving moose population annually. During June 1993, the BOG decided not to allow a wolf control program to be conducted in Subunit 20E. Because of that decision and the present low moose density in Subunit 20E, we can expect the moose population to remain at a low level and the population objective will not be reached by the year 2000. If intensive wolf management is adopted within the next 2 years, the moose population and human use objectives that are strongly supported by area residents can still be met by the year 2002.

In an attempt to reduce the effects of predation on the area's moose population, grizzly bear hunting regulations were liberalized in 1981. As a result, bear harvest increased, causing bear numbers to decline as much as 30% in parts of the subunit. Moose calf survival increased during this period. However, how much of the increase was due to the grizzly bear population decline is not known. I recommend retention of the liberal bear regulations, but harvest results should be studied to document the effects on moose population growth.

Harvest by humans is having little impact on the subunit's moose population. Annual harvest rates have historically been less than 3% of the fall population estimate and for the past 5 years have been less than 2%. The bull:cow ratio has declined over the past 5 years due to moderate harvest rates in the more accessible areas, but still the overall subunit bull:cow ratio indicates a lightly harvested population. Therefore, greater hunting restrictions may be necessary to protect the bull segment of the population in the accessible areas or where people are pioneering routes into areas supporting high moose concentrations.

Federal, state, and Native land managers with responsibilities for managing wildlife habitat on their lands should be persuaded to allow a natural fire regime. Continued degradation of habitat diversity and quality will result as long as naturally ignited wildfires continue to be suppressed. Allowing a more natural fire regime will benefit the subunit's moose population and eventually subsistence and nonconsumptive users.

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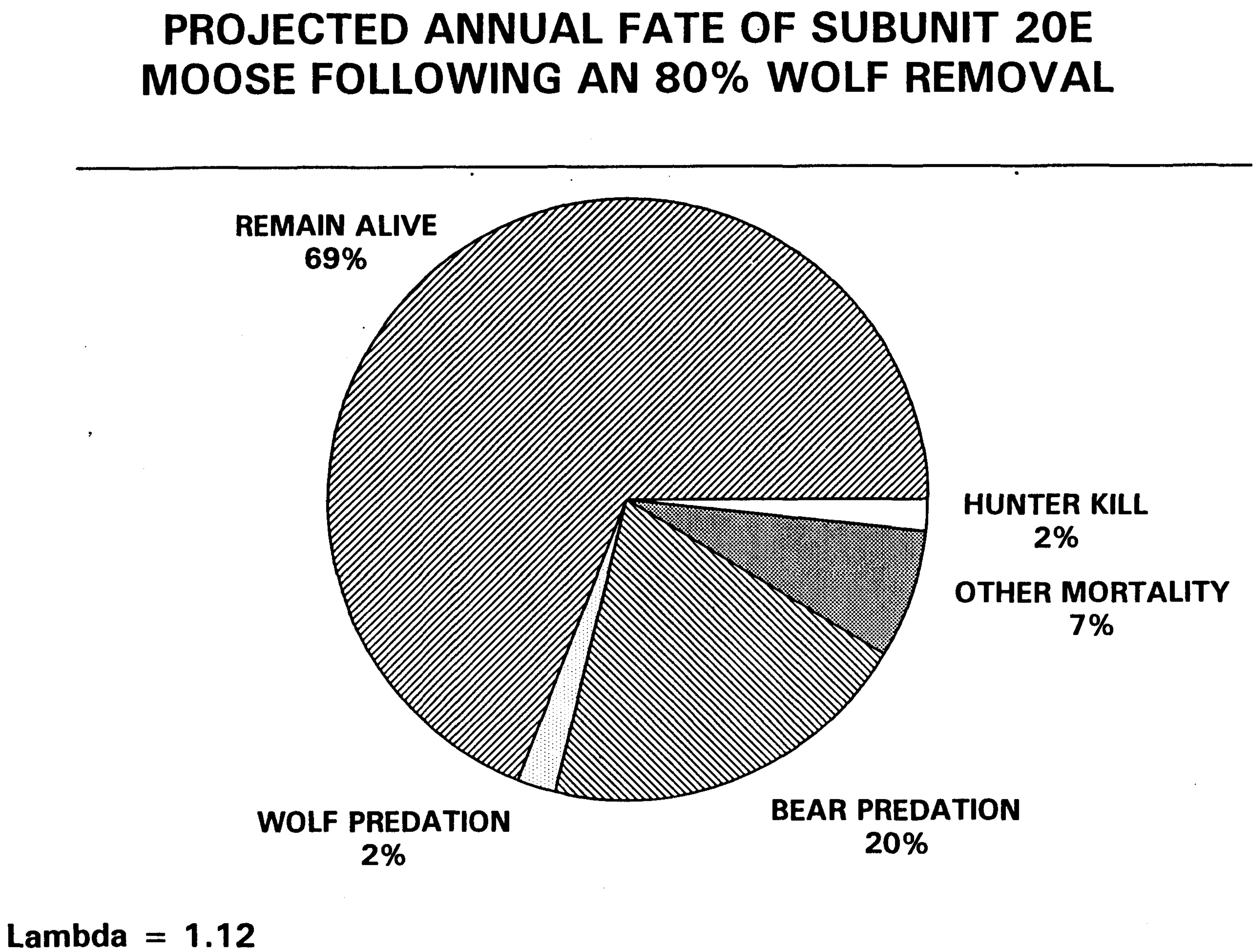

Fig. 1. Predicted response of the Subunit 20E moose population to intensive wolf control.

Table 1. Subunit 20E aerial moose composition counts, 1988-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1988-89	78	13	22	117	11	931	1,048[a]	30
1989-90	56	11	43	43	21	158	201	22
1990-91	64	9	30	105	16	566	671	30
1991-92	65	14	28	120	14	714	834	42
1992-93[b]	59	11	17	19	12	141	160	
1992-93[c]	75	15	28	32	14	200	232	
1993-94	63	10	28	126	15	727	854	40

[a] Includes 585 moose from census not used for moose/hour.

[b] Census results from the Mosquito Flats Study Area.

[c] Census results from the Ladue River Study Area.

Table 2. Subunit 20E moose harvest and accidental death, 1988-93.

Regulatory year	Harvest by Hunters							Accidental death			
	Reported				Estimated						
	M (%)	F (%)	Unk	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1988-89	56 (98)	0	1	57	4-7	5-15	9-22	0		0	66-79
1989-90	37 (100)	0	0	37	4-7	5-15	9-22	0		0	46-59
1990-91	46 (100)	0	0	46	4-7	5-15	9-22	0		0	54-61
1991-92	90 (99)	0	1	91	4-7	5-15	9-22	0		0	100-113
1992-93	68 (99)	0	1	69	4-7	5-15	9-22	1		1	79-92
1993-94[a]	115 (100)	0	0	115	4-7	5-15	9-22	0		0	124-137

[a] Preliminary data.

Table 3. Subunit 20E moose hunter residency and success, 1988-92.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total[b](%)	Local[a] resident	Nonlocal resident	Nonresident	Total[b](%)	
1988-89	14	36	2[c]	57 (17)	44	243	--	287 (83)	344
1989-90	15	22	--	37 (13)	42	202	4	250 (87)	287
1990-91	16	28	--	46 (16)	65	176	2	249 (84)	295
1991-92	34	54	3	91 (21)	112	219	9	343 (79)	434
1992-93	15	45	4	69 (24)	52	135	9	220 (76)	289

[a] Residents of Unit 12 and Subunits 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.

[c] Harvested illegally by nonresident.

Table 4. Subunit 20E moose harvest chronology by time period, 1988-93.

Regulatory year	Harvest periods					Total[a]
	9/1-9/6	9/7-9/13	9/14-9/20	9/21-9/27	9/28-10/5	
1988-89	27	18	7	2	0	57
1989-90	15	9	6	5	0	37
1990-91	20	9	7	6	0	46
1991-92	25	26	22	14	0	91
1992-93	29	28	5	5	0	69
1993-94[b]	45	37	21	6	0	115

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

[b] Preliminary data.

Table 5. Subunit 20E moose harvest and percent by transport method, 1988-93.

Regulatory year	Airplane (%)	3- or Horse (%)	Boat (%)	4-Wheeler (%)	Snowmachine (%)	ORV (%)	Highway vehicle (%)	Unk (%)	*n*
1988-89	15 (26)	1 (2)	8 (13)	9 (16)	0 (0)	6 (10)	11 (20)	7 (12)	57
1989-90	10 (27)	0 (0)	6 (16)	6 (16)	0 (0)	6 (16)	7 (19)	2 (5)	37
1990-91	7 (15)	3 (7)	10 (22)	6 (13)	0 (0)	8 (17)	7 (15)	5 (11)	46
1991-92	11 (12)	2 (2)	18 (20)	10 (11)	0 (0)	15 (16)	35 (38)	0 (0)	91
1992-93	17 (25)	1 (1)	4 (6)	21 (30)	1 (1)	7 (10)	15 (22)	3 (4)	69
1993-94[a]	29 (27)	0 (0)	15 (14)	33 (30)	0 (0)	6 (5)	23 (21)	3 (3)	109

[a] Preliminary data.

LOCATION

Game Management Unit: 21B (4,871 mi^2)

Geographical Description: Lower Nowitna River, Yukon River between Melozitna and Tozitna Rivers

BACKGROUND

Although the establishment of moose in Interior Alaska occurred fairly recently in geologic time, they were present early enough to be mentioned in even the earliest human accounts for the area. Moose had become fairly abundant by the time gold seekers converged on the area in the early 1900s. The village of Ruby had a population of 10,000 people during the 1910 gold rush, and many moose were hunted to supply the townsfolk and miners with meat. The area supported a large moose population from the early 1900s to late 1970s. Several severe winters in the late 1960s and early 1970s initiated widespread declines in moose populations throughout the Interior.

Historically, naturally occurring wildfires have been a major force affecting the productivity and diversity of moose habitat in this area. A major portion of the area was burned by large fires prior to the 1950s when effective fire suppression substantially altered this fire regime. The 1982 Tanana-Minchumina Fire Plan provided the mechanism for returning to a natural fire regime in most of this area by allowing some fires to burn with minimal interference.

The Nowitna River (Novi) drainage to the east of Ruby is the main hunting area for residents of Ruby, Tanana, and, to a lesser extent, Galena. It is also a popular hunting area for Fairbanks residents who use boats and aircraft for access. Because of its long history of use by both local and nonlocal hunters, this area has been the focus of much of the management effort in Subunit 21B over the years.

Aerial surveys in 1977-79 indicated moose numbers were declining in the Novi. Wolves were believed abundant compared with the number of moose, and predation by wolves was probably responsible for the decline in moose numbers. Thus, a wolf control program was approved to augment the existing harvest by hunters and trappers. Total harvest from the drainage, including part of Subunit 21A, during the 3 years of the program amounted to 61 wolves (ADF&G 1983). Hunting restrictions were also implemented while the wolf control program was in effect.

Population estimate surveys (Gasaway *et al.* 1986) in November 1980 and 1990 in a 2,774-mi^2 portion of the subunit that includes the lower Novi indicated that the population declined from 2,386 ± 429 moose to 1,719 ± 237 moose. This difference was significant at the 80% level, but not at the 90% level. Thus, there is a 20% chance the actual 1980 and 1990 population levels were the same. In 1986 a population estimation survey in a 1,556 mi^2 within the 1980 census area indicated a reduction in moose numbers.

Since 1981, hunters have had a 20-day long season and a bag limit of one bull moose per hunter per season. Harvest reports indicate the number of hunters using the Novi has remained stable and the annual harvest has averaged 49 bulls over the last 10 years. A moose hunter check station was operated at the mouth of the river from 1979 to 1983 and from 1988 to the present.

Besides the lower portion of the Novi drainage, Subunit 21B includes the area east of the Ruby-Poorman Road, the banks of the Yukon River from Ruby to Tanana, the Blind River, and the Boney River. These areas produce from 36% to 46% of the reported harvest.

MANAGEMENT DIRECTION

Management Goals

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

2. Provide for continued use of moose by local Alaskan residents who have customarily and traditionally used the population.

3. Provide the greatest sustained opportunity to participate in hunting moose.

4. Provide an opportunity to view and photograph moose.

5. Provide for scientific and educational use of moose.

Management Objectives

The overall objective is to increase the moose population in Subunit 21B to 4,000-4,500 by 1995. More specific objectives have been described for three management areas within the subunit:

The Floodplain Areas of the Yukon and Novi Rivers (400 mi^2):

1. Maintain or increase November moose densities to 2.5-4.0 moose/mi^2.

2. Support an average annual harvest of 40 moose. This would equate to an annual harvest rate of about 2.5-4.0% from the desired population of 1,000-1,600 moose.

Remainder of the Novi Drainage in Subunit 21B (2,200 mi^2):

1. Maintain or increase November moose densities to 0.5 moose/mi^2.

2. Support an average annual harvest of 20 moose. This would equate to an annual harvest rate of less than 2% from the desired population of 1,100-1,300 moose.

Elsewhere in the Unit (2,300 mi^2):

1. Maintain or increase November moose densities to 0.5 moose/mi^2.

2. Support a minimum annual harvest of 30 moose. This would equate to an annual harvest rate of less than 2% from the desired population of 1,600-1,700 moose.

METHODS

Established trend count areas were surveyed from Piper PA-18 (or equivalent) aircraft to assess population status and trend by U.S. Fish and Wildlife Service (FWS). Contiguous survey units of approximately 12 mi^2 each were searched at a rate of at least 5 min/mi^2 to ensure reasonably high sightability, minimal bias, and data comparability between years.

Mortality due to hunting was monitored by checking moose harvest reports and collecting information on hunter residency, moose ages, and antler sizes at a moose hunter check station operated by FWS. Overall mortality due to predation was inferred from interviews with wolf trappers and survey estimates of wolf abundance and distribution. The calf mortality data was from a 1991 study (Osborne *et al.* 1991).

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Based on the results of the 1990 population estimation survey, I estimate there are from 2,635 to 3,785 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 0.86 moose/mi^2 was applied to the remainder of the subunit. High moose densities (2.0-4.0 moose/mi^2) exist in favorable habitat along the Nowitna floodplain and immediately adjacent to the Yukon River. Densities are low to moderate (0.2-0.9 moose/mi^2) away from the river.

Moose density data collected from established trend areas along the lower Novi also indicate the population has increased since 1986, although it is unclear whether that increase is continuing (Tables 1 and 2).

Population Composition:

Composition data are available from aerial surveys conducted with the help of FWS staff in established trend areas on the Nowitna National Wildlife Refuge (Tables 1 and 2). The 1993-94 results indicate bull:cow ratios are remaining stable, calf:cow ratios are down but good, and overwinter survival of calves to yearling age indicates poor recruitment. The occurrence of twin calves among moose observed in these early winter surveys was very poor, ranging from 0-6%. A population with these attributes can be expected to remain stable under light predation. The fact that the bull:cow ratio has been decreasing indicates localized overhunting may be occurring along the river corridor.

Distribution and Movements:

Surveys indicate that moose are numerous along the floodplains of the Nowitna and Yukon Rivers during early winter. The riparian areas contain extensive *Salix pulchra* and *S. alaxensis* stands, preferred browse species for moose.

Most cow moose spend their summer months around open grass and brush meadows on the floodplain away from the river. In October they move to the riparian areas, where they remain until early May. Some cow moose winter in the hills to the north and south of the Novi.

Mortality

Harvest:

Season and Bag Limit.

	Resident	Nonresident
Unit 21B: One bull.	5 Sept.-25 Sept.	5 Sept.-20 Sept.

Game Board Actions and Emergency Orders. In 1990 the Board of Game reduced the nonresident season by 5 days from 5-25 September to 5-20 September. At the spring 1993 meeting, the Board of Game restored the nonresident season ending date to 25 September but added a 50-inch antler spread or 4 brow tine on either side restriction. This action aligned the season length and bag limit with adjacent Subunit 21A. Nonresident hunters using the Nowitna River previously had to contend with different season lengths and bag limits between the upper and lower sections.

Harvest. The estimated harvest for the subunit has remained fairly stable and has averaged 89 moose annually over the past 5 years (Table 3). The unreported harvest is estimated at 5 moose per year in the Ruby area and 10 moose per year in the Tanana area. The Nowitna drainage has produced from 54% to 64% of the subunit's harvest during the last 5 years.

Check Station Results. Since 1988, a moose hunter check station has been located at the mouth of the Novi and operated in cooperation with the FWS to interview hunters using boats on the Novi River. The FWS has solely operated the station since 1992. The results (Table 4) indicated most of the hunters came from the Fairbanks area.

Hunter Residency and Transportation Methods. Based on harvest reports (Table 5), the majority (60%) of hunters were Alaskan residents who resided outside the subunit. Twenty-four percent of the hunters resided in Ruby, Tanana, and Galena. Because of easy river access, 67% of the hunters used boats (Table 6). Another 10% used aircraft, 8% hunted via vehicles on the Ruby-Poorman Road, and 5% were unknown.

Other Mortality:

Predation mortality on moose calves is significant in the subunit (Osborne *et al.* 1991). Black bears were the main predator, killing 38% of all calves. Wolves killed 11% of all calves, unknown predators killed 8%, grizzly bears killed 2%, and 5% died from other natural causes.

Habitat Assessment

No new data were collected on habitat conditions during this report period. Prior observations have indicated that browse availability is not currently limiting the moose population in the subunit.

CONCLUSIONS AND RECOMMENDATIONS

Statistical comparison of the 1980, 1986, and 1990 population estimation surveys indicated the population declined in the early 1980s and increased in the late 1980s. Data from the 1988-93 surveys of permanent trend count areas support the conclusion that the population has grown since 1986 but may be stabilizing.

Predation was probably the primary cause of the decline. Predators remain abundant and continue to be the primary factor controlling moose abundance. The moose calf mortality study indicated that black bears were the major predator on moose calves (Osborne *et al.* 1991).

The moose population level and harvest are currently at planned levels on the floodplain of the Novi. However, the estimated unit-wide moose population currently falls short of the desired level by about 1,000 moose (16-34%). Additional survey information is needed in the remainder of the unit.

The bull:cow ratio is good to fair and may be slowly decreasing. The annual harvest of about 49 bulls is adversely impacting the availability of bulls for hunting in some localized situations. Further monitoring of the bull:cow ratio should continue.

For the present, the seasons should remain the same. However, efforts should be made to increase the harvest of predators.

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Table 1. Subunit 21B Novi/Sulatna confluence trend count area fall aerial moose composition counts, 1988-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1988-89	26	14	52	30	29	73	103	2.1
1989-90	15	5	27	37	19	160	197	2.7
1990-91	33	5	33	20	20	81	101	2.9
1991-92	21	9	29	39	20	161	200	2.7
1992-93	18	1	48	49	29	122	171	2.3
1993-94	22	7	20	27	14	168	195	2.6

Table 2. Subunit 21B Novi Mouth trend count area fall aerial moose composition counts, 1988-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1988-89	22	11	26	28	18	131	159	3.8
1989-90	30	11	27	30	17	144	174	2.6
1990-91	24	10	58	46	32	98	144	2.9
1991-92[a]	--	--	--	--	--	--	--	--
1992-93	30	0	29	28	20	114	142	2.4
1993-94	30	6	30	37	19	159	196	3.3

[a] No survey.

Table 3. Subunit 21B moose harvest, 1988-93.

Regulatory year	Harvest by hunters: Reported M	F	Unk	Total	Estimated Unreported	Illegal	Total
1988-89	102	0	0	102	15		117
1989-90	74	0	0	74	15		89
1990-91	81	0	0	81	15		96
1991-92	65	0	0	65	15		70
1992-93	46	0	0	46	15		61

Table 4. Residency (*N*), harvest (*n*), and success (S%) of moose hunters stopping at the Nowitna River hunter check station, Subunit 21B, 1988-94.

Year	Local villages			Fairbanks			Other residents			Nonresident			Unknown			Total		
	N	*n*	S%	*N*	*n*	S%	*N*	*n*	S%	*N*	*n*	S%	*N*	*n*	S%	*N*	*n*	S%
1988-89	33	9	27	103	40	39	14	5	36	11	5	46	9	0	0	170	59	31
1989-90	32	5	16	94	29	31	23	9	28	12	6	50	6	0	0	167	49	29
1990-91	23	7	30	67	32	48	26	12	46	14	4	29	0	0	0	130	55	42
1991-92	21	9	43	72	24	33	44	11	25	17	2	12	0	0	0	154	46	30
1992-93	24	3	12	38	19	50	53	10	19	10	2	6	0	0	0	125	34	27
1993-94	19	9	16	57	27	48	34	18	32	20	1	2	2	1	2	132	56	42

Table 5. Subunit 21B moose hunter residency and success, 1988-93.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local resident	Nonlocal resident	Nonres.	Unk	Total	Local resident	Nonlocal resident	Nonres.	Unk	Total	
1988-89	22	57	9	14	102	8	45	4	4	61	163
1989-90	19	49	6	0	74	11	60	7	3	81	155
1990-91	22	48	8	3	81	10	41	1	1	53	134
1991-92	21	34	8	2	65	21	56	8	1	86	151
1992-93	12	31	2	1	46	24	55	10	1	90	136

Table 6. Subunit 21B moose harvest by transport method, 1988-93.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unk	Total
1988-89	10	0	70	0	1	0	6	15	102
1989-90	9	0	56	0	0	0	8	1	74
1990-91	9	1	63	0	0	2	5	1	81
1991-92	14	2	114	0	0	0	15	6	151
1992-93	13	0	104	2	0	0	11	6	136

LOCATION

Game Management Unit: 21C (3,671 mi^2)

Geographical Description: Dulbi River above Cottonwood Creek and Melozitna River above Grayling Creek

BACKGROUND

Moose have inhabited Subunit 21C since historic times. Moose densities are generally low; population trend is unknown. There has been little need to extensively monitor this moose population because human use is low and not adversely affecting the population.

The terrain in the subunit is quite mountainous, with peaks as high as 5,000 feet. Two large river drainages, the Melozitna and the Dulbi, intersect the mountains. Numerous fires have burned in the area, producing large expanses of excellent winter habitat.

Moose harvests have ranged from 15 to 30 bulls during the past 15 years. Aircraft provide the only practical access to most of the subunit. A waterfall near the mouth of the Melozitna River restricts travel up that river and extensive sand bars impede boat access to the upper Dulbi River.

MANAGEMENT DIRECTION

Management Goals

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide the greatest sustained opportunity to participate in hunting moose.

Management Objectives

- Increase the moose population to 2,500-3,000 moose in the Melozitna River drainage to increase hunting opportunity.
- Maintain the moose population of 550-750 in the Dulbi River drainage to sustain hunting opportunities.

METHODS

A moose stratification survey was attempted in November 1992 to assess relative density levels and to locate areas for possible future surveys. The subunit was divided into four sections based on Uniform Coding Unit drainages, maps of the sample units were drawn, and areas were calculated. Harvest levels were monitored by reviewing the moose harvest reports submitted by hunters. Mortality by predation was assessed by interviewing wolf trappers.

RESULTS AND DISCUSSION

Population Status and Trend

The moose stratification survey was started on 20 November 1992. The four sections to be surveyed were: Melozi River 1470.3 mi^2 (121 sample units); Upper Melozi River 600.2 mi^2 (49 sample units); Little Melozi River 576.5 mi^2 (47 sample units); and that portion of the Dulbi River drainage not surveyed in 1987 142.5 mi^2 (12 sample units). We surveyed 47 units before a snowstorm curtailed flying. Over the next 4 days, continuous IFR flying conditions precluded any further surveys. At the end of the storm all the available funds, which would have gone towards flight hours, had been spent on the charter operator's 4-hour daily minimum and the stratification was canceled. In the 575 mi^2 we flew, the extrapolated moose density ranged from 0.4-0.6 moose/mi^2. No information was collected on sex or age composition. Prior data indicated good bull:cow and calf:cow ratios (Table 1). However, the ratio of yearling bulls:100 cows was low.

Mortality

Harvest:

Season and Bag Limit. The open season for all hunters is 5-25 September. The bag limit is one bull moose.

Game Board Actions and Emergency Orders. The seasons and bag limits have remained the same during the past 10 years. No changes were made during this reporting period.

Hunter Harvest. The harvest in the subunit has been stable, ranging from 9 to 25 moose annually for the past 5 years (Table 2).

Hunter Residency and Transportation Methods. Currently, no one lives within the subunit. Hunters who reported hunting in Subunit 21C were either state residents residing outside the subunit or nonresidents (Table 2). Hunters mainly used aircraft for transport (Table 3).

Other Mortality:

There are at least 50-60 wolves in the subunit. Grizzly bear habitat is excellent and the estimated density of bears is 1/40 mi^2. Moose and caribou are available as prey for wolves and bears. The Melozitna River also has a major salmon run. Predation is probably the main limiting factor on moose in the subunit.

CONCLUSIONS AND RECOMMENDATIONS

The moose population is low. Human use of the population also remains low. A reasonable estimate of current moose density would be 0.5-1.0 moose/mi^2, based on scant survey data and stratification surveys and densities observed elsewhere in the Interior. If this estimate is correct, it would mean previous harvest levels (15-30 moose/yr) accounted for 0.4-1.6% of the projected population of 1,836-3,671 moose each year. It seems likely that existing hunting pressure could be sustained even if the population experienced a 50% reduction. If no major changes occur, the population should be capable of sustaining double the current harvest without management actions. I recommend minimal commitment of management effort in the subunit until either hunting pressure significantly increases or the population experiences a substantial decline.

A stratification survey of the area should be conducted to ascertain moose distribution, relative abundance, and determine areas for future trend surveys.

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Table 1. Summary of fall aerial moose survey data from Subunit 21C, 1987-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Density moose/mi^2	Area (mi^2)	Estimated population size
1987-88[a]	81	4	35		16		0.7	100.7	67
1988-89[b]	--	--	--		--		--	--	--
1989-90[b]	--	--	--		--		--	--	--
1990-91[b]	--	--	--		--		--	--	--
1991-92[b]	--	--	--		--		--	--	--
1992-93[b]	--	--	--		--		--	--	--
1993-94[b]	--	--	--		--		--	--	--

[a] Source: Dulbi River moose population estimation survey.
[b] No surveys flown.

Table 2. Subunit 21C moose hunter residency and success, 1988-93.

Regulatory year	Successful: Local[a] resident	Nonlocal resident	Nonres.	Unk	Total	Unsuccessful: Local[a] resident	Nonlocal resident	Nonres.	Unk	Total	Total hunters
1988-89	0	13	7	1	21	2[b]	4	3	1	8	29
1989-90	0	14	4	0	18	0	5	1	0	6	24
1990-91	1[b]	18	5	1	25	0	9	3	0	12	36
1991-92	0	15	5	0	20	0	17	3	0	20	40
1992-93	0	7	2	0	9	0	15	7	0	22	31

[a] Resident of Subunit 21C.
[b] Resident of adjacent subunit.

Table 3. Subunit 21C moose harvest by transport method, 1988-93.

Regulatory year	Harvest: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1988-89	17	0	4	0	0	0	0	0	21
1989-90	16	0	1	0	0	0	0	1	18
1990-91	19	0	2	0	0	0	0	3	24
1991-92	19	0	1	0	0	0	0	0	20
1992-93	8	0	1	0	0	0	0	0	9

LOCATION

Game Management Unit: 21D (12,113 mi^2)

Geographical Description: Yukon River from Blackburn to Ruby and Koyukuk River drainage below Dulbi Slough

BACKGROUND

Within historic times moose are a relatively new addition to the fauna of Subunit 21D. Natives first reported seeing occasional moose tracks during winters in the 1930s. During the 1940s and early 1950s, the numbers of moose and wolves slowly increased. Then during the 1950s, federal wolf control and aerial shooting reduced the wolf population, causing a rapid expansion of the moose population during the late 1950s through the 1960s. Statehood in 1959 brought an end to federal wolf control. Legal aerial shooting was stopped with the passage of the Airborne Hunting Act in 1972 and wolves once again became abundant. The moose population reached peak numbers about 1970 (S. Huntington, pers. commun.) and then either stabilized or declined slightly in response to increased predation and hunting levels.

In 1979, the Koyukuk Controlled Use Area (KCUA) was established to reduce participation by hunters from outside the subunit by prohibiting the use of aircraft. However, by 1986 hunters arriving by boat from outside the subunit equalled the number of hunters who previously accessed the area by aircraft.

A moose hunter check station has been operated on the Koyukuk River since 1983. It has enabled me to accurately determine the number of hunters using the river to access the KCUA within Subunit 21D. It has also been a valuable method to educate local residents on licensing and reporting requirements.

Large (100,000-200,000 acres) fires during 1974 and 1977 in the uplands along the Koyukuk River improved moose winter habitat in the subunit. Since 1980, trappers who have used aircraft to land near wolves have been able to consistently shoot enough wolves to keep predation on moose stable at a reduced level. The presence of numerous large lakes and rivers near moose winter concentration areas makes this "land-and-shoot" method particularly effective in Subunit 21D.

Moose trend count areas (TCAs) established in 1981 in the Three-day Slough and Yukon floodplain areas have indicated an increasing density of moose. Initially I thought the increase in density was due to better surveys, but a population estimation survey of the Kaiyuh Flats and the eastern drainages of the Koyukuk River in 1987 confirmed the trend. Moose densities were high along the Yukon River floodplain (3-6 moose/mi^2) and very high between the Kateel River and Dulbi Slough, where densities averaged 9 moose/mi^2 in early winter.

Nineteen moose radio-collared in 1984 in the Three-day Slough area established distribution patterns for moose in that portion of the subunit. Movement patterns are unknown in the rest of the subunit.

There are four villages within the subunit (Kaltag, Nulato, Koyukuk, and Galena), and the residents of each village have traditional hunting areas. However, the area used by Galena residents overlaps those used by residents of some of the other villages because many of the residents of Galena have larger boats and can travel farther. Although Huslia is only 30 miles from Subunit 21D, its residents rarely hunt for moose within the subunit. Nonresidents and Alaskans residing outside Subunit 21D have mainly hunted the Koyukuk River between the Kateel River and the Unit 24 boundary where competition with residents of Subunit 21D was less likely.

The reported harvest prior to 1981 was largely inaccurate because many local residents either did not obtain licenses or failed to report. In 1981, I made it easier for residents of the subunit to obtain harvest reports. Educational and enforcement efforts have increased the reporting rate by local residents.

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 population of at least 4,000 moose south and east of the river, including the Three-day Slough area.

- Maintain an early winter density of at least 4 moose/mi^2 within the Three-day Slough floodplain.

- Maintain a posthunt ratio of at least 30 bulls:100 cows in the population being monitored by the Three-day Slough TCA.

- Develop guidelines for maximum winter browse use within the Three-day Slough area.

- Maintain a moose population level of 900-1,000 in the Kateel River drainage and develop a population level for the Gisasa River.

Yukon River Floodplain:

- Maintain an early winter density of at least 3 moose/mi^2 in floodplain areas along the Yukon River that are subject to both the September and February hunting seasons.

Elsewhere in the Subunit Including Yuki and Nulato Rivers:

- Determine the population level and density estimate by 1994.

METHODS

Established trend count areas were surveyed from Piper PA-18 (or equivalent) aircraft to assess population status and trend. Contiguous survey units of approximately 12 mi^2 each were searched at a rate of at least 5 min/mi^2 to ensure reasonably high sightability, minimal bias, and data comparability among years. I surveyed these areas with staff from the U.S. Fish and Wildlife Service (FWS), Koyukuk/Nowitna National Refuge Complex.

Twinning surveys were flown in May using standard search techniques to determine the percentage of moose calves which were twins versus singles.

Hunting mortality and distribution were monitored through harvest tickets and check stations. Local residents were encouraged to increase their harvest reporting through school visits and check stations. Predation was monitored by interviewing trappers, relocating radio-collared animals, and conducting track surveys in cooperation with FWS.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Moose populations are healthy throughout most of the subunit except in the Yuki River drainage where moose numbers are reported to be lower than in previous years. Moose densities are increasing in areas along the Yukon and Koyukuk Rivers, but the trend is unknown in most of the upland areas.

Two population estimation surveys during November 1987 found 6,340 moose over a 4,883-mi^2 area. Extrapolation of these data suggests a subunit population of 9,000-10,000 moose. No new data on population size were collected during this report period.

Population Composition:

The following guidelines are used to interpret sex and age indices within Units 21 and 24:

1. Bull:cow ratios usually average around 30-40 bulls:100 cows after the hunting season. Higher numbers of bulls are good, but sometimes misleading because the area is subject to either-sex hunting that can inflate bull numbers. Ratios below 20 would be poor.

2. The calf:cow ratio observed during November surveys provides an index to calf survival during the 5 months following birth. Black bears, grizzly bears, and wolves are the primary predators that reduce calf numbers. A November calf:cow ratio of 30-40:100 would be considered average for this area. A ratio of this magnitude would usually allow a population to remain stable in the face of moderate predation and hunting levels. Calf:cow ratios may imply population change, if subsequent overwinter mortality is either consistent or negligible. Ratios of 20 calves:100 cows or less often indicate a decreasing population and ratios of more than 40:100 cows are found in expanding populations.

3. The percentage of yearling bulls within the herd provides an index to the addition (recruitment) of young adults to the breeding population. It can also provide an indication of overwinter survival of calves, if the calf:cow ratio for the previous fall is known. Generally, the yearling bull percentage averages 4-8%, with anything less indicating poor recruitment and anything higher good recruitment.

The number of twins born in May is thought to be a good indication of herd nutritional status. In populations below carrying capacity the twinning rate ranges from 25-90%, near carrying capacity ranges from 5-25% and those above carrying capacity below 5% (Gasaway *et al.* 1992).

The 1993 posthunt bull:cow ratio for Three-day Slough (Table 1) reflected the continued heavy harvest of bulls from the area (Table 2). However, the ratio differed little from those observed in previous years. The yearling and calf numbers were slightly lower than average for the area. The calf twinning rates over the last 2 years have indicated the herd is not being affected by nutrition at this time (Table 3).

In November 1993, the bull segment surveyed in the Three-day Slough TCA included 20% small (£30"), 61% medium, and 18% large-antlered (^{3}50") bulls. This is a slight increase in observed large-antlered bulls than in past years (Table 2). The lower harvest in 1992 coupled with the change in the nonresident bag limit, restricting harvest to larger antlered bulls (see season and bag limit), may have increased the number of older bulls in the herd.

The Pilot Mountain TCA had lowered bull:cow ratios in 1991, (Table 4) which may be indicative of the increased hunting pressure in the area. The calf:cow ratio was very high for an Interior moose population, but the area is close to Galena and the hunting pressure on black bears, the main predator on calves, is higher.

<u>Distribution and Movements</u>:

Tracking movement patterns of moose in the Three-day Slough area is based on radiocollared animals. Most adult and young moose remain in the floodplain area of Three-day Slough from late August until May each year. During May most move 10-60 miles in either a northerly or southerly direction to upland areas where they spend the summer. In August they return to the floodplain area.

Moose movements are unknown in other portions of the subunit. However, local residents suspect that some moose observed on the Kaiyuh Flats migrate seasonally.

<u>Mortality</u>

<u>Harvest</u>:

Season and Bag Limit.

	Subsistence and Resident	Nonresident
Unit 21D:		
Resident hunters: One moose, antlerless moose may be taken only from 21-25 Sept. and 1-5 Feb. Moose may not be taken within ½ mile of the Yukon River, below Bishop Rock, or within 5 miles of the Yukon River above Bishop Rock during the 1-5 Feb. season.	5-25 Sept. and 1-5 Feb.	
Nonresident hunters: One bull with 50-inch antlers or antlers with 4 or more brow tines on one side.		5-25 Sept.

Game Board Actions and Emergency Orders. The fall hunting season was changed numerous times between 1975 and 1981. Since 1981, it has remained a 21-day season allowing cows to be hunted during the last 5 days. Some restrictions have been placed on resident and nonresident hunters because of the redefinition of a subsistence hunter. In 1991, nonresidents were restricted to bulls with an antler spread of 50+ inches or three brow tines on one side. In 1992 the number of brow tines on one side was increased to four, and within the Koyukuk Controlled Use Area, the meat of the front and back legs and ribs had to remain on the bone until removed from the area.

The Middle Yukon Fish and Game Advisory Committee in conjunction with ADF&G and the Board of Game (BOG) has been trying to design a midwinter hunt to meet local needs while minimizing the take of cow moose concentrated in highly accessible riparian areas. The season or areas open to hunting has been changed 12 times in the last 13 years either by board action or emergency orders. The moose population in the hunt area is able to sustain an anticipated winter harvest of 40 moose.

Hunter Harvest. The reported harvest has been about 200-300 moose annually with another 40 moose taken but not reported (Table 5). With the possible exception of the Yuki River drainage, the moose populations in the subunit appear capable of sustaining current harvests. In 1992 very cold weather (0°F) during the last 10 days of the September season disrupted the ability of hunters to move about by boats and float-equipped aircraft. Some hunters who remained in the field because they had not been successful were trapped by frozen rivers or lakes. Other hunters traveling up the Yukon River to return home ran into very thick pan ice. The situation was critical enough that helicopters were used, under emergency authorization, to retrieve hunters and their gear. The harvest was lower due to these conditions.

Check Station Results. Stopping at the moose hunter check station on the Koyukuk River was mandatory in 1990. Data have been collected on residency, harvest chronology, age structure of harvest, antler size, brow tine numbers, and transportation.

The Three-day Slough area has been a good area to hunt for large (^{3}50-inch antlers) moose. Usually, about one-fourth to one-third of the bulls observed in the Three-day Slough TCA have large antler spreads although the percentage decreased in recent years (Table 2).

Beginning with the 1992 fall season, nonresidents hunting in the subunit were required to only harvest bulls with 50-inch or larger antlers or four or more brow tines on one side. This regulation initially caused nonresident success to decline but increased to 80% in 1993 (Table 6). The other new regulation about meat being left on the bone has greatly aided enforcement efforts to stop waste of moose meat. The BOG passed the regulation to help keep the meat from spoiling, since long distance boat travel is used by most hunters, and meat on the bone will keep 3-4 times longer than boned out meat. At the check station we pointed out the regulation to all the hunters who came through in 1992 and 1993, receiving one complaint each year against it. All the other hunters enthusiastically endorsed the regulation, and many thought it should be adopted in other game management units.

Hunter Residency and Transportation Methods. The subunit hunter residency and success (Table 7) is slightly misleading as unit residents rarely report unsuccessful hunt information. The presence of the KCUA and the area's extensive river system make boats the primary transportation method (Table 8). Snowmachines were the main transportation method during the winter hunt.

Other Mortality:

Subunit 21D has high populations of wolves and black bears. Grizzly bears are common in the upland areas of Nulato Hills and Kaiyuh Mountain. Wolves and grizzly bears prey heavily on both calf and adult moose. Black bears are a substantial source of mortality for moose calves (Osborne *et al.* 1991).

The estimated wolf population in Subunit 21D is about 175-190 in 25-30 packs. This number of packs would probably kill 1,000 to 1,900 moose per year, based on an average kill rate of one moose every 3-6 days per pack during the winter months (Gasaway *et al.* 1983). At this rate, wolves in Subunit 21D probably kill about 10-19% of the standing crop annually.

The winter of 1992-93 had the deepest snow conditions in many years. I was concerned the depth would greatly increase overwinter moose calf mortality. According to reports by trappers and trend count area data (Tables 1, 4), moose survived without a large increase in mortality, but west of Kaltag and in the Three-day Slough area, there was a 20% increase in calf mortality. Many of the moose concentrated along the rivers and creeks where overflow lessened the snow depth.

CONCLUSIONS AND RECOMMENDATIONS

Moose are numerous in the riparian lowlands of Subunit 21D. I estimate there are 9,000-10,000 moose in the subunit. The populations are stable and capable of supporting current predation and harvest. However, further liberalization of the seasons or bag limits is not recommended because natural predation remains very high.

The prior growth of the moose population has been attributed to the consistent harvest of wolves in the area. However, the growth of the moose population has caused an increase in the number of moose hunters, especially within the KCUA.

All hunters in the KCUA use boats, and currently there is a problem of congestion in suitable areas for camping sites and calling areas, as well as other problems associated with crowded hunting conditions. In prior years the area was known as a wild site where people had the opportunity to select their bull, watch bulls rut, and hunt and observe other wildlife such as bears and waterfowl. The increased boat traffic and crowded conditions have made cows more wary and compromised our goal of viewing and photographing moose.

The regulations for the winter hunt need to be stabilized to reduce the number of small changes which occur almost yearly. The BOG needs to adopt a regulation which will stand for the next 5 years. Many of the changes have been actions directed at personnel stationed at the U.S. Air Force base in Galena who were perceived to hunt for sport and not from a need for meat. With the base presently closed, a longer lasting solution may now be possible.

The regulation requiring meat to be left on the bone of the legs and ribs has dramatically reduced the number of meat waste complaints received at the check station and in Galena. Although it was passed by the BOG to keep meat from spoiling, its usefulness as an enforcement tool has proven invaluable. It is much easier to count legs than to estimate meat bag weights.

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Table 1. Summary of fall aerial moose survey data from the Three-day Slough count area in Subunit 21D, 1988-94.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults[a]	Total moose observed	Moose /mi^2
1988-89	33	13	45	211	25	503	832	9.9
1989-90	28	8	25	123	16	564	763	9.1
1990-91[b]	--	--	--	--	--	--	--	--
1991-92	34	10	31	170	19	629	909	10.9
1992-93	35	10	31	201	18	755	1,088	13.1
1993-94	38	8	25	172	15	838	1,116	13.7

[a] Moose ≥24 months.

[b] Survey not flown.

Table 2. Bull moose harvest and percent large[a] bulls in the harvest compared with the percentage of large bulls observed during fall aerial survey of the Three-day Slough trend (TDS) count area, Subunit 21D, 1986-94.

Regulatory year	% large bulls in harvest September[b]	Bull harvest Koyukuk River September	% large bulls TDS November
1986-87	58 (78)	99	33
1987-88	57 (109)	138	23
1988-89	53 (168)	172	33
1989-90	45 (133)	143	28
1990-91	47 (167)	175	--[c]
1991-92	48 (196)	199	15
1992-93	54 (149)	161	15
1993-94	50 (169)	178	18

[a] ≥50-inch antler spread.
[b] Number of antlers measured in parentheses.
[c] No survey.

Table 3. Summary of May aerial moose twinning surveys from Three-day Slough count area in Subunit 21D, 1990-93.

Regulatory year	Cows	Cows with single	Cows with twins	Twinning %	Yearlings
1989-90	--[a]	24	21	44	--
1990-91	--	--	--	--	--
1991-92	--	22	23	51	--
1992-93	296	23	19	44	100

[a] No data.

Table 4. Summary of fall aerial moose survey data from the Pilot Mountain Slough trend count area in Subunit 21D, 1988-94.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1988-89[a]	--	--	--	--	--	--	--	--
1989-90[a]	--	--	--	--	--	--	--	--
1990-91[a]	--	--	--	--	--	--	--	--
1991-92	24	8	54	49	30	112	161	6.9
1992-93[a]	--	--	--	--	--	--	--	--
1993-94	21	1	38	33	24	104	137	3.6

[a] Survey not flown.

Table 5. Subunit 21D moose harvest, 1988-93.

Regulatory year	Harvest by hunters								
	Reported				Estimated				
	M (%)	F (%)	Unk	Total	Unreported	Illegal	Total	Potlatch/Stickdance	Total
1988-89	229	20	2	251	40		40	3	294
1989-90	182	22	0	204	40		40	4	248
1990-91	256	22	1	279	40		40	4	323
1991-92	269	34	0	303	40		40	11	354
1992-93	193	22	1	216	40		40	11	267

Table 6. Moose harvest by hunters who stopped at the Koyukuk River Check Station, Subunit 21D, 1987-94.

Regulatory	Unit 21 resident		Alaska resident[a]		Nonresident		Total	
year	Hunter	Moose	Hunter	Moose	Hunter	Moose	Hunter	Moose
1987-88[b]	151	68	92	61	21	16	264	145
1988-89[b]	158	73	121	88	20	20	299	181
1989-90	154	55	125	89	23	14	302	158
1990-91	137	48	133	105	36	30	306	183
1991-92	136	49	189	121	55	38	380	209
1992-93	145	45	173	103	39	19	357	167
1993-94	115	48	132	109	34	28	281	185

[a] Other than Unit 21 residents.

[b] The station was not mandatory prior to 1990.

Table 7. Subunit 21D moose hunter residency and success, 1988-93.

	Successful					Unsuccessful					
Regulatory year	Local[a] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Local[a] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Total hunters
1988-89	94	193	27	31	251	30	34	3	10	77	328
1989-90	78	176	22	6	204	51	47	8	4	110	314
1990-91	100	232	35	12	279	33	26	4	6	69	348
1991-92	106	152	42	6	303	66	91	16	3	176	479
1992-93	71	111	22	12	216	57	81	14	15	167	383

[a] Local means resides in Subunit 21D.

Table 8. Subunit 21D moose harvest by transport method, 1988-93.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1988-89	14	2	196	2	13	0	3	21	251
1989-90	11	0	167	1	14	1	5	5	204
1990-91	10	0	246	0	9	0	7	7	279
1991-92	16	0	260	0	15	0	5	7	303
1992-93	7	0	189	0	7	0	4	6	216

LOCATION

Game Management Unit: 22 (A, B, C, D, and E) - 25,230 mi^2

Geographical Description: Seward Peninsula and that portion of the Nulato Hills draining west into Norton Sound.

BACKGROUND

Moose are thought to have begun immigrating onto the Seward Peninsula during the mid to late 1930s. By the late 1960s, much of the unit's suitable habitat included moose. Numbers continued to increase during the 1970s and early 1980s. Current data suggest densities have since declined.

Demand for moose, primarily by recreational and subsistence hunters residing in the Unit, is high. Gravel roads, trails, and navigable rivers provide hunters with easy access to suitable moose habitat. Annual recorded harvest from 1969 through 1992 ranged from a low of 44 moose in 1972 to a high of 408 moose in 1986 (Table 1). Unit residents, as a rule, have accounted for 70 or more percent of the annual reported harvest.

MANAGEMENT DIRECTION

Population Goals:

The overall population management objective for Unit 22 moose is to maintain a minimum population level of 5,000-7,000 animals throughout the Unit. In Unit 22A the objective is to increase population size from the current estimate of 400-600 moose to at least 800-1,000 moose. In Units 22B and 22D, the objective is to maintain the population at 1,500-2,500 and 2,500-3,000 moose, respectively, with a minimum bull:cow ratio of 30:100. In Unit 22C the objective is to maintain the existing population of 350 with a minimum bull:cow ratio of 20:100. In Unit 22E the objective is to maintain the existing population of 250-350 moose.

Management Objectives:

1. Estimate abundance, sex and age composition, and recruitment to yearling age and determine trends in population size and composition.

    1a. Conduct aerial surveys throughout the Unit during late fall and early spring to provide an index of population status and trends, sex and age composition, and yearling recruitment.

    1b. Conduct moose censuses in each of the 5 subunits to estimate abundance.

2. Monitor human and natural mortality factors affecting the population.

    2a. Evaluate hunting mortality by analyzing all harvest data.

    2b. Improve harvest reporting through public contacts and improved communication.

3. Develop a moose management plan, with special emphasis on areas adjacent to the road system.

METHODS

We conducted spring and fall aerial surveys throughout the Unit to estimate sex composition and short yearling recruitment. In addition, a minicensus was conducted in Unit 22B during spring 1992 and in Unit 22D during spring 1993 to estimate changes in densities and productivity from 1987 and 1988, respectively. The minicensuses used techniques developed by department staff and modified from those initially developed by Gasaway et al. (1986). Harvests were evaluated from harvest ticket reports returned by hunters.

RESULTS AND DISCUSSION

Population Status and Trend:

Although moose numbers in Subunits 22A, 22C, and 22E increased in the late 1980s, densities were never comparable to those of Subunits 22B and 22D. It is not clear what factors (i.e., habitat, natural predation, overharvest, or poor recruitment) restrict herd growth in Unit 22. Moose densities in Subunits 22B and 22D which increased dramatically until the mid-1980s are now declining. Calf survival, particularly in areas of high moose concentrations, is declining as well. The winters of 1989, 1990, and 1992 were particularly severe on moose, and limited data indicate winter mortality was higher than normal. Reports of dead or starving moose were common, particularly in those areas where winter concentrations of moose were known to be high.

Population Size: The minicensus technique developed by Department staff was used in a portion of Unit 22B during spring 1992 and portions of Unit 22D during spring 1993. The purpose of these censuses was to determine density and short yearling recruitment. These data were compared to previously gathered census data from the respective Subunits using the census method developed by Gasaway et al. (1986).

Approximately 860 mi^2 of Unit 22B was censused in spring 1992. The calculated density estimate for the area was 705 moose (Table 2). Short yearling recruitment was estimated at 14% (Table 3).

In order to make the 1992 census data comparable with the census data collected in 1987, we had to recalculate the 1987 data. Comparison of these data confirmed our suspicion that an overall decline of 54% in moose density occurred over a 5-year period.

Because of subunit size and perceived differences in moose densities, we defined two different census areas in Unit 22D during the spring 1988 census. The Kuzitrin census area included portions of Unit 22D draining into the Pilgrim, Kuzitrin, Kougarok, and Noxapaga rivers. The American census area included portions of Unit 22D draining into the American and Agiapuk rivers. The same areas were used during the minicensuses completed during spring 1993.

Approximately 856 mi^2 of the Kuzitrin census area were stratified. The expanded population estimate for the area was calculated at 1,096 moose (Table 4), and the short yearling recruitment was estimated at 14% (Table 5).

Approximately 723 mi^2 of the American census area was stratified. The expanded population estimate for the area was calculated at 483 moose (Table 6), and the short yearling recruitment for the area censused was estimated at 16% (Table 7).

In order to make the 1988 census data comparable with the census data, we recalculated the 1988 data. Results from these data indicated moose numbers had declined by 35% in census areas along the Kuzitrin and American rivers.

Population Composition: Unit 22 fall moose composition surveys are completed only occasionally due to inclement weather and a lack of snow early in the winter. Although we completed a limited number of surveys during the fall of 1991 and 1992, the sample sizes were too small and the areas covered too limited to develop meaningful conclusions.

Mortality

Season and Bag Limit:

	Resident/ Subsistence Hunters	Nonresident Hunters	
Unit 22A			
One bull	Aug. 1-Sept. 30	Aug. 1-Sept. 30	
	Dec.	1-Jan.	31
Unit 22B			
One moose; however,	Aug. 1-Jan. 31	Aug. 1-Jan. 31	

antlerless moose may be taken only from Dec. 1-Dec. 31. No person may take a cow accompanied by a calf.		
Unit 22C		
One bull	Sept. 1-Sept. 14	Sept. 1-Sept. 14
Unit 22D		
One moose; however, antlerless moose may be taken only from Aug. 1-Dec. 31. No person may take a cow accompanied by a calf. Only antlered moose may be taken from Jan. 1-Jan. 31.	Aug. 1-Jan. 31	Aug. 1-Jan. 31
Unit 22E		
One moose.	Aug. 1-Mar. 31	Aug. 1-Mar. 31

Harvest:

Human-Induced Mortality: During the 1991-92 season, 302 moose (207 males and 95 females) were harvested from Unit 22, and 289 moose (217 males and 72 females) were harvested during 1992-93 (Tables 1 and 8). Sex composition of the harvest by subunit for 1991-92 was: 22A, 26 males and no females; 22B, 65 males and 2 females; 22C, 20 males and no females; 22D, 90 males and 87 females; and, 22E, 6 males and 6 females. Sex composition of the reported 1992-93 harvest by Unit was: 22A, 16 males and no females; 22B, 61 males and 4 females; 22C, 23 males and no females; 22D, 102 males and 65 females; and 22E, 15 males and 3 females.

Hunter Residency and Success: Local Unit 22 residents accounted for 73% of the harvest in 1991-92 and 70% in 1992-93 (Table 9). Alaska residents accounted for 91% and 85% of the reported harvest, respectively. Overall hunter success was calculated at 46% for the 1991-92 season and 45% for the 1992-93 season (Table 1).

Harvest Chronology: Most of the hunter effort and reported harvest (72% in 1991-92 and 79% in 1992-93) occurred during August, September, and October when access to suitable moose habitat from roads and rivers was most favorable (Table 10).

Transport Methods: The use of highway vehicles, all-terrain vehicles, boats equipped with jet units, and snowmachines accounted for 87% of the Unit 22 annual harvest during the 2-year reporting period (Table 11).

Natural Mortality:

Specific surveys to determine natural mortality rates among Seward Peninsula moose were not conducted during the reporting period. However, limited information gathered from observations reported by local residents and staff conducting other field activities suggest overwinter mortality rates in late winter-early spring of 1993 were substantial in some portions of Unit 22. On surveys and other similar flights, we observed at least 20 dead moose that spring.

Several grizzly bears were observed feeding on moose carcasses during April and May 1993. It was not known whether these moose were killed by the bears or died of other causes.

Habitat

Assessment: Winter range, particularly in portions of Subunits 22B, 22C, 22D, and 22E, have been heavily browsed in past years. Until recently, the lack of palatable browse had not been considered a significant factor affecting moose mortality. However, the unusual severity of 3 of the last 5 winters may have changed that. In addition, several research studies of moose/willow foraging relationships in the Kuzitrin and other river drainages within Unit 22D have provided insight into interactions occurring among moose, other herbivores and the willow communities (Alaska Cooperative Wildlife Research Unit, 1990).

Many moose utilizing willow riparian winter habitat in portions of Subunits 22B and 22D have a tendency to move during late March onto adjacent hillsides where they feed on sedges and dwarf willows. Moose stay in these areas until spring thaws reduce snow cover sufficiently in adjacent valleys and ravines. It is not uncommon in spring to see "herds" of moose in excess of 50 animals placidly grazing in those areas.

Game Board Actions and Emergency Orders

Actions taken by the Alaska Board of Game affecting Unit 22 regulations during the reporting period were as follows: 1) At the spring 1992 meeting the existing antlerless moose seasons in Unit 22 were reauthorized. 2) At the spring 1993 meeting, the antlerless moose season in Unit 22D was reduced to December 1 - 31, and a sex and antler size restriction was placed on all nonresident hunters.

No emergency orders affecting moose hunting regulations were enacted during the reporting period.

CONCLUSIONS AND RECOMMENDATIONS

Moose are clearly one of the most important big game species available to residents of Unit 22. This largest member of the deer family not only provides successful hunters with a substantial amount of protein annually, but provides many individuals with the opportunity to "get out" and observe as well as photograph moose.

Interest in hunting moose was moderate throughout the 1970s. However, this interest sharply increased in the early 1980's, and peaked in 1983 when approximately 1,300 people reportedly hunted (Table 1). Although hunter effort has since declined, hunter success remains high although a slight decrease has been noted during the past 2 years. Reported harvest fell to a 15-year low during the 1992-93 season, presumably in response to a decrease in the number of available moose.

A shift in location of effort and the sex of the harvest has occurred during the past several years. More effort is being expended in Unit 22D and less in Unit 22B. This is most likely attributable to an overall reduction in moose numbers in Unit 22B, and to a noticeable change in transportation methods used by hunters. The use of ATV's by successful hunters, particularly in Unit 22D, has increased dramatically since 1990 and now ranks as one of the top 3 transportation methods used by successful hunters. The country in Unit 22D is more open to access by ATV's, particularly 4-wheelers. Changes in regulation may be necessary if harvest continues to increase.

The moose population which has steadily grown in size over the years peaked several years ago, and noticeable declines in densities and productivity are now evident throughout much of the Unit. Data obtained from moose censuses and surveys indicated that the population size ranged from 7,000 to 10,000 moose during the late 1980's. Because of declines caused by winter mortality, reduced productivity and increased natural mortality, I estimate the Unit's moose population to currently range between 5,000 and 7,000 animals. A comparison of census data in Units 22B and 22D with data obtained from these areas 5 years previous supports our belief that moose numbers declined sharply. Regulatory changes may be needed within the near future to reduce harvest and slow the rate of decline.

Poor weather conditions in the fall generally make aerial surveys to determine sex composition and bull cow ratios difficult to complete. Limited data were obtained in only 6 of the last 12 years. The time spread between surveys and the small sample sizes collected make any comparisons or conclusions erroneous. Because the population is declining, it is imperative that we obtain adequate sex and age composition data. We are evaluating others ways of gathering these data.

A sound moose management plan based on census information, research programs, and public input is necessary if moose are to be wisely managed. Steps need to be taken to initiate such a plan.

Illegal and/or unreported harvest remains a problem throughout the Unit because some local residents still either fail to acquire harvest tickets prior to hunting or take moose out of season. It is very difficult to accurately measure this illegal harvest. However, I estimate it ranges from 10 to 20 percent of the reported harvest. Public education programs and a visible enforcement effort must be maintained if we are to improve compliance with current regulations.

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Table 1. Unit 22 historical moose harvest by sex, hunter effort, and success rate for regulatory years 1991-92.

Regulatory year	Males	Females	Unknown sex	Harvest	Total hunters[a]	Percent success
1969	69	1	2	72	182	40
1970	70	0	1	71	139	51
1971	59	0	1	60	168	36
1972	44	0	0	44	99	44
1973	103	32	1	136	317	43
1974	149	72	1	222	479	46
1975	136	0	2	139	389	25
1976	186	51	3	240	611	39
1977	151	88	5	244	457	53
1978	198	97	2	297	596	50
1979	193	75	2	270	760	36
1980	156	71	1	228	492	46
1981	225	72	1	298	696	43
1982	244	100	0	344	904	38
1983	291	68	46	405	1292	31
1984	298	91	6	395	1086	36
1985	279	92	3	374	876	43
1986	306	101	1	408	892	46
1987	286	20	4	310	775	40
1988	332	36	7	375	748	50
1989	208	82	0	290	713	41
1990	280	70	0	350	700	50
1991	207	95	0	302	656	46
1992	217	72	0	289	645	45

[a] Minimum known number of hunters.

Table 2. Calculated number of moose and surrounding parameters derived from 1992 Subunit 22B moose census.

Parameters	Strata: Superlow	Strata: Low	Strata: Medium	Strata: High	All Strata
N	13	12	30	12	67
Total area	151.40	143.60	402.40	161.20	858.60
n	4	6	13	8	31
Area sur	45.54	69.12	172.43	105.03	392.12
# seen	10	43	126	150	329
Density	0.2196	0.6221	0.7307	1.4282	0.7534
To	33.2	89.3	294.0	230.2	646.8
V(To)	648.78	726.93	909.48	131.88	2417.07
To df	3	5	12	7	18

SCFo=1.09038	V(SCFo)=0.0027730169	df(SCFo)=30
Te=705.3	V(Te)=4027.27	df (Te)=18
80% CI around	Te = (620.9, 798.7)	is +/- 11.97%
90% CI around	Te = (595.3, 815.3)	is +/- 16.50%
95% CI around	Te = (572.0, 838.6)	is +/- 18.90%

Table 3. Calculated percentage of short yearlings and confidence intervals surrounding those percentages as derived from 1992 Subuit 22B moose census.

p = 0.1367	V(p) = 0.00032277	df(p) - 18
80% CI around	p = (0.1128, 0.1606)	is +/- 17.48%
90% CI around	p = (0.1055, 0.1678)	is +/- 22.80%
95% CI around	p = (0.0989, 0.1744)	is +/- 27.62%

Table 4. Estimated total moose numbers and surrounding parameters from Kuzitrin portion of 1993 Subunit 22D census.

	Strata				
Parameters	Low	Medium	High	Superhigh	All Strata
N	36	17	9	7	69
Total area	438.20	214.90	116.80	85.70	855.60
n	5	5	7	7	24
Area sur	58.65	58.60	89.08	85.74	292.07
# seen	13	48	227	483	771
Density	0.2217	0.8191	2.5483	5.6333	1.2314
To	97.1	176.0	297.6	482.8	1053.6
V(To)	2535.89	283.51	811.88	0.00	3631.28
To df	4	4	6	6	8

SCFo = 1.04050	V(SCFo) = 0.0002930260	df (SCFo) = 23
Te = 1096.2	V(Te) = 4255.54	df(Te)= 8

80% CI around	Te = (1005.1, 1187.4)	is +/- 8.31%
90% CI around	Te = (974.9, 1217.6)	is +/- 11.08%
95% CI around	Te = (945.8, 1246.7)	is +/- 13.72%

Table 5. Estimated percentage calves and confidence intervals surrounding those percentages from Kuzitrin portion of 1993 Subunit 22D census.

p = 0.1436	V(p) = 0.00010331	df(p) = 8
80% CI around	p = (0.1294, 0.1578)	is +/- 9.89%
90% CI around	p = (0.1247, 0.1625)	is =/- 13.17%
95% CI around	p = (0.1202, 0.1670)	is =/- 16.32%

Table 6. Estimated total moose numbers and surrounding parameters from American River portion of 1993 Subunit 22D census.

Parameters	Strata				All Strata
	Low	Medium	High	Superhigh	
N	35	16	7	3	61
Total area	409.90	194.50	83.90	34.80	723.10
n	5	6	6	3	20
Area sur.	55.26	69.68	71.19	34.76	230.89
# seen	7	49	113	161	330
Density	0.1267	0.7032	1.5873	4.6318	0.6680
To	51.9	136.8	133.2	161.2	483.1
V(To)	527.84	907.40	30.13	0.00	1465.37
To df	4	5	5	2	9

SCFo = 1.00000	V(SCFo) = 0.0000000000	df(SCFo) = 19
Te = 483.1	V(Te) = 1465.37	df(Te) = 9
80% CI around	Te = (430.1, 536.0)	is +/- 10.96%
90% CI around	Te = (412.9, 553.2)	is +/- 14.53%
95% CI around	Te = (396.5, 569.6)	is +/- 17.93%

Table 7. Estimated percentage calves and confidence intervals surrounding those percent ages from American portion of 1993 Subunit 22D census.

p = 0.1580	V(p) = 0.00031329	df(p) = 9
80% CI around	p = (0.1335, 0.1825)	is +/- 15.50%
90% CI around	p = (0.1255, 0.1904)	is +/- 20.54%
95% CI around	p = (0.1179, 0.1980)	is +/- 25.34%

Table 8. Unit 22 moose harvest data by Subunit for regulatory years 1991-1992.

Year	22A		22B		22C		22D		22E		Unknown	
	M	F	M	F	M	F	M	F	M	F	M	F
1991	26	0	65	2	20	0	90	87	6	6	0	0
1992	16	0	61	4	23	0	102	65	15	3	0	0

Table 9. Moose hunter residency and success data by Subunit for regulatory years 1991-1992.

	Successful Hunters Residency					Unsuccessful Hunters Residency				
Subunit	Unit	State	Non	Unknown	Totals	Unit	State	Non	Unknown	Totals
1991										
22A	22	23	3	0	26	42	47	1	1	49
22B	37	54	11	2	67	44	57	7	0	64
22C	12	17	2	1	20	31	36	1	0	37
22D	136	165	11	1	177	130	156	4	1	161
22E	11	11	0	1	12	7	7	0	0	7
22Z						30	35	1	0	36
1992										
22A	11	13	2	1	16	47	47	1	0	48
22B	31	44	18	3	65	36	48	8	1	57
22C	19	21	2	0	23	26	33	1	0	34
22D	121	144	21	2	167	152	172	5	1	178
22E	16	16	0	2	18	1	1	0	0	1
22Z						31	37	1	0	38

Table 10. Chronology by Subunit of Unit 22 moose harvest for regulatory years 1991-92.

Subunit	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Unknown	Totals
<u>1991</u>										
22A	1	15	N/S	N/S	7	1	N/S	N/S	2	26
22B	8	27	13	3	7	8	N/S	N/S	1	67
22C	N/S	18	N/S	N/S	N/S	N/S	N/S	N/S	2	20
22D	20	76	30	34	9	3	N/S	N/S	5	177
22E	0	1	1	1	0	1	1	7	0	12
<u>1992</u>										
22A	4	4	N/S	N/S	7	1	N/S	N/S	0	16
22B	3	29	16	3	10	2	N/S	N/S	2	65
22C	N/S	23	N/S	N/S	N/S	N/S	N/S	N/S	0	23
22D	20	86	31	5	17	1	N/S	N/S	7	167
22E	2	1	1	2	4	2	5	1	0	18

NS = No Season.

Table 11. Transport data reports from successful Unit 22 moose hunters by Subunit for regulatory years 1991-92.

Subunit	Aircraft	Horse	Boat	ATV	Snow machine	Off-road vehicle	Highway vehicle	Unknown	Totals
1991									
22A	1	0	11	5	7	0	1	0	26
22B	13	0	14	14	14	1	10	1	67
22C	0	0	2	5	0	1	11	1	20
22D	4	0	23	43	15	17	68	7	177
22E	0	0	1	1	10	0	0	0	12
1992									
22A	0	0	8	0	7	0	0	1	16
22B	9	0	7	15	20	5	8	1	65
22C	1	0	4	6	1	0	11	0	23
22D	9	0	18	35	36	11	51	4	167
22E	0	0	3	0	15	0	0	0	18

LOCATION

<u>Game Management Unit</u>: 23 (43,000 mi^2)

<u>Geographical Description</u>: Western Brooks Range and Kotzebue Sound

BACKGROUND

Moose most recently began recolonizing Unit 23 during the 1940s. Moose currently rank second to caribou as a source of red meat for most residents of Unit 23. Moose are avidly sought by local and nonlocal resident and nonresident hunters. Moose hunting also provides a significant source of income to guides, outfitters, and transporters who operate in the Unit.

From the time moose reappeared in Unit 23 to the late 1980s, public comments and opportunistic observations by Department staff indicated that moose populations generally increased throughout this region. Since approximately 1990, moose populations have either stabilized or declined throughout the Kotzebue Basin.

MANAGEMENT DIRECTION

The following population goals and management objectives have been established for Unit 23:

<u>Population Goals</u>

1. Maintain or enhance existing moose population levels in Unit 23.

2. Maintain a minimum November bull:cow ratio of 40:100 in each major drainage within Unit 23.

<u>Management Objectives</u>

1. Develop a management plan for moose in Unit 23 by December 1995.

   A. Draft a management plan listing management options for moose in Unit 23 by December 1994.

      a. The draft plan will be a conceptual vehicle for determining what landowners and the public want as moose management objectives in Unit 23.

b. Potential effects on moose populations as well as subsistence users, sport hunters, commercial operators, and nonconsumptive users will be listed for each management option considered.

B. Solicit input from the public and Unit 23 landowners on the draft management plan by June 1995.

C. Finalize a management plan by December 1995. At a minimum, the final management plan should include the following:

a. Management goals and objectives;

b. Specific management criteria (e.g. bull:cow ratios, maximum or minimum densities, predator:prey ratios); and

c. Data necessary to evaluate management criteria, and how data will be collected.

2. Continue the cooperative middle Noatak moose radiotelemetry project with NPS to:

A. Improve techniques for monitoring moose population size and sex/age composition;

B. Evaluate the magnitude and causes of moose mortality in this portion of the Unit.

3. Continue to conduct population censuses in each of the major drainages in Unit 23.

METHODS

Evaluation of population trend and sex/age composition are based on aerial surveys of trend count areas, and on censuses using methods developed by Gasaway et al. (1986). All trend count areas include each major moose habitat type of that area (e.g. riparian willow, tundra, spruce forest, etc.). Since 1988, all trend counts have been completed using Piper PA-18 aircraft. The U. S. Fish and Wildlife Service (FWS) assisted with surveys of the Tagagawik trend count area, and the National Park Service (NPS) helped survey the middle Noatak trend count area.

Fall trend counts were conducted during late October through November. Bulls were categorized as yearlings, or by antler width if older. During fall 1991, the Wulik, Nimiuktuk, and middle Noatak trend count areas were surveyed; snow cover was inadequate during November to survey the Tagagawik, Buckland, and Inmachuk trend count areas. During fall

1992, the middle Noatak, Tagagawik, Buckland/Bear Creek, and Inmachuk trend count areas were surveyed. No spring trend counts were conducted in either 1992 or 1993.
Moose densities were estimated using census procedures. The Squirrel River drainage and a portion of the Kobuk River above and below the mouth of the Squirrel River was censused in cooperation with BLM during November 1992.

Natural mortality, distribution and movements of moose in the Noatak River drainage were determined from a cooperative radio telemetry project initiated with the NPS during April 1992 (Dau and Ayres 1993). The study area for this project includes the Noatak drainage between Noatak village and Feniak Lake. Moose that have temporarily emigrated out of the study area have usually been found during each relocation flight.

During 1992, 84 moose (25 females and 59 males) were captured in the Noatak study area using standard helicopter darting techniques. Of these 84 moose, 51 (25 females and 26 males) were fitted with conventional radio collars (Telonics, Inc., Mesa, AZ) and 33 males were marked only with ear tags (Temple Tag, Temple, TX). All radiocollared bulls were also marked with at least one ear tag. All moose were immobilized with 4.3 mg carfentanil and 170 mg xylazine hydrochloride administered in a 3 ml dart (Palmer Chemical Equipment Inc., Douglasville, GA). Naloxone (400 mg) or naltrexone (600 mg) was injected intramuscularly to reverse the effects of the carfentanil on 77 and 7 moose, respectively. During 1993, 21 additional moose (13 males and 8 females) were radiocollared to replace mortalities that occurred during the first year of the study. Two additional males were ear tagged. The same capture techniques were employed in 1993 as in 1992 with the exception that naltrexone was used to reverse the carfentanil for all captured moose, and ear tagging bulls was discontinued except for captured bulls too young to collar.

Harvest information was estimated from hunter harvest reports, and from the Noatak telemetry project.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: The earliest record of an aerial moose survey conducted in Unit 23 occurred in 1959; however, moose surveys were not conducted regularly until the 1970s. From 1973 to the present, moose surveys have been conducted throughout portions of Unit 23 annually. During most years, both spring and fall surveys have been conducted. Unfortunately, from 1973 to 1985, survey techniques and count areas were not standardized. As in other portions of Alaska during this management era, the parameters "moose per hour" and "percentage calves" formed the foundation of survey data. In Unit 23, specific search areas and survey conditions were not recorded. For most of the early moose surveys conducted in Unit 23, accompanying maps were not filed and subsequently lost. As a result, it is impossible to evaluate long-term temporal or spatial changes in moose abundance from this data. Early moose survey data provides little more than limited information on the distribution and sex and age composition of moose populations in portions of Unit 23.

By the late 1970s, wildlife biologists throughout Alaska realized that moose survey techniques needed improvement. As a result, a technique was developed during the early 1980s to quantitatively estimate moose population size and composition (Gasaway et al. 1986). During 1985, 3 attempts were made to use and evaluate the Gasaway moose census technique in Unit 23. These were: 1) a 2115 mi^2 portion of the middle Noatak River drainage (15-19 March); 2) the 4360 mi^2 Selawik National Wildlife Refuge (25 October-1 November); and 3) a 1602 mi^2 portion of the Squirrel River drainage (18-24 November).

The Selawik Refuge and Squirrel River census attempts failed, and the validity of the middle Noatak River estimate was seriously compromised by technical difficulties. Factors that contributed to the failure of these attempts were excessively large census areas, incomplete stratification, inaccurate stratification of sample units (SU's), failure to estimate sightability correction factors, inclement weather, and failure to standardize search effort among SU's.

Following the 3 difficult census attempts of 1985, Department biologists began establishing trend count areas to monitor moose populations throughout Unit 23 during 1986. We recognized that trend count data were inferior to census data. However, trend counts were more easily completed than censuses given the constraints of personnel, aircraft, and weather. Also, trend counts would theoretically still illustrate changes in moose populations over time even if they did not provide cardinal estimates of abundance. At that time, moose populations in Unit 23 generally appeared healthy and increasing, minimizing the need for rigorous and expensive census data. Spring trend count areas were established in the lower Kobuk and lower Noatak River drainages during 1986. Fall trend count areas were established in the middle Noatak (1986), Tagagawik (1986), upper Nimiuktuk (1987), middle Wulik (1987), Buckland/Bear Creek (1989), and Inmachuk (1989) drainages.

Initially, trend count data appeared sufficient for monitoring moose populations in Unit 23. However, after 5 to 6 years of conducting the counts under a range of survey conditions, it became evident that snow depth greatly affected the number of moose and, to some degree, the sex and age composition of moose that were observed. Although moose trend counts were more repeatable than the earliest moose surveys that had been conducted in the Unit, they still failed to provide meaningful estimates of abundance. Because trend counts are not an estimation technique, we could not evaluate the accuracy or precision of the surveys.

As the limitations of trend count data became more evident, northwest Alaska experienced 3 consecutive severe winters beginning in 1988-89 that caused moose numbers to decline. At least 2 of these winters were followed by prolonged, extensive flooding of moose calving areas during the subsequent spring (1989 and 1990). The winter of 1990-91 was particularly harsh on ungulates; large numbers of moose in Unit 23 died directly from starvation. Losses to predators were especially high as a result of malnutrition and deep snow conditions. At this time, brown bear and wolf populations levels were high. Losses of moose to predation were exacerbated by the near absence of caribou wintering in Unit 23. In addition, interest in hunting moose by nonlocal hunters continued to increase. Within a period of only several years, managers needed more accurate moose survey information than trend count data could provide.

During 1990, the department, NPS, Bureau of Land Management (BLM), and FWS staff began discussing ways to improve moose survey data in Unit 23. As a result, a cooperative radiotelemetry investigation of moose was initiated by Department and NPS in the middle Noatak drainage during April 1992. A virtually identical cooperative study will be initiated by Department, FWS and BLM staff in the Tagagawik drainage during April 1994. In addition, a cooperative moose census was conducted in the Squirrel River drainage by the Department and BLM during November 1992, and a cooperative census will be completed in the middle Noatak drainage during late October-early November 1993 by the Department and the NPS. A cooperative population census of the Tagagawik drainage is planned for 1995 or 1996.

Trend count data show no unit-wide trend in moose density over time (Tables 1 and 2). This may be because 1) no trends in moose abundance have occurred; 2) trend count areas have not been surveyed long enough to reflect changes in moose population size; or 3) other factors (e.g., movements of moose or local harvests) mask actual changes in moose populations. Opportunistic observations of moose in heavy to light snow conditions suggest that snow-induced movements probably explain much of the variability in Unit 23 moose trend count data. Existing trend count areas appear too small relative to movements by moose to reflect actual changes in population size and composition.

Spatial differences in moose density within Unit 23 are not evident from trend count data (Tables 1 and 2). Differences in density among trend count areas are likely as attributable to site-specific effects of habitat, snow conditions, and harvest as to real differences in abundance on a drainage level.

Reports from local residents, transporters, guides, and opportunistic observations by Department staff indicate that moose density in the middle Noatak drainage declined during 1988-91. This is not surprising considering the relatively high numbers of brown bears and wolves in this area, the severity of the 1988-89 through 1990-91 winters, and the increasing number of hunters in the Noatak drainage during recent years. Unfortunately, given the limitations of the 1985 census and the trend count data, we cannot quantify this decline.

Public comments and opportunistic observations by Department staff suggest the primary cause of the moose population decline in the middle Noatak drainage was probably natural mortality between 1988-89 and 1990-91. Winter mortality during this period was caused primarily by direct starvation, and predation predisposed by malnutrition and deep snow. The 1989 calf cohort failure was probably attributable to prolonged, extensive flooding of calving habitat during breakup.

During recent years, the influence of predation on the middle Noatak moose population has fundamentally changed. Brown bear census information in an area partially within the Noatak moose census area (Ballard et al. 1991) indicate bear population density is near the midpoint of densities reported from censuses completed in other portions of northern and interior Alaska (ADFG, unpub. data). However, reports from most local residents, as well as some guides and transporters, indicate that brown bear density in the Noatak drainage is currently much higher than observed during the past 10 to 30 years. Public comments and opportunistic observations by Department staff indicate that wolf populations in the Noatak drainage are also high and may still be increasing, compared to previous years. In addition, relatively few caribou have overwintered in the Noatak drainage during 5 of the last 6 winters. Predation by wolves and brown bears probably did not cause the Noatak moose population to decline; however, predation may now be influencing the magnitude and duration of this decline.

A census of the Squirrel River drainage yielded a density estimate of 0.95 moose/mi^2 (Morkill and Dau 1993; Table 4). The 80%, 90% and 95% confidence intervals surrounding the population estimate were $\pm$18%, 24% and 28% of the point estimate, respectively. The estimated density of moose may be slightly high because SU's which almost certainly contained no moose were not selected during the randomization process. Therefore, when extrapolating the results of the low density SU's surveyed over all SU's in that strata we undoubtedly overestimated moose density. We believe this bias is probably minimal, however.

Snow, fog, and high wind delayed the Squirrel River census. Even so, movements of moose were minimal until the final 2 days of the census. Stratification appeared to break down as a result of weather-induced movements of moose for the last 2 SU's surveyed.

Although a census of the Squirrel River drainage was attempted in 1985, it failed to provide a meaningful estimate of moose density (Larsen et al. 1986). Reasons for this failure were 1) movements of moose between stratification and survey flights; 2) navigator error during stratification; 3) inadequate number of SU's surveyed; and 4) inclusion of large areas devoid of moose habitat in the census area (e.g. alpine areas). As a result, there is no basis for comparison to determine trend in moose abundance in this drainage.

<u>Population Composition</u>: Fall calf:cow ratios during 1991 and 1992 were within the range of values observed in previous years (Table 2). Bull:cow ratios were generally lower in the middle Noatak and Wulik River drainages than in other portions of the Unit during this reporting period (Table 2). However, the small size and location of trend counts make them vulnerable to snow-induced movements of moose, and should be viewed with caution. From 1987 through 1992, the bull:cow ratio in the middle Noatak trend count area declined even though a comparison with the 1993 census information suggests the actual proportion of bulls in the trend count area was probably higher.

From the 1992 census of the Squirrel drainage, we estimated the bull:cow ratio at 37:100, and the calf:cow ratio at 32:100 (Table 6). The number of bulls observed among the yearling (spike or fork antlers), medium (antlers larger than forked but <50 inches wide) and large (antlers >50 in wide) categories was 28, 26 and 24, respectively.

Although the 1985 census attempt in the Squirrel River drainage failed, the number of moose actually observed during survey of each SU provides some information on previous bull:cow ratios in this portion of the Unit. During 1985, 131 moose were observed during the SU surveys (42 bulls, 74 cows and 15 calves). Even without a sightability correction factor, this yields a bull:cow ratio of 57:100, and a calf:cow ratio of 21:100. In 1992, the south side of the Kiana Hills and a portion of the Kobuk River floodplain were included in the census area. These areas contained substantial numbers of moose, and a disproportionate number of large bulls. Therefore, the 1992 census would more likely yield higher bull:cow ratios than the 1985 census. This makes the decline in the size of the bull:cow ratio from 1985 to 1992 even more dramatic. Because the sample size of moose from the 1985 census is small (n=131), and relatively few SU's (12) were surveyed, this comparison should be viewed with caution.

The numbers of individuals who reportedly hunted in Unit 23 have increased since 1979. The Squirrel River drainage, like the Noatak River drainage, has received a disproportionate amount of this increase because of its proximity to Kotzebue, and good access by boat and aircraft. It is not surprising that bull:cow ratios have apparently declined in this portion of the Unit. Until another census can be conducted to quantitatively determine the trend of this population, the Squirrel River drainage should periodically be monitored to evaluate numbers of hunters and to at least subjectively assess the size and composition of this moose population.

The calf:cow ratio estimated during the 1992 census was higher than that estimated during the 1985 census attempt. Trend count data indicate calf production in Unit 23 is quite variable annually (Table 2). This suggests that annual factors such as winter severity and flooding during breakup may have a greater effect on calf production than long-term factors such as habitat quality.

<u>Distribution and Movements</u>: As observed in other moose telemetry projects throughout Alaska, radiocollared moose in the Noatak River drainage have exhibited a variety of movement patterns. The collared moose generally displayed fidelity to 2 portions of the study area: the Noatak/Kelly/Kugururuk River area and the Nimiuktuk/Anisak River area. However, this pattern of fidelity has not been complete. For example, a bull collared on the Nimiuktuk River during April 1992 traveled to within 6 to 7 miles of Noatak village by July 1992. One bull and 1 cow collared in the Nimiuktuk River drainage traveled to the Salmon River in the Kobuk River drainage during 1993. At least 4 bulls collared on the Kelly, Kugururuk and Nimiuktuk Rivers spent a portion of the 1992-93 winter on the North Slope, and 1 bull spent the summer and early fall of 1992 near Driftwood in the Utukok River drainage. Nevertheless, all moose that have emigrated out of the study area have returned to the general area where they were collared, and most collared moose can predictably be located within one drainage of their capture location.

Seasonal movements among habitat types generally followed those observed for moose in other portions of Alaska. In forested areas, calving occurred in dense riparian or subalpine spruce habitat. In areas devoid of spruce near the eastern border of the study area, calving occurred in riparian willow thickets. Moose moved upslope during summer to riparian willow (*Salix* spp.) thickets in the headwaters of drainages. Rutting aggregations were usually observed near treeline; however, moose appeared to travel extensively during this time and were observed throughout the study area. Collared moose remained in the upper portions of drainages until snow forced them downslope. Shallow snow allowed moose to remain relatively high in riparian willow thickets throughout winter and failed to disrupt the segregation between bulls and cows soon after rut.

Deep snow had variable effects on the distribution of moose in Unit 23. Deep snow usually causes large, mixed sex and age aggregations of moose to form in riparian spruce/willow habitat. Deep snow accumulated early in the fall of 1992; wind redeposited and hardened this snow in riparian areas. As a result, by November very few moose were observed in riparian portions of the major tributaries of the Noatak River. At least 4 collared bulls spent the last half of the 1992-93 winter in the upper reaches of North Slope drainages and along the northern foothills of the DeLong Mountains. Although little browse was evident near any of the collared bulls, all 4 survived and returned to the Noatak River drainage during spring 1993.

During late winter and spring of 1993, the distribution of moose that remained in the Noatak River drainage was unusual. Most of the collared moose were found in relatively large, cohesive groups in open tundra; this was also evident during the 1993 collaring operation. These groups had dug extensive areas of feeding craters. Apparently, deep snow in riparian areas forced moose out of their normal winter habitat onto open, wind-scoured tundra to search for food. We speculate that moose forced onto the tundra to forage formed large aggregations in response to chronic harassment by wolves. Alternatively, moose may have simply been attracted to areas previously cratered by other moose.

Some collared moose were sedentary, remaining within 1 drainage of their initial capture location during the year. There has been almost no observed difference in fidelity between the Kelly and Kugururuk River drainages.

Lower Wrench Creek, the lower Kelly River, and that portion of the Noatak River between Noatak village and the mouth of the Kugururuk River is an extremely important wintering area for moose in the middle Noatak River drainage.

The largest concentrations of moose observed during the 1992 Squirrel River census occurred on the south side of the Kiana Hills, and in the floodplain of the Kobuk River (Morkill and Dau 1993). Moderate densities were observed in large tributaries of the Squirrel River (e.g., the North Fork and Omar Rivers), and on the north side of the Kiana Hills. Very few moose were observed in the extreme upper Squirrel River or in the Squirrel River Flats.

Opportunistic observations made during numerous trips through the Squirrel River drainage by snowmachine and aircraft have revealed a very predictable movement pattern for moose in this portion of the Unit. The major tributaries of the Squirrel River (e.g. the Omar and North Fork) appear to be important rutting areas for moose. Once snowfall begins, moose rapidly move downstream toward the Kobuk River or to the Aggashashok/Noatak River even before deep snow accumulates. Typically, very few moose overwinter in the upper Squirrel River or its tributaries. This area normally accumulates deep snow, even during years of average snow depth, probably due to prevailing winds and topography. In years of deep snow, this downstream movement by moose is extreme. As a result, residents of Kiana are often beset by "problem" moose that take up residence within the village. Moose gradually reoccupy the Squirrel River drainage throughout summer.

Mortality

Harvest:

Seasons and Bag Limits.

Regulatory Year 1991-92

Unit 23	Resident/ Subsistence Season	Nonresident Season
RESIDENT HUNTERS: One moose; however, antlerless moose may be taken from Sept. 1-Mar. 31; no person may take a cow accompanied by a calf.	Aug. 1-Mar. 31	
NONRESIDENT HUNTERS: One antlerless moose; however, antlered moose with spike-fork or 50 inch antlers may be taken from Sept. 1-Sept. 20; no person may take a cow accompanied by a calf.		Sept. 1-Mar. 31

Regulatory Year 1992-93

Unit 23

RESIDENT HUNTERS:	
One moose; no person may take a cow accompanied by a calf.	Aug. 1-Mar. 31
NONRESIDENT HUNTERS:	
One bull with spike-fork or 50 inch antlers, or with antlers having 3 or more brow tines on one side.	Sept. 1-Sept. 20

Game Board Actions and Emergency Orders. During the fall of 1988, the Alaska Supreme Court ruled that exclusive-use guiding areas were unconstitutional. The State has since replaced the Guide Board with the Big Game Commercial Services Board and has developed a new set of regulations applicable to guiding and outfitting in Alaska. During 1993, the Commercial Services Board began to allocate new guide areas. Currently, the only limitation on the number of guides who can operate in any given area depends on their acquiring the landowner's permission to operate on those lands. If wildlife managers deem it necessary to reduce harvests in an area, a conceptual framework for reducing the number of guides who can operate in that area has been developed. However, this system has not been tested, and at face value appears to have serious limitations.

During the last 5-10 years, 5-7 guides have consistently operated in Unit 23. Although current state policy regulating guides has made it much easier for guides to establish businesses in Alaska, no increase in guiding activity within Unit 23 has yet occurred. The NPS and FWS have independently from the state, and from each other, established their own procedures for allocating areas to guides, and their current policies preclude an increase in the number of guides who can operate on their lands. Lands administered solely by the state and by BLM appear most susceptible to overallocations to guides.

For the 1991-92 regulatory year, the Board of Game reduced the nonresident hunting season for antlered moose in the Noatak River drainage to September 1 to September 20. The Board also established antler size restrictions for nonresident hunters in the Noatak River drainage: nonresident hunters could kill spike-fork bulls, bulls with antlers $\geq$50 inches wide, or bulls with antlers of any width that had $\geq$3 brow tines on at least one antler. During the 1992-93 regulatory year, the Board of Game applied these limitations for nonresident hunters throughout Unit 23.

Human-Induced Mortality. Casual conversations with local hunters indicate that a substantial number of moose harvested by Unit residents are not reported each year. Some local residents have estimated that as few as 10% of the actual harvest is reported. Quimby and James (1985) estimated that residents of Unit 23 report only 14-24% of their actual harvest. Harvest data for nonlocal hunters are more accurate.

The reported annual harvest of moose during 1991-92 and 1992-93 was lower than reported during 1987-88 through 1990-91 (Table 7). If only 14-24% of the local harvest is reported (Quimby and James 1985), the actual harvest by Unit 23 residents could have been 329-564 moose in 1991-92, and 304-521 moose in 1992-93. The proportion of female moose in the total harvest has increased since the last reporting period. Females comprised 19% of the total harvest in 1991-92, and 13% of the total harvest in 1992-93 (Table 7).

As in the past, almost half of the reported harvest came from the Noatak drainage during 1991-92 and 1992-93 (Table 8). In 1992, 3 collared moose (all males) were harvested by hunters. This represents 8% of the total number of collared moose (both sexes), or 13% of the collared males. Three of the 33 ear-tagged bulls were also harvested. If we assume a 10% capture mortality rate (as determined by the radio collars), this represents 10% of collared bulls. Combining the ear-tagged (n=30) and radiocollared (n=23) males indicates approximately 11% of the marked males were harvested during 1992. Given the small sample size of the radiocollared and ear-tagged males, these percentages should be viewed as preliminary approximations.

From a pool of 54 radiocollared moose (31 males and 23 females), 4 males were harvested by hunters during 1993. This represents 7% of the total number of radiocollared moose (both sexes), and 13% of the radiocollared males. No estimate of harvest rate could be made from the ear tags as it is impossible to establish the initial sample size of tagged males that survived from 1992.

No trend in mean antler width has been evident among drainages, or for the Unit overall (Tables 9 and 10). Mean antler width for the northern Seward Peninsula has been higher during 2 of the last 3 years than in the past. Perhaps more significantly, the distribution of harvest among drainages appears to have changed (Table 9). Fewer bulls were reported harvested in the Noatak, Wulik/Kivalina and Kobuk River drainages, while more bulls were reported taken in the Selawik drainage and on the northern Seward Peninsula. As the total number of hunters in the Noatak River drainage has increased (Table 11), their success rate has generally declined and the frequency of hunters complaining about crowding has increased. The higher mean antler width in the northern Seward Peninsula and redistribution of hunters are results of nonlocal trophy hunters shifting their effort from the Noatak River drainage to southern portions of Unit 23.

The demand for transporter services by nonlocal hunters still greatly exceeds their availability in Unit 23 even though more transporters have become active during the last reporting period. If transporters or guides continue to increase their activity in Unit 23, harvests could quickly increase beyond sustainable levels.

<u>Hunter Residency and Success</u>. The number of individuals hunting moose in Unit 23 was higher during both 1991-92 and 1992-93 than in all but one previous year on record (Table 12). Although the antler size restriction and season reduction imposed on nonresidents during this reporting period appears to have reduced the number of nonresidents slightly, the overall

number of hunters in Unit 23 has increased. This seems primarily due to the continuing increase in nonlocal Alaskan resident hunters and to a leveling off of the declining trend in the number of local resident hunters.

According to one knowledgeable, longtime transporter in Unit 23, the demand for transporter services exceeds availability to such a degree that if all nonresidents were excluded from hunting moose in Unit 23, nonlocal resident hunters could easily replace them. Some nonlocal residents are currently not hunting in Unit 23 because they cannot secure the services of a reputable transporter. If it becomes necessary to reduce moose harvests in Unit 23, regulatory action must affect nonlocal resident as well as nonresident hunters. There are several available management options to accomplish this: 1) sharply restrict the season during the period between August 20 and September 31; 2) regulate the number of clients that guides and transporters can contract within given areas; 3) establish controlled-use areas to restrict the use of aircraft for transporting moose hunters and their equipment; or 4) impose permit hunts to closely control numbers of hunters in given areas.

The disparity between supply and demand for transporters has also resulted in a proliferation of private individuals illegally functioning as transporters in Unit 23. According to longtime guides, transporters, and residents of northwest Alaska, this has been a chronic problem in the Unit. Because it is relatively easy to conceal, we do not know the magnitude of this problem. The only individuals who come to attention are the most blatant offenders. If illegal transporters are allowed to continue to operate in Unit 23, they will compromise the effectiveness of regulatory actions taken to conserve wildlife resources, and will continue to reap large financial gains at the expense of commercial operators who comply with the law.

Hunter success rates were slightly lower during 1991-92 and 1992-93 than during the previous 6 years (Table 12). Nonlocal resident Alaskan and nonresident hunters composed approximately three quarters of hunters who reported hunting moose in Unit 23. The significance of large numbers of nonlocal hunters is that they specifically target large bulls.

Relatively few Unit 23 residents reported hunting moose during this reporting period compared to the number of nonresidents and nonlocal residents (Table 12). This is at least in part a function of poor compliance with licensing and reporting requirements by Unit residents. Because local subsistence users prefer caribou much more than moose, they have become less reliant on moose as the Western Arctic Caribou Herd has increased. This probably explains the long-term decline in the number of local residents hunting moose. However, this decline in local moose hunters has not offset the increase in nonlocal moose hunters, and the effect since at least 1979-80 has been an overall increase in hunting pressure.

Harvest Chronology. Despite an 8-month moose season, most of the reported harvest occurred during the last week of August through September (Tables 13 and 14). As in past years, 78% and 75% of the harvest occurred during this period in 1991-92 and 1992-93, respectively. Virtually all recreational hunting occurs during this time. Local subsistence hunters rarely harvest mature bulls after the rut begins (roughly mid-September). However, cows are taken by local hunters throughout the season.

Transport Methods. Aircraft are still the primary mode of transportation for hunters who reported hunting moose in Unit 23 (Table 15). Hunters using aircraft took 126 (72%) of the total reported harvest during 1991-92, and 123 (69%) of the reported harvest during 1992-93. The majority of nonlocal hunters initially access hunting areas by aircraft even though many individuals hunt by boat while floating rivers. Snowmachines and boats were the next most common means of transportation for taking moose in the Unit, and are the predominant mode of transportation by local hunters. Due to many local hunters' noncompliance with reporting requirements, the number of hunters who used boats or snowmachines is undoubtedly higher than reported.

Natural Mortality:

The winter of 1990-91 was exceptionally severe on all ungulates in Unit 23. Winter conditions were also severe during 1988-89 and 1989-90. These 3 severe winters caused drastic winter mortality throughout the Unit, especially in the Noatak River drainage. Winter mortality was caused by direct starvation, predation predisposed by malnutrition, and deep snow conditions. At least 2 to 4 times as many carcasses were observed during spring composition counts in the Noatak and Kobuk River drainages as during any of the preceding 5 years. When combined with high numbers of wolves and brown bears, and with increasing pressure from nonlocal hunters, the effect of these 3 winters cannot be underestimated. This period probably represents the inflection point Unit 23 moose populations transitioned from a long period of growth to a period of stable or declining numbers.

During the first year of the Noatak moose telemetry project, 22% of the collared moose died of natural causes. The causes of natural mortality were not confirmed, but predation appeared to be the most likely explanation for most of the deaths. Natural mortality appears to be affecting moose abundance more than hunting mortality. However, the sample sizes for the Noatak moose telemetry study are small, and only 2 years of data have been collected. Therefore, these results should be viewed as tentative.

Habitat

Assessment: Moose habitat has not been critically examined in Unit 23. A Department staff member from the Kenai Moose Research Center (Chuck Schwartz) assisted with radio-collaring moose in the middle Noatak River drainage during 1992. During this time, Schwartz examined willow browse throughout this portion of the drainage with local staff. Our impression was that the condition of winter habitat was relatively good. Little "clubbing" of willows was observed, and in many willow thickets much of the current year's annual growth had not been removed by moose. Our impressions contrast those of a longtime guide in this area who reported that extensive clubbing of willows is evident in the Kugururuk River drainage (P. Driver, pers. commun.). Browse lines from the last peak in the snowshoe hare population cycle were still evident in Ericaceous shrubs in at least portions of the Unit (e.g. the lower Kelly River area); however, regrowth of vegetation has largely obscured this.

Highly variable snow conditions strongly affect the availability of browse. This undoubtedly excludes moose from some areas and prevents chronic overbrowsing. Because Unit 23 is at the northern margin of moose range distribution in Alaska, the effects of adverse winters are probably at least as important on moose population dynamics in Unit 23 as are long-term changes in forage availability. A series of severe winters combined with high levels of predation and hunting can depress moose populations despite abundant food.

CONCLUSIONS AND RECOMMENDATIONS

The department should develop a comprehensive management plan for moose throughout Unit 23 during the next several years. This plan should be developed and implemented in cooperation with other land management agencies, local organizations including NANA and the Northwest Arctic Borough, and the public. This should remain a high priority when allocating resources for moose management in Unit 23.

As suspected for several years, trend counts are inadequate for monitoring moose population size and composition. The foundation of moose management in Unit 23 should be based on census information. Trend counts should be replaced with a sampling technique, e.g., "super stratification," if possible. If personnel, aircraft availability, or financial constraints necessitate continuation of trend counts, they should be enlarged to include entire drainages when possible to minimize local effects of moose movements and harvest.

A census area should be established in each of the following drainages: middle Noatak River, upper Kobuk River, Tagagawik River, Buckland/Kiwalik Rivers, and middle Kobuk or Squirrel Rivers. One area should be censused each year, preferably in the fall to provide bull:cow ratio information. In this way, each area would be censused every 5 to 7 years.

The middle Noatak moose telemetry project should be continued for at least 1 to 2 more years to evaluate the magnitude and causes of moose mortality in this area. However, the benefits of ear tagging males do not outweigh the capture expense and risk imposed on moose, and should be discontinued.

Hunting pressure in the middle Noatak River drainage remained high. Bull:cow ratios need to be closely monitored in this area. At least 40 bulls:100 cows should be maintained until a moose management plan is developed for the Unit. This will maintain the maximum number of management options for consideration in the planning process.

The recent increase in hunter effort on the Tagagawik River and northern Seward Peninsula warrants careful monitoring of moose populations in these areas. During April 1994, the Department will initiate a moose telemetry project on the Tagagawik River in cooperation with the USFWS and BLM. The Department should continue to support this cooperative project in the future.

Local compliance with harvest reporting requirements remains poor. Department personnel should continue to inform the public of the need for accurate harvest information. Also, alternative methods of collecting harvest information should be explored.

In summary, I recommend the department takes the following actions:

1. Draft a moose management plan for Unit 23 by December 1995;

2. Continue the moose telemetry project in the middle Noatak River drainage for at least 1-2 more years;

3. Continue to monitor moose abundance and population composition in the middle Noatak River drainage, the Tagagawik River drainage, and on the northern Seward Peninsula;

4. Continue to establish moose census areas in the upper Kobuk River, Tagagawik River, and on the northern Seward Peninsula;

5. Attempt to collect more accurate local harvest information by explaining to the public why harvest data is necessary, and by exploring new techniques to collect harvest data; and

6. Maintain a minimum November bull:cow ratio of 40:100 in each major drainage until a management plan can be implemented for the Unit.

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Table 1. Fall moose sex and age composition from aerial trend counts, Unit 23, 1984-93.

Location and Date	Males				Females				Total calves	Total adults	Total moose
	sp-fk[a]	<50 in	≥50 in	Total	w/0 ca	w/1 ca	w/2 ca	Total			
Tagagawik											
11/22/86	13	31	21	65	99	35	9	143	53	208	261
11/09-10/87	19	33	32	84	145	59	4	208	67	292	359
11/23/88	36	4	29	108	134	42	6	182	54	290	344
11/07/89	39	57	35	131	152	60	5	217	70	348	418
11/20/92	29	62	54	145	225	43	6	274	57	419	476
11/26-27/93	31	39	30	100	163	63	4	230	72	330	402
Middle Noatak											
11/23/86	16	14	21	51	76	37	3	116	44	167	211
11/11-15/87	19	37	39	95	101	65	5	171	76	266	342
11/28-29/88	22	46	55	123	203	90	10	303	110	426	536
11/21-27/89	31	39	17	87	223	24	0	247	26	334	360
11/07/90	13	58	26	97	226	86	6	318	98	415	513
11/6-7/91	3	18	18	39	74	30	3	107	36	146	182
11/17-19/92	7	43	23	73	222	13	1	236	16	309	325
Wulik											
11/25/87	2	5	8	15	13	11	0	24	11	39	50
11/14/88	6	9	3	18	15	25	3	43	31	61	92
10/25/89	12	7	6	25	31	8	1	40	10	65	75
11/06/90	5	30	18	53	52	51	8	111	67	164	231
11/05/91	3	10	4	17	44	14	1	59	16	76	92
11/01/93	3	6	1	10	19	20	2	41	24	51	75

Table 1. Continued.

Location and Date	Males sp-fk[a]	Males <50 in	Males ≥50 in	Males Total	Females w/0 ca	Females w/1 ca	Females w/2 ca	Females Total	Total calves	Total adults	Total moose
Nimiuktuk											
11/24/87	3	18	13	34	39	12	1	52	14	86	100
11/06/88	3	5	11	19	17	12	1	30	14	49	63
11/01/89	6	10	11	27	43	13	2	58	17	85	102
11/09/90	6	16	10	32	28	10	1	39	12	71	83
11/03/91	0	10	12	22	26	8	2	36	12	58	70
Buckland											
11/15/85	15	23	22	60	69	21	2	92	26	152	178
11/02/89	5	6	10	21	58	15	1	74	17	95	112
11/19/92	10	17	14	41	72	13	1	86	16	127	143
Inmachuk											
11/27/87	2	10	19	31	27	10	1	38	13	69	82
11/09/89	5	13	13	31	38	14	2	54	18	85	103
11/18/92	6	8	22	36	39	15	1	55	18	91	109
Upper Kobuk											
10/17-20/84	14	14	18	46	50	21	3	74	27	120	147

[a] Spike or fork antlers.

Table 2. Sex and age ratios for fall moose trend count data, Unit 23, 1984-93.

Location and Date	Bulls:100 Cows sp-fk[a]	Bulls:100 Cows <50 in	Bulls:100 Cows ≥50 in	Bulls:100 Cows Total bulls	Calves: 100 Cows	% of All Cows with Calves	Size of Area Surveyed (mi^2)	Density ($moose/mi^2$)
Tagagawik								
11/22/86	9	22	15	45	37	30.8	190	1.4
11/9-10/87	9	16	15	40	33	30.3	190	1.9
11/23/88	20	24	16	59	30	26.4	190	1.8
11/07/89	18	26	16	60	32	30.0	190	2.2
11/20/92	11	23	20	53	21	17.8	190	2.5
11/26-27/93	13	17	13	43	31	29.1	190	2.1
Middle Noatak								
11/23/86	14	12	18	44	38	34.5	185	1.1
11/11-15/87	11	22	23	56	44	40.9	278	1.2
11/28-29/88	7	15	18	41	36	33.0	278	1.9
11/21-27/89	13	16	7	35	11	9.7	278	1.3
11/07/90	4	18	8	31	31	28.9	278	1.8
11/6-7/91	3	17	17	36	34	30.8	278	0.6
11/17-19/92	3	18	10	31	7	5.9	278	1.2
Wulik								
11/25/87	8	21	33	62	46	45.8	69	0.7
11/14/88	14	21	7	42	72	65.1	69	1.3
10/25/89	30	18	15	62	25	22.5	69	1.1
11/06/90	4	27	16	48	60	53.1	69	2.7
11/05/91	5	17	7	29	27	25.4	69	1.3
11/01/93	7	15	2	24	59	51.2	69	1.1

Table 2. Continued.

Location and Date	Bulls:100 Cows sp-fk[a]	Bulls:100 Cows <50 in	Bulls:100 Cows ≥50 in	Bulls:100 Cows Total bulls	Calves: 100 Cows	% of All Cows with Calves	Size of Area Surveyed (mi^2)	Density ($moose/mi^2$)
Nimiuktuk								
11/24/87	6	35	25	65	29	25.0	90	1.1
11/06/88	10	17	37	63	47	43.3	90	0.7
11/01/89	10	17	19	47	29	25.9	90	1.1
11/09/90	15	41	26	82	31	28.2	90	0.9
11/03/91	0	28	33	61	33	27.7	90	0.8
Buckland								
11/15/85	16	25	24	65	28	25.0	225	0.8
11/02/89	7	8	14	28	23	21.6	134	0.8
11/19/92	12	20	16	48	19	16.3	134	1.1
Inmachuk								
11/27/87	5	26	50	82	34	28.9	197	0.4
11/09/89	9	24	24	57	33	29.6	192	0.5
11/18/92	11	15	40	65	33	29.1	197	
Upper Kobuk								
10/17-20/84	19	19	24	62	36	32.4	969	0.2

[a] Spike or fork antlers.

Table 3. Estimated population size for Squirrel River moose census, November 1992 (variance pooled across strata).

Parameters	Low	Medium	High	Total
N	56	51	20	127
Total area	628.28	579.98	232.601	1440.86
n	11	14	7	32
Area sur	130.59	162.75	85.53	378.87
# seen	41	129	176	346
Density	0.3140	0.7926	2.0578	0.7881
To	197.3	459.7	478.6	1135.6
V(To)	1344.95	14116.72	4587.42	20049.09
SCFo=1.16707	V(SCFo)=0.0038978609		df(SCFo)= 29	
To df	10	13	6	21
Te = 1325.3	V(Te) = 32256.53		df(Te) = 21	
80% CI around	Te = (1087.7, 1562.9)		is +/- 17.93%	
90% CI around	Te = (016.2, 1634.4)		is +/- 23.32%	
95% CI around	Te = (951.8, 1698.9)		is +/- 28.19%	

Overall density = 1325.3/1627.9 = 0.95 moose/mi^2

Table 4. Estimated bull:cow and calf:cow ratios for the Squirrel River drainage moose census, November 1992 (variance pooled across strata).

Bull:cow ratio:

Numerator = Total Bulls
Denominator = Total Cows
Ratio: p = Numerator/Denominator

p = 0.3770	V(p) = 0.00179892	df(p) = 22
80% CI around	p = (0.3210, 0.4330)	is +/- 14.86%
90% CI around	p = (0.3042, 0.4498)	is +/- 19.32%
95% CI around	p = (0.2890, 0.4650)	is +/- 23.33%

Calf:cow ratio:

Numerator = Total Calf
Denominator = Total Cows
Ratio: p = Numerator/Denominator

p = 0.3185	V(p) = 0.00138076	df(p) = 22
80% CI around	p = (0.2695, 0.3676)	is +/- 15.41%
90% CI around	p = (0.2547, 0.3823)	is +/- 20.03%
95% CI around	p = (0.2415, 0.3956)	is +/- 24.19%

Table 5. Annual reported moose harvest from Unit 23, 1979-80 through 1992-93.

Season	Male	Female	Unspecified	Total
1979-80	129	10	0	139
1980-81	97	6	9	112
1981-82	160	15	1	176
1982-83	119	8	1	128
1983-84	129	12	0	141
1984-85	160	17	3	180
1985-86	112	12	0	124
1986-87	139	8	0	147
1987-88	191	14	1	206
1988-89	202	14	0	216
1989-90	200	11	2	213
1990-91	185	14	1	200
1991-92	143	33	0	176
1992-93	154	24	0	178

Table 6. Moose harvest by sex and drainage in Unit 23, 1991-92 and 1992-93.

Drainage	1991-92 Males	1991-92 Females	1991-92 Unspec.	1991-92 Total	1992-93 Males	1992-93 Females	1992-93 Unspec.	1992-93 Total
Noatak River	64	22	0	86	68	15	0	83
Kobuk River	36	3	0	39	22	4	0	26
Selawik River	24	1	0	25	32	3	0	35
Northern Seward Pen.	8	6	0	14	25	1	0	26
Kivalina/Wulik Rivers	8	0	0	8	7	1	0	8
Unspecified	3	1	0	4	0	0	0	0
Total	143	33	0	176	154	24	0	178

Table 7. Mean antler widths (inches), standard deviations (SD), and sample sizes (n) for the reported moose harvest by drainage and year, Unit 23, 1984-85 through 1992-93.

Year		Noatak	Kobuk	Kivalina Wulik	Northern Seward Peninsula	Selawik	Total[a]
1984-85							
	mean	49.4	46.1	35.0	46.6	45.0	47.8
	SD	12.4	11.6		16.1	15.4	12.8
	n	86	39	1	12	15	153
1985-86							
	mean	50.1	42.0	49.3	30.0	49.3	48.3
	SD	13.0	13.9	12.0		16.9	14.0
	n	67	17	3	1	16	107[b]
1986-87							
	mean	47.5	44.2		42.2	50.5	46.8
	SD	11.6	9.7		9.4	13.2	11.3
	n	78	29	0	8	12	130[b]
1987-88							
	mean	53.4	47.2	50.5	44.1	52.0	51.4
	SD	10.9	14.1	15.2	17.5	8.3	12.1
	n	93	32	14	7	21	173[b]
1988-89							
	mean	52.3	49.4	54.2	45.3	51.9	51.1
	SD	9.8	10.0	12.6	17.0	10.6	10.6
	n	102	56	6	11	17	193[b]
1989-90							
	mean	51.0	48.1	52.3	42.5	53.0	50.4
	SD	10.2	12.7	10.9	12.4	11.0	11.2
	n	92	50	9	6	27	187[b]
1990-91[c]							
	mean	55.2	50.5	57.7	48.7	47.7	52.5
	SD	8.8	10.8	6.1	13.2	11.2	10.3
	n	84	52	7	12	23	178

Table 7. Continued.

Year	Noatak	Kobuk	Kivalina Wulik	Northern Seward Peninsula	Selawik	Total[a]
1991-92[c]						
mean	52.0	49.9	56.6	41.7	54.5	51.7
SD	8.4	9.3	4.2	11.5	8.4	8.9
n	58	31	7	6	23	127
1992-93[c]						
mean	50.0	50.8	59.5	50.7	54.6	51.4
SD	11.0	11.2	4.9	14.6	9.9	11.4
n	62	17	2	22	32	135

[a] All drainages combined.

[b] Includes antler widths for moose taken in GMU 23 where drainage was not reported.

[c] Nonresident hunters could only take bulls with spike/fork antlers, or antlers 50 inches or wider.

Table 8. Number (percentage, excluding unknowns) of bull moose harvested in various antler width (inches) categories, Unit 23, 1985-86 through 1990-91.

Regulatory year	<20"	20-<30"	30-<40"	40-<50"	50-<60"	>60"	Total[a]
1985	3 (3)	12 (11)	15 (14)	15 (14)	37 (34)	26 (24)	108
1986	1 (1)	8 (6)	28 (21)	29 (22)	49 (38)	15 (11)	130
1987	2 (1)	9 (5)	17 (10)	26 (15)	66 (38)	51 (30)	171
1988	1 (1)	4 (2)	24 (11)	35 (16)	82 (38)	41 (19)	187
1989	7 (4)	8 (4)	21 (11)	32 (17)	90 (47)	34 (18)	192
1990[b]	1 (1)	7 (4)	15 (8)	32 (17)	71 (40)	53 (30)	179
1991[b]	0 (0)	0 (0)	13 (10)	26 (20)	67 (53)	21 (17)	127
1992[b]	2 (1)	6 (4)	15 (11)	20 (15)	58 (43)	34 (25)	135
Total	17 (1)	54 (4)	148 (12)	215 (17)	520 (42)	275 (22)	1229

[a] Excludes bulls where antler width not reported.

[b] Nonresident hunters could only take bulls with spike/fork antlers, or antlers 50 inches or wider.

Table 9. Moose hunter success in the Noatak River drainage.

Year	Successful	Unsuccessful	Total	% Successful
1979-80	51	28	79	65
1980-81	35	14	49	71
1981-82	67	52	119	56
1982-83	63	41	104	61
1983-84	79	67	146	54
1984-85	100	75	175	57
1985-86	74	49	123	60
1986-87	86	64	150	57
1987-88	100	90	190	53
1988-89	125	18	143	87
1989-90	104	60	164	63
1990-91	109	34	143	76
1991-92	86	63	149	58
1992-93	83	99	182	46

Table 10. Unit 23 moose harvest, 1979-92.

Regulatory Year	No. of Hunters			Percent Successful	Hunter Residency			
	Successful	Unsuccessful	Total		Unit 23 Resident	Alaska Resident[a]	Non-Resident	Unknown
1979	139	100	239	58	148	51	32	8
1980	108	80	188	57	99	61	47	4
1981	176	153	329	54	161	80	47	41
1982	128	139	267	48	141	81	28	17
1983	141	165	306	46	152	115	26	13
1984	180	165	345	52	137	127	71	10
1985	124	99	223	56	72	98	46	7
1986	150	124	274	55	106	99	58	11
1987	210	137	347	61	101	104	132	10
1988	222	98	320	69	59	114	132	15
1989	213	152	365	58	81	117	141	26
1990	200	136	336	60	69	117	131	19
1991	176	170	346	51	79	130	121	15
1992	178	178	356	50	73	149	123	11

Table 11. Chronology of moose harvest in Unit 23 during the 1991 regulatory year.

Week ending		Males	Females	Unspecified	Total
August	4	0	1	0	1
	11	0	0	0	0
	18	1	0	0	1
	25	1	0	0	1
September	1	10	0	0	10
	8	31	8	0	39
	15	29	4	0	33
	22	38	3	0	41
	29	13	2	0	15
October	6	0	0	0	0
	13	1	1	0	2
	20	0	0	0	0
	27	0	0	0	0
November	3	0	0	0	0
	10	0	0	0	0
	17	0	0	0	0
	24	0	0	0	0
December	1	0	1	0	1
	8	0	0	0	0
	15	1	0	0	1
	22	0	0	0	0
	29	0	0	0	0
January	5	2	0	0	2
	12	1	2	0	3
	19	0	1	0	1
February	16	0	2	0	2
	23	2	0	0	2
March	2	0	0	0	0
	9	0	0	0	0
	15	1	1	0	1
	22	1	1	0	2
	29	3	2	0	5
April	5	0	2	0	2
Unknown		8	2	0	10
Total		143	33	0	176

Table 12. Chronology of moose harvest in Unit 23 during the 1992 regulatory year.

Week ending		Males	Females	Unspecified	Total
August	4	2	1	0	3
	11	3	1	0	4
	18	2	0	0	2
	25	5	1	0	6
September	1	8	2	0	10
	8	30	7	0	37
	15	42	3	0	45
	22	33	2	0	35
	29	7	0	0	7
October	6	2	0	0	2
	13	0	0	0	0
	20	1	0	0	1
	27	0	0	0	0
November	3	1	0	0	1
	10	0	0	0	0
	17	1	0	0	1
	24	0	0	0	0
December	1	1	0	0	1
	8	0	0	1	0
	15	0	0	0	0
	2	0	0	0	0
	29	0	1	0	1
January	5	1	0	0	1
	12	0	1	0	1
	19	0	0	0	0
February	2	0	0	0	0
	9	1	0	0	1
	16	0	0	0	0
	23	3	0	0	3
March	2	1	2	0	3
	9	0	1	0	1
	16	2	1	0	3
	23	0	1	0	1
	30	1	0	0	1
April	6	1	0	0	1
Unknown		6	0	0	6
Total		154	24	0	178

Table 13. Transportation used by moose hunters in Unit 23, 1991-92 and 1992-93.

Regulatory Year	Vehicle	Successful	Unsuccessful	Total
1991				
	Aircraft	126	124	231
	Horse/Dog team	1	1	2
	Boat 18	47	65	
	3- or 4-Wheeler	4	3	7
	Snowmachine	24	3	27
	Off-road vehicle	0	0	0
	Highway vehicle	2	1	3
	Unknown	1	10	11
	Total 176	170	346	
1992				
	Aircraft	123	124	247
	Horse/Dog team	1	0	1
	Boat	25	33	58
	3- or 4-Wheeler	5	2	7
	Snowmachine	20	2	22
	Off-road vehicle	0	0	0
	Highway vehicle	2	1	3
	Unknown	2	16	18
	Total	178	178	356

LOCATION

Game Management Unit: 24 (26,055 mi^2)

Geographical Description: Koyukuk River drainage above Dulbi River

BACKGROUND

Moose are a recent addition to the fauna of Unit 24, having moved into the area during the 1930s through the 1950s. Colonization was slow until predator control efforts in the 1950s allowed rapid expansion of local populations, especially in the southern third of the unit. During the early 1970s, the population reached a peak and mortality started to exceed recruitment in some areas.

The habitat is excellent along most of the Koyukuk River lowlands, providing expansive areas of winter browse. Lightning-caused fire is a frequent event and the large areas of burned uplands are producing good moose browse. Browse availability is not limiting the size of the moose population at current moose densities.

Historical reported harvests during the past 25 years have ranged from 44 to 134, but did not exceed 100 moose until 1980. The unreported harvests during this period probably ranged from 160 to 300 moose per year. Since 1980, the reported harvests have exceeded 100 moose because more local residents have become aware of the reporting requirement, compliance with the reporting requirement has increased, and access to the unit has become easier with the opening of the Dalton Highway.

MANAGEMENT DIRECTION

Management Goals

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide for continued use of moose by local Alaskan residents who have customarily and traditionally used the population.
- Provide the greatest sustained opportunity to hunt moose.
- Provide an opportunity to view and photograph moose.
- Provide for scientific and educational use of moose.

Management Objectives

- Manage a moose population at the current level of 5,000-7,000 in the area south of Hughes, including the Koyukuk Controlled Use Area (CUA).

- Increase the moose population to 5,000-6,000 in the area from Hughes to Bettles, including the Kanuti CUA and the South Fork drainage.

- Increase the moose population north of Bettles, excluding the Gates of the Arctic National Park, to 3,000-3,500.

- Maintain the population in the Gates of the Arctic National Park at 1,300-1,500.

METHODS

One standard Alaska Department of Fish and Game (ADF&G) population estimation survey (Gasaway *et al.* 1986) was conducted in the subunit in cooperation with the U.S. Fish and Wildlife Service (FWS) and National Park Service (NPS).

Hunting mortality and distribution were monitored through harvest tickets and check stations. Local residents were encouraged to increase their harvest reporting through school visits and check stations. Predation was monitored by interviewing trappers and conducting track surveys and a predation rate study in the Kanuti National Wildlife Refuge (NWR).

RESULTS AND DISCUSSION

Population Status and Trend

Moose are numerous in the Koyukuk River lowlands in the southern third of the unit (south of Hughes). The population is believed stable, except near the village of Huslia where moose numbers are growing.

Moose densities are low in the middle third of the unit (Hughes to Bettles, including the Kanuti CUA and the South Fork drainage) and the population appears to have grown since 1989 within the Kanuti NWR. The increase in population may be due to a variety of factors. The area experienced large burns in the mid and late 1970s which produced excellent moose browse. The moose population was unable to rapidly expand due to wolf and bear predation and some overhunting within the Kanuti CUA. In recent years large numbers of caribou have wintered in the area providing alternate meat for hunters and prey for wolves. The number of wolves taken by hunters has also increased which produces a decreased but stable predation rate.

Moose densities are moderate in the northern third of the unit (north of Bettles, including the Gates of the Arctic National Park) and moose numbers are probably stable in most areas. However, moose numbers may be slowly declining within the park.

Population Size: A population estimation survey (Table 1) was conducted within the Kanuti CUA during the report period in cooperation with personnel from the FWS and NPS. The survey produced a combined population estimate of 8,339 moose (CI = ± 20-25%) and an average density of 0.43 moose/mi^2. In 1989, we previously estimated the population at 1,137 ± 26% moose.

Approximately 5,000-7,000 moose are in the southern portion of Unit 24, based on the results of 1988 and 1989 population estimation surveys and extrapolations of density estimates from trend count surveys.

I estimate 3,000-4,000 moose are present in the middle portion of Unit 24. This estimate is based on population estimation surveys of the Kanuti NWR and the Dalton Highway Corridor. These surveys indicated a rather low overall early winter density of 0.42-0.76 moose/mi^2.

Approximately 3,000-4,150 moose are in the northern portion of Unit 24, including approximately 1,500-2,000 moose within the Gates of the Arctic National Park. This estimate is based on the distribution of moose during a 1987 stratification survey and density estimates arbitrarily assigned each stratum. By extrapolation, the unit population probably numbers between 11,000 and 15,000 moose.

Population Composition: Composition data from an established trend count area (Huslia River Flats) and a population estimation survey in the Kanuti NWR (Tables 2 and 3) indicate recruitment was much improved over previous surveys. The moderate ratio of yearling bulls to cows indicates more calves are surviving. The bull:cow ratio remained at an acceptable level, but may be misleading because substantial numbers of cow moose are taken in parts of the unit.

Historically, I have interpreted the population indices in Unit 24 similarly to those in Subunit 21D. A summary of my management guidelines can be found in the Subunit 21D report.

Distribution and Movements: Information is scarce regarding movements of moose within the unit. Thirteen moose radio-collared in northern Subunit 21D had a summer migration into the southwestern parts of Unit 24. Moose are found at treeline in the northern part of the unit during early winter and move into the river bottoms during late winter and summer.

Mortality

Harvest:

Season and Bag Limit.

Season and Bag limit	Resident	Nonresident
Unit 24, that portion within the Koyukuk Controlled Use Area.		
Resident hunters: One moose; however, antlerless moose may be taken only from 21 Sept.-25 Sept., 1 Dec.-10 Dec. and 1 Mar.-10 Mar.	5 Sept.-25 Sept. 1 Dec.-10 Dec. 1 Mar.-10 Mar.	
Nonresident hunters: One bull with 50-inch antlers.		5 Sept.-25 Sept.
All hunters: Harvest ticket required. Evidence of sex required.		
Unit 24, that portion including the John River drainage upstream from but excluding the Hunt Fork drainage: One moose. Harvest ticket required. See Federal Regulations for people qualified to hunt in National Parks and Monuments.	1 Aug.-31 Dec.	No open season
Unit 24, the Alatna River drainage upstream from and including Helpmejack Creek drainage, the John River drainage upstream from and including the Malemute Fork drainage and downstream from and including the Hunt Fork drainage, the Wild River drainage upstream from and including the Michigan Creek drainage, and the North Fork Koyukuk River drainage north of the Bettles/Coldfoot winter trail.		
Resident hunters: One moose; however, antlerless moose may be taken only from 21 Sept.-25 Sept. and 1 Mar.-10 Mar.	25 Aug.-25 Sept. 1 Mar.-10 Mar.	

Nonresident hunters: One bull with 50-inch antlers.		5 Sept.-25 Sept.
All hunters: Harvest ticket required. Evidence of sex required. See Federal Regulations for people qualified to hunt in the National Parks and Monuments.		
Remainder of Unit 24.		
Resident hunters: One bull.	25 Aug.-25 Sept.	
Nonresident hunters: One bull with 50-inch antlers.		25 Aug.-25 Sept.
All hunters: Harvest ticket required. Evidence of sex required.		

<u>Game Board Actions and Emergency Orders</u>. In 1992, the board required nonresidents to harvest bulls with a ^{3} 50-inch antler spread or 4 or more brow tines on either side. They also required the meat to remain on the bone for the legs and ribs of moose harvested within the Koyukuk CUA until exported from the area. In 1993 the board changed season dates for resident hunters to open 1 September instead of 5 September in the Koyukuk CUA and 25 August in the northern part of the unit. They also altered the physical description of the northern part of the unit. The size of the area was increased, but it should not affect harvests in the area. Hunters from Allakaket will now be able to hunt antlerless moose closer to the village. No emergency orders were issued.

<u>Hunter Harvest</u>. The hunting seasons in the unit are diverse and reflect the various moose densities and consumptive use patterns. The annual reported harvest since 1988 has averaged 135 moose (Table 4). Generally 96% of the reported moose harvest was taken during the September portion of the hunting season.

Illegal and unreported harvests by local residents continue to hamper department efforts to manage moose. The actual harvest is estimated to be about twice the reported harvest (Table 4). Moose taken during winter are rarely reported even when the season is open. Hughes does not have a license vendor, contributing to the problem of hunters' hunting without licenses or harvest tickets. I am attempting to increase public awareness of the importance of accurate reporting, and am seeking additional license vendors. Fortunately, most of the unreported harvest comes from the southern portion of the unit which has a large enough moose population to support the additional harvest.

The estimated annual harvest by residents of Unit 24 is about 172 moose according to Marcotte (1986), Marcotte and Haynes (1985), and my personal estimates. We estimate the 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 live outside of the villages.

Hunter Residency and Transportation Methods. The Dalton Highway was initially closed to the public at the Yukon River bridge. The road was opened to public use throughout Unit 24 in 1981. Since that time the hunter effort and moose harvest increased to the present level (Table 4), and now is fairly stable.

Final harvest data for 1993 were not available at the time this report was written. However, over the previous 4 years the reported harvest averaged 135, with unit residents accounting for 42 of those, on average (Table 5). The harvest by nonresident hunters averaged 18 moose per year. There was an average of 259 hunters reporting during the preceding 4 years, but this average is probably minimal since unit residents rarely report unsuccessful hunt information.

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 two CUAs (Table 6). Highway vehicles are only used on the Dalton Highway which crosses the eastern part of the unit. Snowmachines were the main transportation method used during the winter hunt.

Other Mortality: A minimum of 400-440 wolves in 55-60 packs and a large population of black bears inhabit the middle and southern portions of the unit. Grizzly bears are common throughout the mountain areas.

Predation on moose is high except around the villages of Huslia, Allakaket, and Bettles where predators are kept at lower numbers. Predation is keeping the moose population low throughout much of the central portion of the unit.

The winter of 1992-93 had the deepest snowfall on record at Bettles (with nearly 8 feet on the ground) and similar depths were assumed to have fallen over the rest of the unit. Calf mortality was high in the Hogatza River, Middle Fork, and lower Alatna River. Trappers estimated losses from 25% to 50% in those areas. Moose concentrated on the river and creek systems where refrozen overflow moderated snow levels and allowed moose access to riparian foods. Moose on side hills and flat areas had harder conditions and more dead moose were found in these areas. At Coldfoot seven moose were reported killed in 10 days on the Dalton Highway when moose concentrated along the highway to escape the deep snow.

CONCLUSIONS AND RECOMMENDATIONS

The previous population objective in the southern portion of the unit was intended to reflect the current size of the population. Recent surveys have indicated the population most likely numbers 5,000-7,000 instead of 3,000-5,000. The status of the population in this area relative to its habitat and human- use demands has not changed. What has changed is our ability to estimate the true size of the population. The population objective has been revised upward accordingly.

We need to obtain population estimates for the Hogatza River drainage and the northern area including Gates of the Arctic National Park. In the future, a population estimation survey may be undertaken in cooperation with NPS when funding is available.

The indication of an increase in the moose population from the Kanuti population estimation survey is welcome news. The area has had excellent moose habitat regeneration following several large fires in the late 1970s, but the population was not responding as expected.

The habitat is excellent throughout much of the unit, with an abundance of successional willow regrowth due to either fire or riverine erosion. The availability of browse is not limiting the moose population.

With the exception of limited areas around Allakaket, Bettles, and Huslia, predation on moose by wolves and bears is the major factor limiting Unit 24 moose populations. Moose numbers will not increase in those areas where the population objectives are not being met unless predation is reduced. Unit residents are meeting their wild food requirements, but hunting opportunities cannot be increased for people living outside the unit until moose numbers expand. Although moose numbers might have declined due to the deep snows in 1992-93, the Kanuti population estimation survey results indicated moose numbers increased in a large portion of the middle of the unit. The status of the moose in the southern Brooks Mountains is unknown.

Reporting and licensing procedures are not being followed by unit residents. More emphasis needs to be placed on education, enforcement, and the recruitment of license vendors.

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Table 1. Summary of moose population estimation survey data from Kanuti National Wildlife Refuge in Unit 24, 5-16 November 1993.

Statistic	Strata: Low	Strata: Medium	Strata: High	All strata combined
Sample units (N)	84	127	17	228
No. surveyed (n)	6	26	8	40
Total area (mi^2)	974	1,475	195	2,644
Stratum as % of total	36.8	55.8	7.4	100.0
Area surveyed (mi^2)	68.3	301.9	98.1	468.3
% of stratum surveyed	7.0	20.5	50.33	17.7
No. moose seen	10	212	292	514
Observed density (moose/mi^2)	0.15	0.70	2.98	0.76
Uncorrected[a] estimate (T_o)	142	1,036	580	
Variance $V(T_o)$	1,200	29,564	51,540	
Deg of freedom $df(T_o)$	5	25	7	
Observed sightability correction factor (SCF_o)	1.14	1.14	1.14	
Variance $V(SCF_o)$	0.0000	0.01114	0.06261	
Degrees of freedom $df(SCF_o)$	9	25	6	
Corrected estimate (T_e)				2,010
Variance $V(T_e)$				35,918
Degrees of freedom $df(T_e)$				33
90% CI[b] around T_e				22.0%

[a] Not corrected for sightability.
[b] Confidence Interval.

Table 2. Summary of fall aerial moose survey[a] data from Kanuti National Wildlife Refuge in Unit 24, 1988-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1988-89	82	19	37	145	77	724	869	--
1989-90	74	14	18	29	9	282	311	0.45
1990-91[b]	--	--	--	--	--	--	--	--
1991-92	54	9	20	42	12	322	364	--
1992-93	--	--	--	--	--	--	--	--
1993-94	61	19	33	73	17	441	514	0.76

[a] 1989 and 1993 data were based on a population estimation survey, the other years are based on trend count areas (Kanuti Canyon and Peavey Creek).
[b] No surveys completed

Table 3. Summary of fall aerial moose survey data from Koyukuk CUA, Huslia Flats trend area in Unit 24, 1988-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1988-89[a]	--	--	--	--	--	--	--	--
1989-90[b]	50	2	30	15	17	75	90	2.4
1990-91	--	--	--	--	--	--	--	--
1991-92	--	--	--	--	--	--	--	--
1992-93	--	--	--	--	--	--	--	--
1993-94	81	15	24	57	12	426	483	6.1

[a] No surveys completed.
[b] Only partial count of trend area.

Table 4. Unit 24 moose harvest and Dalton Highway hunter success, 1988-94.

Regulatory year	Harvest by Hunters: Reported M	F	Unk	Total	Estimated Unreported	Illegal	Total	Total	Dalton Highway Success	Unsuc.
1988-89	132	5	0	137	124	--	124	261	50	44
1989-90	119	8	1	128	125	--	125	253	57	35
1990-91	141	2	1	144	120	--	120	264	67	61
1991-92	141	2	1	144	120	--	120	264	55	33
1992-93	118	5	0	123	119	--	119	242	27	100
1993-94	--[a]	--	--	--	172	--	172	--	36	48

[a] No data.

Table 5. Unit 24 moose hunter residency and success, 1988-93.

Regulatory year	Successful: Local[a] resident	Nonlocal resident	Nonres.	Unk	Total	Unsuccessful: Local[a] resident	Nonlocal resident	Nonres.	Unk	Total	Total hunters
1988-89	41	57	16	23	137	13	63	18	25	119	256
1989-90	40	68	17	3	128	28	107	16	4	155	283
1990-91	43	71	22	8	144	17	81	16	9	123	267
1991-92	43	77	23	1	144	14	138	16	3	171	315
1992-93	48	62	7	6	123	27	129	27	3	186	309

[a] Unit residents.

Table 6. Unit 24 moose harvest by transport method, 1988-93.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
1988-89	32	2	67	1	0	4	18	13	137
1989-90	27	1	61	2	1	1	34	13	135
1990-91	23	4	80	5	1	3	23	5	144
1991-92	36	3	64	5	1	3	25	7	144
1992-93	20	0	69	4	6	1	16	7	123

LOCATION

Game Management Unit: 25A, 25B, and 25D (49,000 mi^2)

Geographical Description: Upper Yukon River Valley

BACKGROUND

Moose have been scarce in the upper Yukon River valley throughout most of recorded time. Longtime residents of the area state that moose were hard to find in the early 1900s and have been more common in recent years (F. Thomas, H. Petersen, K. Peter, pers. commun.). Compared with many other areas, moose density continues to be low, especially in the western and northern parts of Unit 25. Systematic surveys were done in the late 1970s and more extensive surveys began in 1981 when ADF&G established a Fort Yukon office. Survey techniques were modified to reflect advances in sampling techniques and accommodate the area's relatively low moose density.

Hunting in Subunit 25D West has been regulated by permit systems since 1983, when a registration permit was established. Winter seasons were added to the fall season in 1984 to accommodate traditional hunting periods. In 1985 permits were limited to qualified Tier II applicants, and in 1986 permits were further limited to residents of Subunit 25D West and a harvest quota was established. Regulations were largely unchanged through 1989, but in 1991 a federal permit system was established for hunting by residents on federal land.

Subunit 25D has been divided into Subunits 25D West and 25D East to allow the use of regulatory schemes that reflect the generally different status of moose populations. The boundary between the two areas lies along Preacher and Birch Creeks south of the Yukon River and along the Hadweenzic River to the north. Moose density is generally lower in Subunit 25D West. This fact, combined with the local residents' demand for moose, has resulted in the use of permit systems that limit hunting largely to residents of Subunit 25D West.

Trend surveys and observations by local residents indicate moose numbers increased during the 1980s in Subunits 25D West and in 25D East. However, trend counts during 1991 and a census in 25D West in 1992 suggest this increase has slowed or stopped. This means the complicated regulations governing moose hunting in the unit cannot be liberalized, and thus simplified, as was hoped. Composition surveys were last conducted in Subunit 25A in 1991, in Subunit 25B in 1987, and in Subunits 25D East and West in 1993. As discussed below, moose population status has not changed dramatically in most areas, although there are some trends that cause concern.

The result of moose telemetry studies in Subunit 25D West from 1983 to 1987 and in Subunit 25D East from 1989 to 1991, as well as studies of moose population dynamics in similar habitat elsewhere, indicate predation by black bears, brown bears, and wolves is the primary cause of summer mortality, with wolves and illegal hunting of both cow and bull moose important sources of winter mortality. Predation and illegal hunting are major factors determining moose population welfare. Moose browse is abundant and used at a low rate. The area is characterized by low to moderate snowfall; malnutrition because of deep snow is rare.

MANAGEMENT DIRECTION

Management Goals

Unit 25:

A goal for all subunits is to protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.

Subunit 25A:

The moose management goals for Subunit 25A are to provide an opportunity to hunt under aesthetically pleasing conditions and provide for subsistence use.

Subunits 25B and 25D:

The moose management goals for Subunits 25B and 25D are to provide for subsistence use and provide for the greatest opportunity to harvest moose.

Management Objectives

Unit 25 Overall:

1. Continue efforts to communicate with and educate local residents about moose management.

2. In cooperation with U.S. Fish and Wildlife Service (FWS), monitor moose population status as funding permits.

3. Cooperate with FWS in periodically determining population status.

Subunit 25A:

1. Evaluate the possible effects of increasing hunting on moose along major drainages along the Brooks Range.

2. Educate local residents regarding the importance of not taking cow moose.

Subunit 25B:

Plan for and conduct biannual trend counts in selected areas for comparison with previous trend counts.

Subunit 25D:

In cooperation with FWS, plan for and conduct periodic moose population surveys in the eastern and western portions of the subunit.

METHODS

Moose composition surveys were flown in PA-18 aircraft about 500 feet above ground level at 70 miles per hour. We circled moose to determine sex, age, antler size of bulls, and locate other moose. Moose habitat in established count areas was searched systematically at an intensity of at least 4 minutes/mi^2. A moose census (Gasaway *et al.* 1986) was conducted in November 1992 in 25D West using multiple PA-18 aircraft and a C-185 for stratification. Mandatory harvest reports provided information on hunter effort, residency, success, transportation, and antler size. Public contact was limited because the Fort Yukon area biologist position was vacant from late 1990 to late 1991. Casual contacts with area residents and moose hunter check stations on the Porcupine River have provided insight into hunter effort and attitudes since 1991.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: Population estimation surveys have not been conducted in Unit 25 in recent years. However, extrapolations from trend surveys and stratification efforts have resulted in estimates of 1,253 moose in 1984 and 2,000 moose in 1989 in a 5,400-mi^2 area in Subunit 25D East (Maclean and Golden 1991). Population density on the Yukon Flats has ranged from a low of 0.1 moose/mi^2 in the west in 1984 to 0.64 moose/mi^2 in the east in 1989 (ADF&G files). The 1992 census in 25D West resulted in an estimate of 602 moose (± 22%) in an area of 4,544 mi^2, a density of 0.12 moose/mi^2. Population density in limited areas approaches 0.5 moose/mi^2. These densities are low relative to most other areas in interior Alaska and, despite some increase in recent years, are clearly well below the level that could be sustained by existing habitat.

Population Composition: Trend surveys in Subunit 25A in 1987, 1989, and 1991 indicated populations in this area have high bull:cow ratios, ranging from 60 to 90 bulls:100 cows, and moderate calf and yearling survival (Table 1). Weather precluded more recent survey attempts, but moderate to low harvests (Table 5) related to poor weather may indicate high bull:cow ratios.

Surveys have not been conducted in Subunit 25B in recent years (Table 2). However, reports from hunters in the area suggest that moose continue to be moderately abundant south of the Porcupine River and in the upper Black River drainage, but are scarce in the Porcupine River drainage to the north. Reports from some knowledgeable observers suggest moose numbers in northern 25D East and 25B, and southern 25A have declined in recent years.

Relatively good survey conditions in Subunit 25D East allowed complete trend counts in 1989, 1991, and 1993. Poor conditions limited surveys in 1990 and none were attempted in 1992. Although trends in indicators of population welfare are not uniform, there has been a moderate decline in the proportion of bulls, yearlings, and calves compared with the early and mid 1980s (Table 3). Moose density may have declined also. The increase in numbers that occurred during the 1980s has apparently slowed or stopped. The bull:cow ratio continues to decline, especially in the last few years, suggesting that the limited harvest is effecting the proportion of bulls. The low yearling recruitment in 25D East seen in 1993 may be related to a flood in May 1992. High water persisted for a week or more in the vicinity of Fort Yukon, stemming mainly from excessive runoff in the Porcupine, Black, Grass, and Sucker Rivers. High water extended for miles back from the main rivers and remained high for an unusually long time, and probably had a negative effect on calving success in local areas.

In Subunit 25D West, a census in 1992 and trend counts in 1993 suggest moose density continues to be low. Table 4 summarizes composition and population data for 25D West. Most parameters of population welfare have been fairly stable during the past several years, with moose persisting at a chronically low density. Although moose numbers have historically been low in this area, reports from hunters and other longtime observers suggest that abundance may have declined over the last several years.

Bull:cow ratios continue to be high in Subunit 25D West, but calf survival and yearling recruitment are relatively low. In terms of assessing effects of harvest on moose, composition data should be used with caution, particularly for Subunit 25D. The harvest of cow moose is known to be significant near settlements and major travel routes. Thus, sex ratio data cannot be interpreted as they would be in areas where cows are rarely taken.

Distribution and Movements: Moose occur throughout the area but density varies greatly. Large areas currently support low densities ranging from 0.1 to 0.3 moose/mi^2. Densities approach or exceed 1 moose/mi^2 in very limited areas in Subunit 25D West and in some more extensive areas in Subunit 25D East in the lower reaches of the Black and Porcupine River drainages. During early winter moose concentrate along the upper Sheenjek and Coleen Rivers in Subunit 25A, but these concentrations are limited. A stratification effort in November 1991 indicated moose were scarce in most of the middle and lower portions of these drainages in Subunit 25A and in northern Subunit 25B as well, with most sample units showing no sign of moose. Telemetry studies in Subunits 25D East and 25D West suggest that some moose are migratory, often moving between higher elevation early winter range to low elevation late winter and summer ranges (Maclean and Golden 1991). There appear to be significant early winter movements of moose into the mountains in Subunit 25A, but no studies of marked moose have been done.

Mortality Harvest:

Seasons and Bag Limits.

	Resident Open Season	Nonresident Open Season
Subunit 25A All hunters, 1 bull	5 Sept.-25 Sept.	5 Sept.-25 Sept.
Subunit 25B; upstream from the Coleen River drainage, 1 bull	20 Sept.-30 Sept.	20 Sept.-30 Sept.
Remainder of 25B	5 Sept.-25 Sept. 1 Dec.-15 Dec.	5 Sept.-25 Sept.
Subunit 25D West; all hunters, 1 bull by Tier II subsistence hunting permit only; up to 125 permits will be issued	25 Aug.-25 Sept. 1 Dec.-10 Dec. 18 Feb.-28 Feb.	No open season.
Subunit 25D East; remainder		
Resident Hunters: 1 bull	10 Sept.-20 Sept. 1 Dec.-10 Dec.	
Nonresident Hunters: 1 bull with 50-inch antlers		10 Sept.-20 Sept.

Board of Game Actions and Emergency Orders. In 1990, the Federal Subsistence Board was established and set regulations for subsistence use on federal lands. These regulations took effect 1 July 1991. A federal subsistence moose permit system was established in Subunit 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 affected regulations in Subunits 25A, 25B, and 25D East. Seasons on federal land for eligible local residents are longer than the state season on private lands and for nonlocal hunters on federal lands, and in most areas extend from 25 August to 25 September and from 1 December to 10 December.

Hunter/Trapper Harvest. The harvest of moose has varied considerably in most of Unit 25 during the past 5 years (Table 5, 6, 7) largely because of weather conditions. The reported harvest for Subunits 25A, 25B, and 25D East has ranged from 156 moose in 1990 to only 54 in 1992. Low harvests in 1989 and 1992 coincided with unusually cold or rainy weather during September. In 1992 in particular, a near record early freeze-up in mid-September even at low elevations near Fort Yukon greatly limited hunting effort. An extensive flood in May 1992 also contributed to poor success in the Fort Yukon area. Local residents report that widespread flooding pushed moose away from rivers. Moose were unusually scarce in flooded areas throughout the summer and fall of 1992. Although final harvest figures are not available for 1993, reports from hunters in Fort Yukon, Chalkyitsik, Circle, and the upper Porcupine areas indicate success was high. Some hunters speculate that a large fire in the upper Little Black River area may have forced moose into other areas.

The reported harvest in connection with the Tier II and federal permit hunts in Subunit 25D West is very small (Table 8), with 9-15 moose reported taken in the last few years. The reporting rate has been poor for this hunt, but has improved recently because of the use of reminder letters. The actual number of moose harvested in Subunit 25D West is unknown, but verbal reports by village residents indicate the number of bulls harvested may approach the present quota of 35.

Unreported harvest, particularly by local residents, is a chronic problem in the upper Yukon River valley. The previous area biologist estimated the unreported harvest at 100-200 moose annually. I have no reason to revise this estimate, and current information indicates that cow moose are taken at any time of year, especially in areas near and between communities. While the illegal taking of moose seems to have declined somewhat in recent years and is disapproved of by some residents, it is still common. In response to this problem, two educational videos were produced in 1993 in a cooperative effort between FWS and ADF&G. The effects of shooting cow moose is a central message in each to educate people about moose management.

Permit Hunts. Although the Tier II moose permit hunt in Subunit 25D West is largely supported by local residents, a number of problems are associated with it. These include confusion about the differences in applicability of federal and state permits, the boundaries of federal and private lands (which are subject to different seasons and permit requirements), and the fact that local residents have not submitted enough applications to acquire all 125 permits available. Increased efforts by community leaders and agencies involved are required if existing regulations are to accomplish the intended goal.

Data on moose populations in Subunit 25D West indicate that a liberalization and a simplification of regulations for Subunit 25D West is not warranted. Efforts should be focused on making the present system function better. An increase in the number of local applicants, clarification of permit conditions, and better harvest reporting are all necessary.

Hunter Residency and Success. As in previous years, most hunters reporting from Subunits 25A, 25B, and 25D are Alaska residents. The proportion of nonresidents is greatest in the most remote portion of Subunit 25A (Table 9), where guiding activity and float trips are more common. Local residents outnumber other hunters by a wide margin in Subunits 25B (Table 10) and 25D East (Table 11). The number of local participants in moose hunting is underrepresented because of a low reporting rate, especially in Subunit 25D East. Success among reporting hunters is high, often approaching or exceeding 50% in Subunits 25A and 25B and ranging from 40% to 50% in Subunit 25D East. Success in 1991 and 1992 was low due to weather.

Harvest Chronology. Most moose taken in Unit 25 are killed during the second and third weeks of September, with a few reported killed before and after this period (Tables 12, 13, and 14). A number of moose are also taken in late August when the state Tier II and federal subsistence seasons open on 25 August. A few moose are reported taken in the 1-10 December open season, but hunting by local residents occurs during this period, and the number of moose killed is greater than reported.

Transport Methods. Aircraft are the most common transport mode in Subunit 25A, being used by more than 50% of the successful hunters. Horses and boats each account for 10-25% of the remainder (Table 15). Boats are used by 75% of successful hunters in Subunit 25B, with airplanes being used in 25% of successful hunts (Table 16). A similar pattern characterizes Subunits 25D East (Table 17). Snowmachines are used in taking a small percentage of the moose killed in both Subunits 25B and 25D East, but the reported occurrence underrepresents the importance of this mode of transportation.

Habitat Assessment and Enhancement

No systematic evaluation of habitat took place during this period. However, previous work, empirical observations, and comparison with habitat elsewhere indicate that the upper Yukon River valley provides excellent moose habitat. Present moose populations are well below densities supportable by the habitat.

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 amounts in the area, conditions more than adequately support present moose numbers.

CONCLUSIONS AND RECOMMENDATIONS

The overall status of the Unit 25 moose population has not changed dramatically in the last few years. However, signs of a decline in recruitment rates are evident in some areas, and a decline in numbers may have occurred in parts of the unit. In terms of previously established management objectives, moderate progress has been made in some areas. Objectives for Subunit 25A are generally being met, and in the remainder of the unit the harvest of moose seems to satisfy local subsistence needs as well as provide a moderate amount of hunting for other Alaskans and some nonresidents.

The political, biological, and logistical realities affecting moose management in Unit 25 suggest basic questions need to be addressed by the public and various governmental agencies. An issue that remains unsettled is whether the local public wants and would support measures to increase moose numbers to levels commensurate with habitat potential. The facts that moose are noticeably more abundant now than in earlier times and that many local residents are satisfied contribute to the confusion. More important, however, are political considerations relating to management authority and priority, and exclusivity of wildlife uses.

These considerations override and generally dominate public discussions. The actual abundance and welfare of wildlife populations are generally less at issue than are perceived problems with competition from other hunters and reluctance to participate in what are viewed as external management systems, particularly the state of Alaska's. Until there is more agreement on management goals and the role and responsibilities of public and private entities in achieving them, maintaining and enhancing moose populations will be plagued with obstacles. The practice of shooting cow moose, for example, probably will not lessen unless local citizens and their leaders realize it is in their best interest to play an active part in fostering increased moose numbers.

At present, there are relatively narrow problems in individual subunits that should be addressed or more clearly monitored. Effects of increased hunting on concentrations of moose in the Sheenjek and Coleen drainages in Subunit 25A should be evaluated. Air taxi operators who fly hunters to these areas are aware of potential problems and have agreed to distribute and limit hunting pressure. In cooperation with FWS, we should help users maintain the opportunity for high quality hunting in these areas. Doing aerial surveys immediately before the hunting season would help by providing information on the size and extent of these moose concentrations relative to access and hunting activity. FWS and ADF&G may begin population studies in this area in the near future.

More time should be spent monitoring the Tier II harvest in Subunit 25D West. The actual harvest of moose is unknown, making it impossible to know whether the upper limit of 35 bulls is being exceeded. The confusion over state and federal permits is substantial and a better understanding of the situation is important. A related problem is the potential to exceed the harvest quota because there is no limit on the number of federal permits issued to residents of the three area villages. Under a cooperative agreement between FWS and local governments, a harvest monitoring program was initiated in 1993. This effort should contribute to the knowledge of wildlife harvests in the area.

There is considerable confusion about the relatively long federal subsistence seasons and the short state general hunting season in Subunits 25A, 25B, and 25D East. While some confusion is inherent in the regulations, making maps available that show land status, hunting seasons, and bag limits would help clarify regulations. Such maps should be posted in public buildings in local communities beginning in midsummer. Staff visits to local communities to explain regulations before the hunting season and to contact hunters by riverboat during the hunting season are recommended.

Trend surveys in representative areas of various subunits should be continued to clarify 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. Knowledge of wolf numbers will help in assessing effects of wolf predation on moose numbers.

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Table 1. Subunit 25A early winter aerial moose composition counts, 1986-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1986-87[a]	--	--	--	--	--	--	--	--
1987-88[b]	63	9	33	--	17	--	149	n/a
1988-89[a]	--	--	--	--	--	--	--	--
1989-90[c]	75	18	29	52	14	--	367	1.01
1990-91[a]	--	--	--	--	--	--	--	--
1991-92[d]	55	n/a	26	8	19	41	49	--
1991-92[c]	91	13	31	44	14	--	314	0.87
1992-93[e]	n/a	n/a	n/a	8	15	44	52	n/a

[a] No survey.

[b] Upper Sheenjek River only.

[c] Includes upper Sheenjek and Coleen rivers.

[d] Observed during moose stratification flights in lower Sheenjek, Coleen, and East Fork Chandalar Rivers.

[e] March 1993 survey in East Fort of Chandalar drainage around Arctic Village.

Table 2. Subunit 25B early winter aerial moose composition counts, 1986-92.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose $/mi^2$
1986-87[a]	--	--	--	--	--	--	--	--
1987-88	119	6	10	6	5	105	111	n/a
1988-89[a]	--	--	--	--	--	--	--	--
1989-90[a]	--	--	--	--	--	--	--	--
1990-91[a]	--	--	--	--	--	--	--	--
1991-92[a]	--	--	--	--	--	--	--	--
1992-93[a]	--	--	--	--	--	--	--	--

[a] No survey.

Table 3. Subunit 25D East early winter aerial moose composition counts, 1986-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1986-87	84	13	34	26	15	144	170	0.7
1987-88	81	18	27	29	13	196	225	0.9
1988-89[a]	--	--	--	--	--	--	--	--
1989-90	63	9	41	59	20	235	294	1.0
1990-91[b]	64	5	32	7	16	36	43	0.7
1991-92[c]	66	9	26	25	13	168	193	0.7
1992-93[a]	--	--	--	--	--	--	--	--
1993-94	38	8	40	37	22	128	165	1.0

[a] No survey.
[b] Poor survey conditions, partial count.
[c] Part of the Graveyard trend area was not completed.

Table 4. Subunit 25D West early winter aerial moose composition counts, 1986-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1986-87	78	23	27	20	13	132	152	0.42
1987-88	71	8	25	13	13	87	100	0.57
1988-89	84	18	29	13	14	83	96	0.55
1989-90[a]	--	--	--	--	--	--	--	--
1990-91[b]	44	12	29	4	15	23	27	n/a
1991-92[c]	98	8	31	15	13	97	112	0.47
1991-92[d]	146	8	46	6	16	32	38	0.22
1991-92[e]	81	8	25	9	12	65	74	1.15
1992-93[f]	71	12	25	48	13	345	393	0.12
1992-93[g]	70	11	19	5	10	46	51	0.47
1993-94[h]	51	14	30	17	16	86	103	0.50

[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 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.

Table 5. Subunit 25A moose harvest and accidental death, 1986-92.

Regulatory year	Harvest by hunters: Reported[a] M	F	Unk	Total	Estimated: Unreported	Illegal	Total	Accidental death[b]: Road	Train	Total	Total
1986-87	47	0	0	47	--[c]	--	--	--	--	--	47
1987-88	41	0	0	41	--	--	--	--	--	--	41
1988-89	39	0	0	39	--	--	--	--	--	--	39
1989-90	25	0	0	25	--	--	--	--	--	--	25
1990-91	56	0	0	56	--	--	--	--	--	--	56
1991-92	47	0	0	47	--	--	--	--	--	--	47
1992-93	17	0	0	17	--	--	--	--	--	--	17

[a] Source: moose harvest reports.
[b] No roads or railroads in subunit.
[c] No data.

Table 6. Subunit 25B moose harvest and accidental death, 1986-92.

Regulatory year	Harvest by hunters: Reported[a] M	F	Unk	Total	Estimated Unreported	Illegal	Total	Accidental death[b] Road	Train	Total	Total
1986-87	27	0	0	27	--[c]	--	--	--	--	--	27
1987-88	26	0	0	26	--	--	--	--	--	--	26
1988-89	28	0	0	28	--	--	--	--	--	--	28
1989-90	24	0	0	24	--	--	--	--	--	--	24
1990-91	47	0	0	47	--	--	--	--	--	--	47
1991-92	32	0	0	32	--	--	--	--	--	--	32
1992-93	18	0	0	18	--	--	--	--	--	--	18

[a] Source: moose harvest reports.

[b] No roads or railroads in subunit.

[c] No data.

Table 7. Subunit 25D East moose harvest and accidental death, 1986-92.

Regulatory year	Harvest by hunters: Reported[a] M	F	Unk	Total	Estimated: Unreported	Illegal	Total	Accidental death: Road	Train	Total	Total
1986-87	39	0	0	39	--[c]	--	--	--	--	--	39
1987-88	47	0	0	47	--	--	--	--	--	--	47
1988-89	32	0	0	32	--	--	--	--	--	--	32
1989-90	38	0	0	38	--	--	--	--	--	--	38
1990-91	52	0	1	53	--	--	--	--	--	--	53
1991-92	29	0	0	29	--	--	--	--	--	--	29
1992-93	19	0	0	19	--	--	--	--	--	--	19

[a] Source: moose harvest reports.
[b] No roads or railroads in subunit.
[c] No data.

Table 8. Subunit 25D West moose harvest data by permit hunt, 1986-92.

Hunt No. /Area	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Bulls (%)	Cows (%)	Unk	Total harvest
994T	1986-87	--	--	--	--	--	--	--	--
	1987-88	--	--	--	--	--	--	--	--
	1988-89	--	--	--	--	--	--	--	--
	1989-90	50	1 (2.0)	8 (16.0)	7 (14.0)	7 (100)	0 (0)	0	7
	1990-91[a]	60	9 (15.0)	3 (5.0)	4 (6.7)	4 (100)	0 (0)	0	4
	1991-92[b]	57	44 (77.2)	13 (22.8)	6 (10.5)	6 (100)	0 (0)	0 (0)	6
	1992-93[c]	95	67 (70.5)	21 (22.1)	5 (5.3)	5 (100)	0 (0)	0 (0)	5

[a] Federal permit system, reported harvest = 11.
[b] Federal permit system, reported harvest = 8.
[c] Federal permit system, reported harvest = 4.

Table 9. Subunit 25A moose hunter residency and success, 1986-92[a].

Regulatory year	Successful: Local[b] resident	Successful: Nonlocal resident	Successful: Nonres.	Successful: Unk	Successful: Total (%)	Unsuccessful: Local[b] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonres.	Unsuccessful: Unk	Unsuccessful: Total (%)	Total hunters
1986-87	4	22	6	5	37 (59.7)	2	13	10	0	25 (40.3)	62
1987-88	4	16	18	3	41 (61.2)	4	14	3	5	26 (38.8)	67
1988-89	3	19	11	6	39 (59.1)	2	15	9	3	29 (40.9)	68
1989-90	3	12	10	0	25 (52.1)	4	14	5	0	23 (47.9)	48
1990-91	5	27	22	2	56 (71.8)	1	16	5	0	22 (28.2)	78
1991-92	4	21	22	0	47 (57.3)	0	22	13	0	35 (42.7)	82
1992-93	2	7	7	1	17 (35.4)	5	20	6	0	31 (64.6)	48

[a] Source: moose harvest reports.
[b] Resident of Subunit 25A.

Table 10. Subunit 25B moose hunter residency and success, 1986-92[a].

Regulatory year	Successful: Local[b] resident	Successful: Nonlocal resident	Successful: Nonres.	Successful: Unk	Successful: Total (%)	Unsuccessful: Local[b] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonres.	Unsuccessful: Unk	Unsuccessful: Total (%)	Total hunters
1986-87	9	10	3	5	27 (46.5)	6	18	2	5	31 (53.5)	58
1987-88	9	10	1	6	26 (53.1)	5	9	6	3	23 (46.9)	49
1988-89	9	9	8	2	28 (50.0)	2	20	6	0	28 (50.0)	56
1989-90	7	16	1	0	24 (40.0)	9	24	1	2	36 (60.0)	60
1990-91	9	31	5	2	47 (56.6)	9	25	2	0	36 (43.4)	83
1991-92	9	17	4	2	32 (45.7)	12	22	4	0	38 (54.3)	70
1992-93	6	9	2	1	18 (19.1)	7	61	4	3	76 (80.9)	94

[a] Source: moose harvest reports.
[b] Resident of Subunit 25B.

Table 11. Subunit 25D East moose hunter residency and success, 1986-92[a].

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	
1986-87	23	10	1	5	39 (42.4)	29	22	1	1	53 (57.6)	92
1987-88	24	16	6	1	47 (53.4)	22	13	3	3	41 (46.6)	88
1988-89	18	5	4	5	32 (47.0)	19	8	4	5	36 (53.0)	68
1989-90	24	11	2	1	38 (43.7)	24	20	5	0	49 (56.3)	87
1990-91	35	17	0	1	53 (46.1)	31	26	4	1	62 (53.9)	115
1991-92	17	11	1	0	29 (31.9)	31	31	0	0	62 (68.1)	91
1992-93	10	8	1	0	19 (22.6)	31	31	3	0	65 (77.4)	84

[a] Source: moose harvest reports.
[b] Resident of Subunit 25D.

Table 12. Subunit 25A reported moose harvest chronology,[a] percent by time period, 1986-92.

Regulatory year	Harvest periods					Dec.	Unk	n
	9/1-9/7[c]	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5			
1986-87	31.9	42.5	12.8	10.6	--[b]	--[b]	2.1	47
1987-88	12.2	34.1	34.1	17.1	--[b]	--[b]	2.4	41
1988-89	10.2	53.8	30.8	2.5	--[b]	--[b]	2.5	39
1989-90	20.0	36.0	40.0	4.0	--[b]	--[b]	0.0	25
1990-91	21.4	53.6	19.6	3.6	--[b]	--[b]	1.8	56
1991-92	19.1	42.6	31.9	2.1	--	--	4.3	47
1992-93	11.8	41.2	35.3	11.8	--	--	--	17

[a] Source: moose harvest reports.
[b] No open season.
[c] Includes 1 moose reported taken in late August.

Table 13. Subunit 25B reported moose harvest chronology,[a] percent by time period, 1986-92.

Regulatory year	Harvest periods 9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	Dec.	Unk	*n*
1986-87	7.4	22.2	51.8	7.4	--[b]	0.0	11.1	27
1987-88	7.7	19.2	38.5	19.2	3.8[b]	7.7	3.8	26
1988-89	3.7	40.7	44.4	3.7	--[b]	3.7	3.7	27
1989-90	8.3	20.8	41.7	12.5	--[b]	16.7	0.0	24
1990-91	10.6	27.6	34.0	12.8	2.1	10.6	2.1	47
1991-92	3.1	40.6	37.5	12.5	0.0	3.1	3.1	32
1992-93	11.1	44.4	16.7	0.0	0.0	27.8	0.0	18

[a] Source: moose harvest reports.
[b] No open season.

Table 14. Subunit 25D East reported moose harvest chronology,[a] percent by time period, 1986-92.

Regulatory year	Harvest periods 9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	Dec.	Unk	*n*
1986-87	0.0	56.4	30.8	2.6	--[b]	7.7	2.6	39
1987-88	0.0	20.0	53.3	13.3	--[b]	6.7	6.7	45
1988-89	0.0	46.9	31.2	3.1	3.1	12.5	3.1	32
1989-90	0.0	44.7	23.7	10.5	2.6	13.2	2.6	38
1990-91	7.7	36.5	40.4	1.9	1.9	5.8	5.8	52
1991-92	17.2	55.2	24.1	3.4	0.0	0.0	0.0	29
1992-93	0.0	42.1	52.6	5.3	0.0	0.0	0.0	19

[a] Source: moose harvest reports.
[b] No open season.

Table 15. Subunit 25A moose harvest percent by transport method, 1986-92.[a]

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1986-87	72.3	17.0	8.5	0.0	0.0	0.0	0.0	2.1	47
1987-88	60.9	12.2	17.1	0.0	0.0	0.0	2.4	7.3	41
1988-89	60.9	17.1	19.5	0.0	0.0	0.0	4.9	4.9	41
1989-90	56.0	16.0	24.0	0.0	0.0	0.0	4.0	0.0	25
1990-91	60.7	10.7	26.8	0.0	0.0	0.0	0.0	1.8	56
1991-92	76.6	14.9	8.5	0.0	0.0	0.0	0.0	0.0	47
1992-93	76.5	5.9	11.8	0.0	0.0	0.0	0.0	5.9	17

[a] Source: moose harvest reports.

Table 16. Subunit 25B moose harvest percent by transport method, 1986-92[a].

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1986-87	29.6	0.0	63.0	0.0	0.0	0.0	0.0	7.4	27
1987-88	26.9	0.0	65.4	0.0	3.8	0.0	0.0	3.8	26
1988-89	28.6	0.0	61.0	0.0	3.6	0.0	0.0	7.1	28
1989-90	20.8	0.0	75.0	0.0	0.0	0.0	0.0	4.2	24
1990-91	23.4	0.0	68.1	0.0	6.4	2.1	0.0	0.0	47
1991-92	9.4	0.0	78.1	0.0	0.0	0.0	0.0	12.5	32
1992-93	22.2	5.6	61.1	0.0	11.1	0.0	0.0	0.0	18

[a] Source: moose harvest reports.

Table 17. Subunit 25D East moose harvest percent by transport method, 1986-92[a].

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1986-87	12.8	0.0	66.7	0.0	5.1	0.0	2.6	12.8	39
1987-88	17.0	0.0	65.9	0.0	6.4	0.0	2.1	8.5	47
1988-89	28.1	0.0	46.9	0.0	15.6	0.0	0.0	9.4	32
1989-90	25.6	0.0	51.3	0.0	12.8	0.0	2.6	7.7	39
1990-91	26.4	0.0	64.1	1.9	1.9	0.0	0.0	5.7	53
1991-92	20.7	0.0	72.4	0.0	0.0	6.9	0.0	0.0	29
1992-93	42.1	0.0	52.6	0.0	0.0	5.3	0.0	0.0	19

[a] Source: moose harvest reports.

LOCATION

Game Management Unit: 26A (56,000 mi^2)
Geographical Description: Western North Slope

BACKGROUND

Evidence from archaeological excavations indicates that 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 become well established in Unit 26A. Although moose can be found throughout the Unit during the summer, they are confined to the riparian river corridors during the winter. The largest winter concentrations of moose are found in the inland portions of the Colville River drainage.

Late-winter surveys for assessing population status and short yearling recruitment have been conducted annually since 1970. Complete surveys of all major drainages in Unit 26A were conducted in 1970, 1977, 1984, and 1991. The 1991 survey yielded a count of 1535 moose.

Regular harvest by hunters using aircraft as transportation began in the early 1970s. Reported harvest has increased from 37 in 1983 to 67 in 1991. Hunting pressure and wolf predation have increased during recent years.

MANAGEMENT DIRECTION

The following population management goals and objectives have been established for moose populations in Unit 26A:

Population Goals

Maintain the moose population in Unit 26A at the current level of 1500 moose with a minimum bull:cow ratio of 30 bulls:100 cows.

Management Objectives

1. Conduct spring and fall trend count surveys annually. Spring surveys will be used to monitor short-yearling survival and fall counts to monitor sex and age composition.

2. Census the population at intervals of 7 years or less.

3. Maintain a hunter success level of greater than 50%.

4. Manage the harvest for spatial and temporal separation of recreational and local hunters.
5. Establish a management plan and an upper harvest limit for moose.

METHODS

We used a Cessna 185 and a Piper PA-18 aircraft to conduct spring and fall population surveys in trend count areas along the Colville, Chandler, and Anaktuvuk Rivers. We attempted to locate all moose within the trend count areas, and determine sex and age composition during the fall surveys, and short yearling recruitment during the spring surveys. Fall surveys were completed during 7-10 November 1991 and 8-12 November 1992. Spring surveys were conducted during 23-25 April 1992 and 21-23 April 1993. We compiled harvest data from harvest reports submitted by hunters. Additional harvest data were gathered by staff during the first week of September in the Umiat area while contacting hunters and monitoring the hunt.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: A complete census of the Subunit conducted in 1991 yielded a count of 1535 animals. Census results of 1219, 1258, and 1447 moose were observed in 1970, 1977, and 1984, respectively. The population has apparently been very stable for 20 years and may be increasing slightly (Table 1). The percentage of short yearlings observed during Subunit-wide censuses has ranged from 25% in 1970 to 20% in 1991.

Population Composition: Of the 748 moose counted during the spring 1992 survey, 615 adults and 133 calves were observed, yielding a short yearling recruitment rate of 18%. During the 1993 survey, we observed 569 moose of which 484 were adults and 85 were calves, yielding a recruitment rate of 15% Both years were higher than the recruitment rate observed during 1987 through 1990 which ranged from 10% to 12%. During the 5 years previous to 1987, the mean recruitment rate was 18% (Table 2).

During fall composition surveys completed in 1991, we observed 325 moose. Of these, 72 were bulls (40 bulls per 100 cows), 182 were cows, and 71 were calves (22% calves). The estimated antler sizes of the bulls were as follows:

Inches	<30	30-39	40-49	50-59	60+
Percent	16%	11%	18%	43%	12%

We observed 248 moose during the 1992 fall surveys. Of these, 50 were bulls (36 bulls per 100 cows), 140 were cows, and 58 were calves (23% calves). The estimated antler sizes of the bulls were as follows:

Inches	<30	30-39	40-49	50-59	60+
Percent	20%	14%	14%	40%	12%

The ratio of bulls per 100 cows declined between 1983 and 1990 from 54 to 32 bulls per 100 cows but increased slightly during 1991 and 1992 (Table 3).

Distribution and Movements: Moose are widely dispersed during the summer months, ranging from the northern foothills of the Brooks Mountain Range to the arctic coast. During the fall as snow cover accumulates, moose move onto riparian corridors in the large river systems, primarily the Colville River system. During April, when snow cover begins to disappear in the foothills, moose begin to move away from the riparian corridors.

Mortality

Harvest:

Human-Induced Mortality. Hunter harvest report data indicate that 67 moose (59 bulls and 8 cows) were harvested during fall of 1991, and 60 moose (52 bulls and 8 cows) were taken in 1992. The 1991 harvest was the largest ever reported (Table 4). The number of harvested bulls with antler spreads larger than 60 inches was relatively high during 1991 and 1992 reflecting the increased use of the area by trophy hunters (Table 5).

Season and Bag Limit.

Unit 26A	Subsistence/ Resident Season	Nonresident Season
RESIDENT HUNTERS: One moose. However, no person may take a cow accompanied by a calf.	Aug. 1-Dec. 31**	
NONRESIDENT HUNTERS: One bull with 50 inch antlers.		Sept. 1-Dec. 31

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

Game Board Actions and Emergency Orders. During the reporting period, the Alaska Board of Game changed the bag limit for nonresident hunters from 1 moose to 1 bull with 50 inch antlers, and the antlerless moose hunt was reauthorized for residents.

Hunter Residency and Success. The number of local Unit 26A residents that reported hunting was higher in 1992 than it had been for several years (Table 6). The number of nonlocal Alaska residents hunting in the Subunit during 1991 was the highest ever reported. The hunter success rate was 66% in 1991 and 57% in 1992. The 1992 success rate was the lowest ever reported in Unit 26A, but is still above the management objective of 50%.

Harvest Chronology. Most of the harvest occurred during the first 2 weeks of September (Table 7). This pattern is similar to that reported during previous years.

Transport Methods. As reported for past years, most hunters used aircraft for transportation (Table 8).

Natural Mortality: More moose carcasses have been seen during recent spring surveys than in years prior to 1991. We counted 14 and 18 moose carcasses, respectively, during the 1992 and 1993 spring trend counts, and 33 moose carcasses during the 1991 census. During the 1984 census, the most recent census completed prior to 1991, only 11 moose carcasses were counted. During the 1991 census, 14 moose carcasses were counted along the Colville River between Umiat and the mouth of the Killik River. During the 1989 and 1990 spring surveys which were conducted in the same area, only 4 carcasses were found during each survey. Only some carcasses were closely examined, and it was often impossible to definitely determine the cause of death for those carcasses that were examined; however, it appeared that most of the moose were killed by predators.

Wolf and grizzly bear numbers appear to be increasing in the area. Increasing numbers of wolves have been observed while conducting moose surveys in recent years. During the 1991 moose census, we counted 26 wolves, compared with 3 in 1984. A wolf survey using the line-intercept probability sampling technique was conducted in an area encompassing much of the moose survey area during the spring of 1992. We found a density of 1 wolf per 76 mi^2, compared to density estimates of 1 wolf/147 mi^2 and 1 wolf/119-144 mi^2 found during 1986 and 1987, respectively. Grizzly bear research conducted in the western portion of the Brooks Range in Unit 26A indicates the grizzly bear population is increasing in size as well (Reynolds 1989).

CONCLUSIONS AND RECOMMENDATIONS

We conducted a census in the spring of 1991 and counted 1535 moose. This census indicated that the overall population of moose in Unit 26A has been stable or may have increased slightly during the last 20 years. However, the number of moose seen during both fall and spring trend area counts decreased during 1992 and 1993. In addition, the hunter success rate for 1992 was 57%, which is the first time it has dropped below 60%. Although a census has traditionally been conducted once every 7 years, warning signs of possible population decline indicate that it may be necessary to conduct another census during 1994 or 1995.

The ratio of bulls per 100 cows observed during the fall surveys had dropped from 54 to 33 between 1983 and 1990, but was 40 in 1991 and 36 in 1992, and the ratio has apparently not continued to decline. However, the entire moose population may be declining, and the bull:cow ratio may be indicating that the number of cows is declining faster than the number of bulls. Composition surveys should be conducted each fall, and special attention should be given to estimating calf survival.

In order to determine if predation may be having an effect on the population, a wolf survey was conducted during the spring of 1992 and will be repeated during the spring of 1994. Annual spring moose surveys should be continued to monitor recruitment and evaluate overwinter mortality.

Remote portions of Unit 26A have become more accessible to hunters in recent years because people are driving up the Dalton Highway and using commercial transporters to fly in. In addition, hunting regulations in Subunits 26B and 26C have recently become more restrictive, encouraging more hunters to hunt in Unit 26A. We should continue to examine harvest patterns and population size and composition data to determine whether more restrictive moose regulations are needed in Unit 26A.

Efforts to make licenses and harvest tickets more available to local hunters and to inform people about harvest reporting requirements and the reasons for these requirements need to be increased in Unit 26A. The inability of the state to resolve the current subsistence dilemma has confused and alienated many North Slope residents, greatly setting back efforts to bring people into the regulatory system. Little progress will be made until this issue is satisfactorily resolved.

The goal of spatial and temporal separation of recreational and subsistence hunters was realized for the most part. A controlled use area was established in Unit 26A which requires that aircraft cannot be used to hunt during August, allowing local residents using boats to complete much of their hunting activities before recreational hunters arrive. In addition, local hunters tended to concentrate their efforts on the lower part of the Colville River, while recreational hunters generally flew into the upper regions of the drainage.

It is desirable to maintain a hunter contact and enforcement effort on the Colville River. These efforts should include both the areas upstream of Nuiqsut and around Umiat.

Although there are warning signs that the moose population may be declining, the reported harvest during the reporting period was less than 4% of the current population estimate. It will be necessary to carefully monitor the moose population and hunting pressure during the coming years. No changes in seasons and bag limits are recommended at this time.

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Table 1. Results of Subunit 26A spring subunit-wide censuses, 1970-1991.

Year	Adults	Calves	Total	% Calves
1970	911	308	1219	25
1977	991	267	1258	21
1984	1145	302	1447	21
1991	1231	304	1535	20

Table 2. Colville River trend counts: Anaktuvuk River, Chandler River, and Colville River between Anaktuvuk and Killik Rivers, 1970, 1974-81, and 1983-93.

Year	Total moose	Adults	Calves	Calf % of herd
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	755	666	89	12
1991	881	705	176	20
1992	748	615	133	18
1993	569	484	85	15

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

Table 3. Unit 26A fall aerial moose composition counts 1983-92.

Regulatory Year	Bulls: 100 cows	Calves: 100 cows	Calves (%)	Adults	Total moose observed
1983	54	38	20	150	188
1986	47	18	11	302	339
1987	39	21	3	101	104
1990	33	45	25	277	371
1991	40	39	22	254	325
1992	36	41	23	190	248

Table 4. Subunit 26A moose harvest, 1985-92.

Regulatory Year	Reported hunter harvest		
	Male	Female	Total
1985	50	15	65
1986	46	6	52
1987	49	13	62
1988	51	6	57
1989	41	3	44
1990	60	4	64
1991	59	8	67
1992	52	8	60

Table 5. Subunit 26A percentage of harvested moose in each antler spread category (inches), 1983-1992.

Year	<20	20-29	30-39	40-49	50-59	60+	N
1983	0	4	35	15	35	12	26
1984	3	5	18	33	30	13	40
1985	0	7	11	18	47	19	45
1986	0	7	18	29	42	4	45
1987	0	0	20	24	47	9	45
1988	2	2	0	27	55	14	49
1989	0	3	14	14	51	18	39
1990	0	4	15	10	59	12	57
1991 16% unknown)	0	3	3	13	49	16	56
1992 (13% unknown)	0	2	5	7	48	25	52

Table 6. Unit 26A moose hunter[a] residency and success, 1987-92.

Regulatory year	Successful						Total hunters				
	Local[b] res.	Nonlocal res.	Nonres.	Unk.	Total	(%)	Local[b] res.	Nonlocal res.	Nonres.	Unk.	Total hunters
1985					65	66	29	45	24	0	98
1986					52	65	29	33	18	0	80
1987					62	61	40	20	39	0	99
1988					57	69	12	30	37	5	84
1989	9	13	21	1	44	66	10	23	33	2	68
1990	8	19	35	2	64	65	13	40	43	3	99
1991	9	37	29	1	67	66	13	51	37	1	102
1992	12	16	29	3	60	57	25	35	41	4	105

[a] Excludes hunters in permit hunts.
[b] Local hunters are North Slope Borough residents.

Table 7. Unit 26A moose harvest[a] chronology percent by time period, 1987-92.

Regulatory year	Harvest periods Aug.	09/1-7	09/8-14	09/15-21	09/22-31	Oct-Dec	*N*
1985							
1986	6	21					
1987	9	36	35	6	4	10	62
1988	9	45	34	6	3	0	57
1989	17	48	18	16	0	2	44
1990	4	44	39	6	5	2	64
1991	6	37	14	6	0	2	67
1992	5	35	12	2	5	1	60

[a] Excludes permit hunt harvest.

Table 8. Unit 26A moose harvest[a] percent by transport method, 1987-92.

Regulatory year	Percent of harvest Airplane	Boat	3 or 4-Wheeler	Snowmachine	ORV	*n*
1987	80	15	2	1	2	59
1988	81	18	1			53
1989	84	14	2			40
1990	62	28	3	2	3	61
1991	57	5	2	2	1	67
1992	51	8	0	1	0	60

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit: 26B and 26C (26,000 mi^2)

Geographical Description: North slope of the Brooks Range and Arctic Coastal Plain east of the Itkillik River

BACKGROUND

Moose were scarce in Arctic Alaska before the early 1950s when populations expanded and reached high densities in the limited riparian habitat in major drainages (LeResche *et al.* 1974). Predation, as well as hunting by humans, contributed to the historical scarcity of moose. The reduction of wolf numbers by federal control programs during the late 1940s and early 1950s was important in allowing moose populations to increase and become established in most of the riparian shrub habitat on the North Slope. Moose are at the northern limit of their range in the eastern Arctic.

Composition surveys have been conducted by the staff of the FWS, Arctic National Wildlife Refuge (ANWR) (Martin and Garner 1984; Weiler and Leidberg 1987; Mauer 1988, 1989, and 1990). The Canning River has been surveyed almost annually since 1983, and areas to the west were surveyed in 1986, 1988, 1989, 1990 and 1991. No surveys were accomplished in Subunits 26B and 26C in 1992 or 1993 because of poor survey conditions.

Habitat severely limits the number of moose that can be sustained and harvested, and the concentrated nature of moose distribution and open habitat create the potential for excessive harvest in accessible areas. Although travel to the area is expensive and often logistically difficult, hunting pressure around the larger and better known aircraft landing sites is considerable. Concern about the excessive concentration of hunters has been expressed by guides, outfitters, hunters, and ANWR staff. The Dalton Highway in central Subunit 26B provides unique opportunities for viewing and photography, but has also created the potential to adversely affect moose populations and associated human uses by increasing access to certain areas.

Kaktovik and Nuiqsut are the only subsistence communities in the area, and residents take 5-10 moose annually. The small subsistence harvest results from the scarcity of moose near Kaktovik and the fact that most hunting by Nuiqsut residents occurs in the Colville River drainage in adjacent Subunit 26A.

Government agencies and the public have been concerned recently about increased hunting by people living outside the area. The opening of the Dalton Highway to commercial use in 1978, the ability of the public to contrive "commercial" reasons to use the road, and establishment of guide and outfitter bases at points along the road increased hunting pressure on moose.

National publicity about wildlife resources in ANWR and the increased use of the area by hunters and recreational visitors also contributed.

The Dalton Highway Management Area (DHMA) continues to be closed by Alaska statute to the use of firearms north of the Yukon River and within 5 miles of the highway, and also to the use of motorized vehicles, except aircraft, boats, and licensed highway vehicles for transporting game or hunters. In 1987, the Board of Game added a restriction on using motorized vehicles, bringing them into alignment with Alaska statutes. The board's actions also created a penalty for violations, something that had not been included in the statute passed by the legislature.

Moose hunting regulations are more restrictive now than they were several years ago. In 1987, the open season for most hunters was shortened to 1-30 September and the previous bag limit of one moose was changed to one bull. At the same time, the season for qualified subsistence hunters residing in Unit 26 was lengthened to 1 August-31 December, and the bag limit of one moose of either sex continued. Changes in season and bag limit during the late 1980s apparently reduced the harvest to a sustainable level in the DHMA and in the remainder of Subunit 26B. Excessive hunting pressure in the DHMA could develop; a more conservative approach may be warranted in the future.

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 season sex ratio of at least 50 bulls:100 cows.
- Maintain a mean antler spread of at least 50 inches among bull moose harvested during the general season.
- Maintain an annual hunter success rate of at least 40%.
- Determine subsistence needs and harvest levels.

METHODS

Riparian willow habitat associated with drainages of Subunit 26B is usually flown during early winter using Piper PA-18 aircraft at 70-90 miles/hour and at altitudes of 200-600 feet above ground level. In 1988 and 1990, portions of several drainages with poor habitat and few moose (Mauer 1988, 1990) were not surveyed. Mandatory hunter harvest reports provided data on harvest characteristics and hunter effort.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: A complete moose population survey has not been conducted in Subunits 26B and 26C. Annual trend surveys account for a large percentage of the moose in areas supporting major concentrations. Total numbers observed during years of the most complete surveys were 629 in 1988 and 600 in 1989. The total population includes 1,000-1,200 moose in Subunit 26B and 700-800 in Subunit 26C, for a total of 1,700-2,000 (F. Mauer, FWS, pers. commun.).

Population Composition: Survey results in Subunit 26B indicate moose population status has not changed dramatically during the past 5 years (Table 1). Although calf survival declined sharply in 1989, when only 5% of the moose seen were calves, 1990 surveys indicated survival had returned to previous levels, with 16% of the sample being calves. Other indicators of population welfare, including the proportion of bulls, yearlings, and calves, and total numbers observed, suggest a relatively stable population trend.

Surveys were completed in the Firth and Mancha areas in eastern Subunit 26C in 1989 and 1991, and in the upper Kongakut River in 1991. There are no previous data for comparison, but apparently these populations have high bull:cow ratios and moderate calf and yearling survival (Table 2).

In contrast, annual surveys in the Canning River area (boundary between Subunits 26B and 26C) indicate moose numbers have declined steadily after 1985. Various indices to population welfare including total numbers observed, calf:cow, bull:cow, and large bull:cow ratios, and yearling recruitment suggest recruitment is chronically low and that harvest of bulls has noticeably affected the population (Table 3). The number of moose observed during standardized trend counts has declined from a high of 203 in 1985 to less than 90 in 1990 and 1991. The number of bulls seen has likewise declined from 76 to near 20. The decline in total numbers, chronically poor calf survival and yearling recruitment, declining bull:cow ratios, and the small number of bulls in the population indicate that further restrictions on hunting should be considered. Although other factors such as habitat quality and increased predation by wolves and bears have probably been responsible for causing and perpetuating the decline, at this point hunting is a contributing factor and the present season should be reconsidered.

Distribution and Movements: Except for some summer dispersal, moose are limited to narrow strips of shrub communities along drainages. The greatest concentrations occur along the Canning, Kavik, Ivishak, Toolik, Kuparuk, and Kongakut Rivers. Moose movements have not been intensively studied, but casual observations suggest there may be extensive seasonal movements within or between drainages.

Mortality

Harvest:

Season and Bag Limit.

	Resident Open Season	Nonresident Open Season
Subunit 26B, that portion within the Dalton Highway Corridor Management Area: All hunters: One bull with 50-inch antlers or antlers with 4 or more brow tines on one side by bow and and arrow only.	5 Sept.-15 Sept.	5 Sept.-15 Sept.
Remainder of Subunit 26B and 26C:		
Resident Hunters: One bull.	5 Sept.-15 Sept. 1 Nov.-31 Dec.	
Nonresident Hunters: One bull with 50-inch antlers or antlers with 4 or more brow tines on one side.		5 Sept.-15 Sept.

Board of Game Actions and Emergency Orders. Beginning in 1990, all Alaska residents qualified as subsistence users under state law. To compensate for the large increase in hunters eligible for the subsistence season, the season was shortened to 5-15 September and 1 November-31 December, and the one-bull bag limit was extended to all hunters. Additionally, a 50-inch minimum antler size was established for nonresidents.

Hunter/Trapper Harvest. The reported moose harvest in Subunit 26B has ranged from 24 in 1988 to 45 in 1992 (Table 4). Harvests in 26B are fairly stable despite a general increase in hunting activity adjacent to the Dalton Highway. In Subunit 26C, the harvest has declined substantially from 17 in 1987 to 1 in 1989 and 6 in 1991 (Table 5). Eliminating the either-sex bag limit in 1987 probably accounts for a small part of the decline, and the poor reporting by unit residents causes reported harvest to slightly underrepresent the actual harvest.
The decline in harvest in Subunit 26C may also be caused by a decline in the number of hunters using the area. Hunter success declined noticeably in the last couple of years (Table

6), but is still high relative to other areas, with a success rate of about 50%. The average antler spread of bull moose taken in Subunits 26B and 26C continues to exceed 50 inches, with 75% of the moose taken exceeding 50-inch antler spreads.

Permit Hunts. There are no permit hunts in Subunits 26B and 26C.

Hunter Residency and Success. The proportion of nonresidents among moose hunters usually approached 50% during 1988-93, based on hunter reports. Alaska residents living outside the area comprised all but one of the remaining hunters (Table 6). Although reporting by local residents is considered poor, relatively few people reside in the area, and many of these do not emphasize hunting moose.

Hunter success declined during the last 5 years but was generally high compared with other areas in Alaska. Nonresidents report a higher success rate than Alaska residents, probably because nonresidents benefit from guide/outfitter services. Hunting success in the Canning River area declined dramatically compared with other areas (Table 7); a preliminary accounting of 1991 harvest reports indicated that no moose were taken. One moose was reported taken in 1992.

Harvest Chronology. Most moose killed in Subunits 26B and 26C are taken during the first 3 weeks of September, and in 1992, all moose were killed during the 10-day open season from 5 September to 15 September (Table 8). The concentration of hunting activity in early autumn results from the relatively early onset of winter in the region.

Transport Methods. Aircraft continued as the predominant transport method used by 75-96% of successful moose hunters (Table 9).

Natural Mortality: Although there have been no intensive studies of natural sources of moose mortality in the eastern Arctic, it is probable that predation by bears and wolves and periodic malnutrition during severe winters are most important. Wolves and bears are common in the region, particularly in mountains and northern foothills of the Brooks Range, and incidental observations by biologists, hunters, and pilots suggest that wolf numbers increased during the 1980s. Winter 1989-90 was unusually severe and noticeably affected calf survival and yearling recruitment. Similar losses can be expected when snow accumulation is exceptionally great.

Habitat Assessment and Enhancement

There has been no systematic habitat assessment in the area. An assessment of habitat condition would be useful, particularly in the Canning River area. Efforts to enhance habitat have not been contemplated and do not seem feasible. Fire is not a factor in maintaining moose habitat in this area.

CONCLUSIONS AND RECOMMENDATIONS

Although most population and use objectives were met during the 1980s, changes in moose population status indicate that changes in regulations should be considered, especially for the Canning River area. Knowledge of population status and trend is generally adequate, and the objective of maintaining 50 bulls:100 cows in posthunting season populations has been met by an increasingly small margin. Hunter success is good but has also declined, and antler size among harvested bulls continues to exceed 50 inches. Shortcomings in our knowledge exist regarding movements, habitat condition, the causes and patterns of natural mortality, and reasons for the continued decline of the Canning River population.

The Canning River decline is the most serious management problem at present. The combination of low numbers and chronically low recruitment (Mauer 1990) indicates the population should be managed more conservatively, even though the present harvest is small. The actual number of bulls in this population has declined from approximately 80 in the mid-1980s to about 45 in 1990 (Mauer 1990). A survey in 1991 accounted for about 30 bulls, with indications of continued poor recruitment (F. Mauer, pers. commun.). Closing the season or reducing it to 5 days in the Canning River drainage would be appropriate. Although hunting was probably not a primary factor in initiating and maintaining the decline, it is the source of mortality we can most easily control.

The status of the Subunit 26B moose population is generally good, but increased access in certain areas, including the Dalton Highway area, and a decline in bull:cow ratios and possibly total numbers indicates additional restrictions be considered for this area as well. Instituting a 50-inch antler size limit for residents hunting in the DHMA may be wise because of the high access to, and visibility of, moose near the haul road. Increased enforcement could help avoid the need for more restrictions and should be encouraged.

Annual trend surveys should be continued. Better information on moose movements, mortality, and habitat condition would allow better management of moose populations in the eastern Arctic.

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Table 1. Subunit 26B early winter aerial moose composition, 1986-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1986-87	52	9	36	83	17	395	478	1.33
1987-88[a]	--	--	--	--	--	--	--	--
1988-89	49	30	34	64	12	447	511	1.42
1989-90	56	13	8	25	5	462	487	1.35
1990-91	63	7	30	73	16	392	465	1.54
1991-92	47	10	25	63	17	314	377	1.48
1992-93[a]	--	--	--	--	--	--	--	--
1993-94[a]	--	--	--	--	--	--	--	--

[a] No survey.

Table 2. Subunit 26C, Kongakut and Firth Rivers and Mancha Creek early winter aerial moose composition counts, 1987-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1987-88[a]	--	--	--	--	--	--	--	--
1988-89[a]	--	--	--	--	--	--	--	--
1989-90[b]	114	7	24	17	10	152	169	0.47
1990-91[a]	--	--	--	--	--	--	--	--
1991-92[c]	85	10	34	63	15	343	406	0.47
1992-93[a]	--	--	--	--	--	--	--	--
1993-94[a]	--	--	--	--	--	--	--	--

[a] No survey.
[b] Firth/Mancha area only.
[c] Includes Kongakut and Firth/Mancha count areas.

Table 3. Canning River (on boundary of Subunit 26B and 26C) early winter aerial moose composition counts, 1986-93.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2
1986-87	75	15	18	13	9	126	139	0.80
1987-88[a]	--	--	--	--	--	--	--	--
1988-89	51	4	16	11	9	107	118	0.68
1989-90	45	8	10	7	6	106	113	0.65
1990-91	43	2	12	5	8	60	65	0.87
1991-92	49	7	5	3	3	85	88	0.94
1992-93[a]	--	--	--	--	--	--	--	--
1993-94[a]	--	--	--	--	--	--	--	--

[a] No survey.

Table 4. Subunit 26B moose harvest and accidental death, 1986-92.

Regulatory year	Harvest by Hunters: Reported[a] M (%)	Reported[a] F (%)	Reported[a] Unk	Reported[a] Total	Estimated Unreported	Estimated Illegal	Estimated Total	Accidental death Road	Accidental death Train	Accidental death Total	Total
1986-87	43(83)	9(17)	0	52	--	--	--	--	--	--	52
1987-88	37(100)	0(0)	0	37	--	--	--	--	--	--	37
1988-89	33(100)	0(0)	0	33	--	--	--	--	--	--	33
1989-90	24(100)	0(0)	1	25	--	--	--	--	--	--	25
1990-91	24(100)	0(0)	0	24	--	--	--	--	--	--	24
1991-92	28(100)	0(0)	0	28	--	--	--	--	--	--	28
1992-93	45(100)	0(0)	0	45	--	--	--	--	--	--	45

[a] Source: moose harvest reports.

Table 5. Subunit 26C moose harvest and accidental death, 1986-92.

Regulatory year	Harvest by hunters: Reported[a] M (%)	F (%)	Unk	Total	Estimated: Unreported	Illegal	Total	Accidental death: Road	Train	Total	Total
1986-87	6 (60)	4 (40)	0	10	--	--	--	--	--	--	10
1987-88	16 (94)	1 (5)	0	17	--	--	--	--	--	--	17
1988-89	10 (100)	0 (0)	0	10	--	--	--	--	--	--	10
1989-90	1 (100)	0 (0)	0	1	--	--	--	--	--	--	1
1990-91	3 (100)	0 (0)	0	3	--	--	--	--	--	--	3
1991-92	6 (100)	0 (0)	0	6	--	--	--	--	--	--	6
1992-93	4 (100)	0 (0)	0	4	--	--	--	--	--	--	4

[a] Source: moose harvest reports.

Table 6. Subunit 26B and 26C moose hunter residency and success, 1986-92[a].

Regulatory year	Successful: Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Unsuccessful: Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Total hunters
1986-87	0	33	20	9	62 (86)	0	8	0	2	10 (14)	72
1987-88	0	21	22	11	54 (64)	1	21	5	3	30 (36)	84
1988-89	0	13	26	4	43 (64)	0	14	6	4	24 (36)	67
1989-90	0	11	15	0	26 (32)	0	24	6	26	56 (68)	82
1990-91	0	7	18	2	27 (51)	0	21	5	0	26 (49)	53
1991-92	1	11	19	3	34 (57)	1	13	10	2	26 (43)	60
1992-93	0	23	25	1	49 (52)	0	43	2	1	46 (48)	95

[a] Source: moose harvest reports.
[b] Reside in Subunits 26B or 26C.

Table 7. Number of moose hunters, moose harvest, and percent success in the Canning River drainage, 1983-92.[a]

Regulatory year	Hunters	Harvest	Percent success
1983-84	3	1	34
1984-85	8	7	88
1985-86	8	6	75
1986-87	15	6	40
1987-88	36	14	40
1988-89	17	8	47
1989-90	10	1	10
1990-91	8	1	13
1991-92 [b]	5	0	0
1992-93	1	1	100

[a] Source: moose harvest reports.
[b] Data as of 28 January 1992, additional reports may be filed.

Table 8. Subunits 26B and 26C moose harvest chronology, percent, (*n*) by time period, 1986-92[a].

Regulatory year	Harvest periods								
	9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	Oct.	Nov.	Dec.	*n*
1986-87	41.1	23.2	10.7	8.9	0.0	3.6	3.3	7.1	56
1987-88	36.5	32.7	23.1	5.8	--[b]	--[c]	--[c]	1.9	52
1988-89	41.6	25.0	22.2	11.1	--[b]	--[c]	--[c]	--[c]	36
1989-90	26.9	30.8	30.8	3.8	3.8	--[c]	--[c]	--[c]	26
1990-91	37.1[d]	51.8	3.7[e]	--[f]	--[f]	--[f]	--[g]	2.0[g]	27[h]
1991-92	52.9	41.2	--	--	--	--	--	5.9	34
1992-93	63.3	36.7	--	--	--	--	--	--	49

[a] Source: moose harvest reports.
[b] General season closed 30 September.
[c] Subsistence.
[d] General season opened 5 September.
[e] General season closed 15 September.
[f] No open season.
[g] Alaska resident only.
[h] Only three moose were reported taken in Subunit 26C.

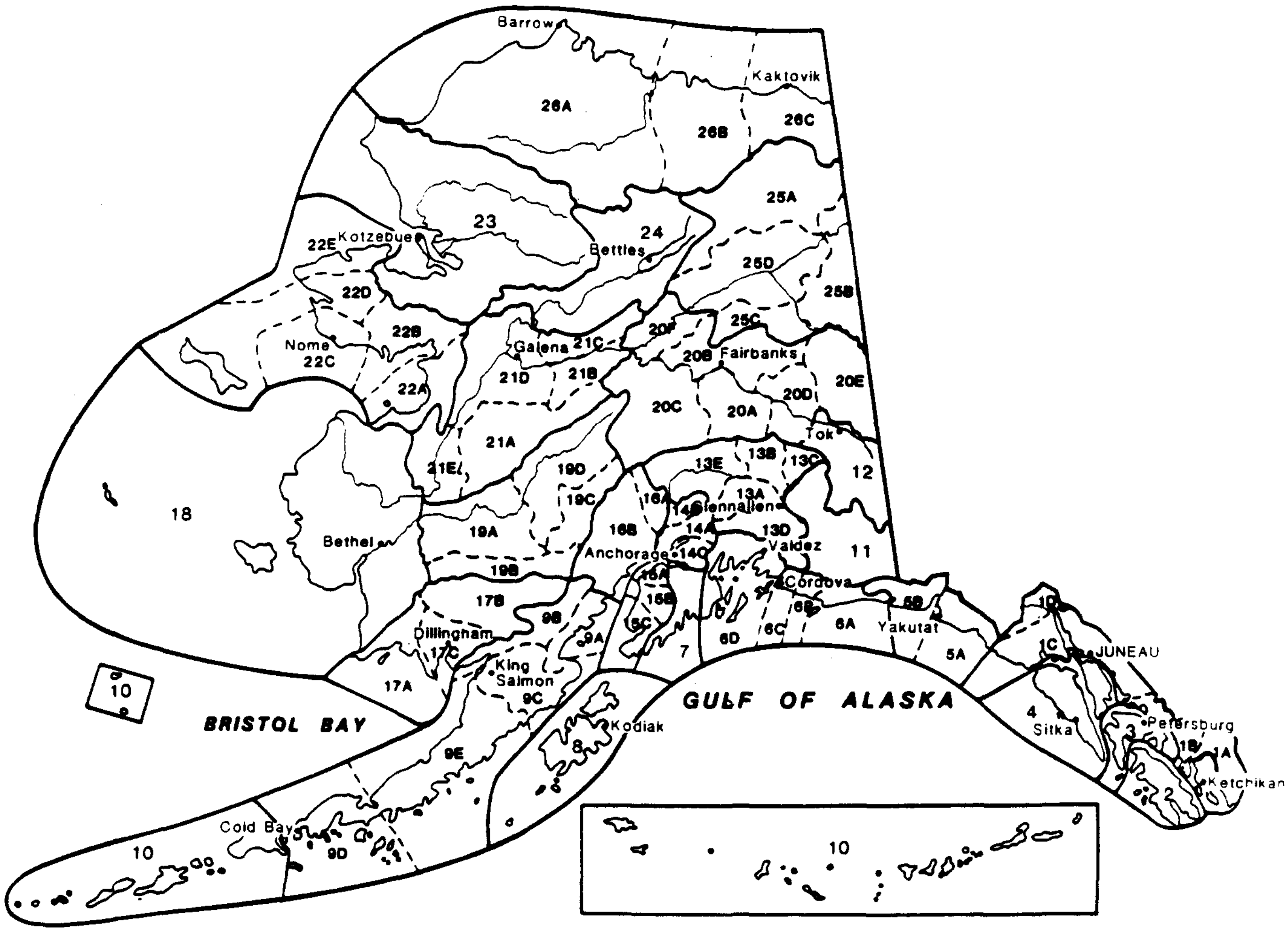
Table 9. Subunits 26B and 26C moose harvest percent by transport method, 1986-92[a].

Regulatory year	Percent of harvest								Total
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1986-87	75.0	0.0	0.0	3.3	11.7	3.3	6.7	--	60
1987-88	93.6	0.0	4.2	0.0	2.3	0.0	0.0	--	47
1988-89	82.9	2.4	4.9	0.0	2.4	0.0	7.3	--	41
1989-90	96.2	0.0	3.8	0.0	0.0	0.0	0.0	--	26
1990-91	75.0	4.2	20.8	0.0	0.0	0.0	0.0	--	24
1991-92	76.5	0.0	14.7	0.0	5.9	0.0	0.0	2.9	34
1992-93	83.7	0.0	8.2	0.0	0.0	0.0	8.2	0.0	49

[a] Source: moose harvest reports.

NOTES

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.

PAT COSTELLO