Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Survey-Inventory Management Report
1 July 1989 - 30 June 1991

MOOSE

Susan M. Abbott, Editor

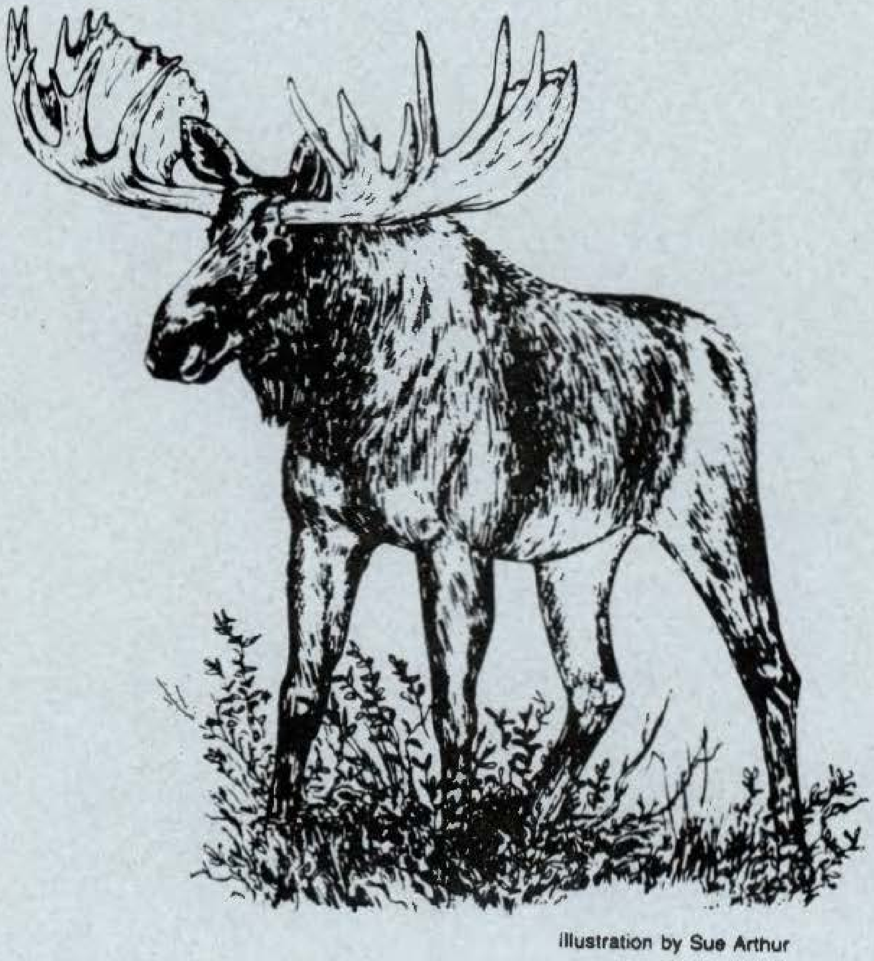

Illustration by Sue Arthur

Projects W-23-3 and W-23-4, Study 1.0
February 1993

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LOCATION

Game Management Units:	Subunit 1A (5,000 mi^2) Unuk River, Chickamin River Subunit 1B (3,300 mi^2) Thomas Bay, Stikine River Unit 2 (3,400 mi^2) Prince of Wales Island Unit 3 (3,600 mi^2) Wrangell Island
Geographical Description:	Southeast mainland and adjacent islands from Cape Fanshaw south to the Canadian border.

BACKGROUND

The moose population of Subunit 1A concentrates in the Unuk River drainage and appears stable. Good habitat is limited and moose numbers are low. Harvest is sporadic, ranging from 0-8 each year. The Chickamin River south of the Unuk River supports a few moose and did so before a supplemental transplant of moose into the area during the early 1960s. A short-term increase followed the release but moose populations have probably returned to pre-transplant levels. Three bulls were taken from the Chickamin River drainage in the past 15 years. Moose are occasionally reported from other parts of Subunit 1A.

Moose occur throughout Subunit 1B where appropriate habitat exists, primarily near Thomas Bay in northern Subunit 1B and along the Stikine River in central Subunit 1B. Separate hunting regulations exist for each of these two populations.

The Coast Mountains isolate the Thomas Bay moose population from populations in mainland Canada. Thomas Bay moose occupy a heavily logged area. Sparse population trend information suggests that the Thomas Bay moose may be more susceptible to periodic reproductive failures than other Southeast moose populations. The Thomas Bay population may decline significantly in clearcut areas as conifers attain second growth characteristics. The average annual harvest of Thomas Bay moose during the 1950s, 1960s, 1970s, and the 1980s was 5, 8, 10, and 20, respectively. The season was closed and no harvest occurred in 1982 and 1983.

Moose inhabiting the Alaska portion of the Stikine River represent the westernmost tip of a population that extends into Canada. This Alaska population was estimated at 300 animals in 1983 (Craighead et al. 1984). Since 1983, winters have been mild and the population appeared to increase. Average annual harvest of Stikine River moose from the 1950s to the 1970s was 27. From 1980-90 the average annual harvest was 42.

The first reports of moose on Prince of Wales Island in Unit 2 were received by the Alaska Department of Fish and Game (ADF&G) in 1987 when the U.S. Forest Service (USFS) reported that a cow and calf were observed 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 major islands of Unit 3. Increased moose sightings in the 1980s suggested these populations are growing. From 1960-67, the season was open from 15 September to 15 October with a limit of one bull. Wrangell Island only was opened to hunting in 1990.

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

Management Objectives

GMU 1A: Unuk/Chickamin	Objective Current	Objective 1994
Post-hunt numbers	35	35
Annual hunter kill	1	3
Number of hunters	28	20
Hunter-days of effort	141	90
Hunter success	4%	15%
Subunit 1B: Stikine River		
Post-hunt numbers	450	450
Annual hunter kill	38	40
Number of hunters	321	300
Hunter-days of effort	2,214	2,100
Hunter success	12%	13%
Thomas Bay		
Post-hunt numbers	200	200
Annual hunter kill	20	20

Number of hunters	168	160
Hunter-days of effort	766	675
Hunter success	12%	12%

Unit 2: No formally stated objective

Unit 3: No formally stated objective

We identified objectives from 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

Helicopter surveys of the Chickamin and Unuk river drainages were conducted early in 1991. Fall and winter aerial surveys were flown in Subunit 1B to estimate sex and age composition of the Stikine River and Thomas Bay moose populations. Registration permits for Thomas Bay (northern Subunit 1B) and harvest reports for Stikine River (central Subunit 1B), Subunit 1A, and Wrangell Island in Unit 3 were used to estimate hunter participation. Hunter check stations were maintained in the Thomas Bay and Stikine River areas to monitor and administer the hunt and to obtain accurate hunter participation and harvest information. Reported moose sightings were recorded to document their continuing expansion in Unit 3. Public meetings were held in Wrangell and Petersburg to discuss moose management directions.

ADF&G personnel attempted to monitor moose calving and predation of calves during May and June 1990. This pilot project assessed the feasibility of using ground observers to obtain calf production and loss data.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: The data are insufficient to make a quantitative determination of population trends during the past five years. Subjectively, however, the moose populations appeared stable in Subunit 1A (low density), and increased slightly in Thomas Bay in northern Subunit 1B (moderate to high density). The Stikine River population (moderate to high density) seems to have decreased slightly. Increasing reports of moose in Unit 2 suggest a growing resident population. Moose numbers in Unit 3 (low to moderate density) appeared to increase during the past five years.

A subjective estimate of the number of moose in Subunit 1A is 20-30 in the Unuk River drainage and probably not more than 5 in the Chickamin River drainage (R. Wood, pers.

comm.). During two helicopter surveys totaling 2.25 hours of search time, 15 moose were observed in the Unuk River drainage. The first flight located 5 adults and 2 calves and the second located 6 adults and 2 calves. Calves comprised 28% of the moose seen on the first flight and 25% on the second. We did not locate any moose or tracks in 0.6 hours of search time during an overflight of the Chickamin River in February 1991.

The Stikine River population in Subunit 1B was estimated at 300 moose and increasing in 1983 (Craighead, op. cit.). Post-1983 harvest levels and subjective impressions suggested the Stikine River population slowly increased and then began to decrease in 1988. Based on aerial survey data (Table 1) and recruitment estimates from harvest data we estimate a population of 450 moose after the 1989 hunt.

Harvest data indicate that the Thomas Bay moose population may be larger than in the late 1970s estimate of 180 animals (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 and 3.

<u>Population Composition</u>: Table 1 shows sex and age composition data of the Stikine River moose population for the past five years. The bull:cow ratio and the calf:cow ratio data do not reliably indicate trends because of small sample size. However, aerial surveys provide an indication of relative calf numbers. Late winter surveys in the Stikine River drainage show a decline in the percentage of calves found, from 30% in 1980 to less than 10% in February 1991. No surveys have been completed after the fall hunt to determine bull:cow ratios.

<u>Distribution and Movements</u>: Increasing reported sightings of moose, primarily on Mitkof Island, and to a lesser extent on Etolin, Kupreanof and Kuiu islands suggest that the Unit 3 moose population is increasing. Residents on Wrangell and Mitkof islands report substantial moose populations. Both the Stikine River and Thomas Bay populations occur on the mainland directly opposite Etolin, Mitkof, and Kupreanof islands and are logical sources of immigrating moose. Bulls, cows, and calves have been observed in Unit 3, which suggests that reproduction of resident moose also contributes to the overall increase. Incidental sightings of moose tracks and trails on Kupreanof Island during winter suggest that substantial numbers of moose exist in several areas.

<u>Mortality</u>

<u>Harvest</u>:

<u>Season and Bag Limit</u>.

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

Board of Game Actions and Emergency Orders

Hunting regulations for the Stikine River remained unchanged the past five years. Because of the apparent low calf survival and reduced harvest, several proposals were made to the Board of Game at its spring 1990 meeting. The Board did not consider any proposals containing subsistence implications because of pending federal action regarding subsistence.

Low calf production in the early 1980s led to closure of the Thomas Bay season in 1982. From 1984 through 1987 only bulls with three points or more on at least one antler were legal. This was intended to ensure at least some bulls would be available the following season (Land 1986). Under this restriction the harvest went from 12 to 22 bulls, and the proportion of yearlings in the harvest was about 33% in the unrestricted Stikine River hunt (ADF&G files, Petersburg).

After four years of this harvest regime the age structure of bulls was still strongly skewed toward young age classes. Based on an ADF&G recommendation that it would be desirable to further develop an age structure containing more older bulls, the Board of Game approved a regulatory change effective in 1988 to restrict the harvest to only bulls having spike or forked antlers on at least one side.

In 1990, after two years of protecting moose with larger than spike-fork antlers, the Board of Game passed a regulatory proposal allowing the take of 50"-antlered bulls along with spike-fork bulls. The Thomas Bay antler restrictions were changed from spike/fork only to spike/fork-50" antlers.

The Board of Game approved the opening of Wrangell Island for an antler restricted hunt, spike/fork-50," beginning in 1990. The Board also approved opening Mitkof Island for a spike/fork-50" bull season to begin in 1991. No emergency orders were issued during the report period.

Hunter Harvest: In Subunit 1A the Unuk and Chickamin River moose populations are small, isolated, difficult to hunt, and attract very few hunters. The Unuk River population has supported a mean annual harvest of three animals. One bull was killed in 1989 (Table 2). Harvest reports indicate 28 hunters participated. Five bulls were reported killed in 1990 with approximately 21 hunters afield. These numbers should be increased by at least 10% to correct for non-reporting hunters if Subunit 1A hunters are comparable to Subunit 1B hunters discussed below.

The 1989 harvest of 38 bulls in the Stikine hunt was 34% less than the 1988 hunter kill (Table 3). The kill dropped to 36 bulls in 1990, and one illegal cow was also killed. The 1989 harvest of 38 bulls was substantially less than the previous 5-year (1984-88) average of 47. Although the average take for the 1980s was 43, a substantial increase over the 1970s average of 27, the decline in kill for two consecutive years merits close attention.

The percentage of yearling bulls in the Stikine River harvest dropped from 80% in 1988 to just over 40% in 1989. Late winter surveys in February and April indicated very low calves surviving from the preceding year. This apparent weak age-class was verified by examination of incisors from harvested moose. In 1990, 65% (n=21) of the moose aged were yearlings. The remaining 11 were aged as follows: 16%(n=5) were two years old, 16%(n=5) were three years old, and one bull was seven years old. That 97% of the bulls killed were three years old or younger suggests few older bulls available.

The Stikine River hunt is intensively monitored by ADF&G and Fish and Wildlife Protection (FWP) personnel in the field for the entire 30-day season. Approximately 320 people hunted in 1989, compared to 305 hunting in 1988. Harvest reports under-reported hunter effort by about 12% in 1988, 11% in 1989, and 22% in 1990. Four successful hunters failed to report in 1989, while eight failed to report in 1990. At least 45 unsuccessful hunters in 1990 did not report. If this indicates a long-term trend then all previous data from hunter reports should be increased by at least 10%. Goodwin (1991) reports that statewide failure to return moose hunter reports is 30%. The previously held assumption that most nonrespondents did not hunt may be incorrect.

The 1989 moose harvest of 19 legal bulls and one illegal bull (which failed to meet antler restrictions) at Thomas Bay was lower than the 27 bulls taken in 1988 (Table 4) yet higher than the 1984-1988 average of 17. In 1990, 23 legal bulls were killed, two illegal bulls were taken, and one cow was killed after the season by a deer hunter in defense of life. The two illegal bulls did not meet the antler requirement. Of the 23 legal bulls, 8 were 3-brow tined, and 15 were in the spike/fork class.

Wrangell Island hunters failed to report any kills but check station data confirmed that three legal bulls were taken (Table 5). Twenty-one hunters reported they were unsuccessful on Wrangell Island.

Hunter Residency and Success. The number of hunters increased in the Stikine River hunt through 1989 but dropped slightly in 1990. Wrangell residents, included in Table 6 as "local," harvested 61% of the bulls killed in 1989 and 75% in 1990. Hunters from Petersburg, the other "local" residents, took 29% in 1989 and 25% in 1990. Other state residents took the remaining 10% in 1989. No hunters from outside Southeast Alaska were successful in 1989 and only Petersburg and Wrangell hunters were successful in 1990.

Local residents (Petersburg) continued to prevail in the Thomas Bay hunt, taking 90% of the moose in 1989 and 96% in 1990. In 1989, 146 hunters participated and 162 hunted in 1990. Only 13 hunters in 1990 were not from Petersburg and one of these was a non-resident (Table 7).

Harvest Chronology. Unlike previous years where most moose were harvested during the first two weeks, the 1989 Stikine harvest was slightly more dispersed throughout the season. In the first two weeks 23 bulls were killed and 15 were killed during the last 16 days. The 1990 kill followed the trend of previous years with 75% (n=27) of the bulls being killed in the first two weeks even though hunter numbers were slightly reduced.

The 1989 Thomas Bay hunt was consistent with previous years in that 17 of the 20 bulls killed were taken in the first half of the 2-week season. In 1990, 18 bulls were taken the first week and 5 the second.

Transport Methods. No apparent changes occurred in transport methods used by hunters in Subunit 1B. Most hunters used boats and a few used airplanes. On Wrangell Island in Unit 3 all hunters used highway vehicles for transportation. Motorized land vehicles use is prohibited in the Thomas Bay hunt and in the Stikine Wilderness.

Other Mortality. The extent of predation on moose herds in these areas is unknown. Brown bears, black bears, and wolves occur in association with the moose populations. In the Coast Mountain area in the southern Yukon, wolves removed 64% of moose calves during two winters and 11-14% of adults (Hayes, et al 1991). The same study assumed wolf predation rates of 8-10 moose/wolf/year. They found that wolves primarily took calves, yearlings, and middle-old age adults. These age classes were taken in proportions higher than their occurrence in the herds. Wolves are frequently seen and heard along the Stikine River but population estimates are not available.

On the Kenai Peninsula of Alaska black bears took 31% of monitored moose calves during one year and 34% over a 2-year period (Franzmann, et al, 1980). Observations by

ADF&G personnel and reports from the public suggest a relatively high density of black bears in southern and central southeast Alaska.

Brown bears are frequently seen in the hunt areas but the density of the population is believed low. In a study of 136 moose calves in 1977 and 1978, 55% died of natural causes, of which 79% were from brown bear predation (Ballard, et al, 1980). Subsequently in the same Nelchina and Upper Susitna River study area 27 calves were monitored. Fifteen calves died of natural causes and brown bear predation caused 80% of those deaths.

The above studies suggest that predation may be a major cause of low recruitment to the Stikine River moose herd. The three major moose predator species are present in substantial numbers. The low bull:cow ratio may also contribute to low calf production and survival.

Habitat

Moose in Thomas Bay have used young-age clearcuts since logging began there in the 1950s. Conifer regrowth in the clearcuts is progressively reducing moose habitat. As the canopy closes, the value of these areas are lost to moose. The current moose population probably cannot be sustained at the present level without habitat enhancement. Enhancement program planning has begun with the USFS. The first phase, removal of 100 acres of mature alder and cottonwood from the Patterson River plain, occurred in winter 1989-90. Program progress will be documented in future reports.

The central Subunit 1B Stikine River herd occupies the Stikine/LeConte Wilderness area and is generally within the Stikine River drainage. Moose habitat in this area was identified in Craighead (1984). The USFS has designated the area as "wilderness" which means the area cannot be manipulated mechanically for habitat improvement.

CONCLUSIONS AND RECOMMENDATIONS

The small Unuk and Chickamin river moose populations attract very few hunters. I recommend no changes in regulations at this time.

The Subunit 1B Stikine River population objective of providing for a harvest of at least 40 moose was not accomplished, nor was the 13% hunter success objective met. However, the objective of providing for participation by 300 hunters was exceeded in 1989. The extremely low carryover calf crops from 1988, 1989, and 1990 suggests a need for immediate restriction. A spike/fork-50" antler restriction hunt should be implemented for 1993. This will protect most bulls for one year but will still provide liberal hunting opportunity. In subsequent years, about half of all yearling bulls would be protected.

Harvest will be reduced for a period but should increase over time as bulls are allowed to reach older age classes.

The Subunit 1B Thomas Bay population objective to provide for a harvest of 20 moose was accomplished if the one illegal bull is included. No progress was made in determining carrying capacity and I doubt that such a project can be done at existing staff and funding levels. Plans to improve habitat are being developed in conjunction with the USFS. The first year of the spike/for-50" restriction was favorably accepted by hunters.

Responses at public hearings during the moose management planning process indicate little interest for moose in Unit 2 (Flynn and Paul 1989). Many public responses identified moose in Unit 3 as desirable for viewing (Flynn and Paul 1989). A proposal to open Mitkof Island to a spike-fork/50" season failed to be endorsed by the local Advisory Committee by a tie vote but was endorsed the following year.

I recommend that Unit 2 remain closed to the taking of moose. I recommend consolidating Subunit 1B and Unit 3 with a season of 1 October through 31 October, and a bag limit of one bull with spike/fork or 50" antlers by registration permit only. We need the information a registration hunt provides and with an antler restriction the season can easily be extended to 31 days where it is now 15. An opening date of 1 October would ensure some breeding could occur before the hunting season.

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Table 1. Subunit 1B, Stikine River area aerial moose surveys, 1986-91.

Regulatory year Month/day	Adults	Calves (%)		Unidentified	Total moose observed	Moose/ hour
1986/87	No survey					
1987/88	No survey					
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

[a] Helicopter survey

[b] River stage high, full leaf out in lower river, moose not visible.

Table 2. Subunit 1A moose harvest, 1986-91.

Regulatory year	Hunter Harvest: Reported M	(%)	F	(%)	Unk.	Total	Estimated: Unreported	Illegal	Total	Grand 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

Table 3. Subunit 1B (Stikine) moose harvest[a], 1986-91.

Regulatory year	Hunter Harvest: Reported M	(%)	F	(%)	Unk.	Total	Estimated: Unreported	Illegal	Total	Grand total
1986/87	51	100	0	0	0	51	0	0	0	51
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

[a] Excludes permit hunt harvest.
[b] Illegal kill.

Table 4. Subunit 1B (Thomas Bay) moose harvest data by permit hunt, 1986-91.

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

[a] Includes illegal kill

Table 5. Unit 3 (Wrangell Island) moose harvest, 1990-91.

	Hunter Harvest									
	Reported						Estimated			
Regulatory year	M	(%)	F	(%)	Unk.	Total	Unreported	Illegal	Total	Grand total
1990/91	3	0	0	0	0	3	0	0	0	3

Table 6. Subunit 1B (Stikine) moose hunter[a] residency and success, 1986-91.

Regulatory year	Successful						Unsuccessful						Total hunters
	Local[b] resident	Nonlocal resident	Nonres.	Unk.	Total	(%)	Local[b] resident	Nonlocal resident	Nonres.	Unk.	Total	(%)	
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[c]	41	16	0	0	57	19	167	74	4	3	248	81	305
1989/90[c]	23	15	0	0	38	13	170	106	7	0	283	87	321
1990/91[c]	36	0	1[d]	0	37	12[e]	215	27	1	0	243	88	280

[a] Excludes hunters in permit hunts.
[b] Residents of Petersburg and Wrangell
[c] Unsuccessful hunter data expanded to correct for nonreporting hunters, see text.
[d] Illegal cow killed by nonresident hunting on resident license
[e] Legal kill only.

Table 7. Subunit 1B (Thomas Bay) registration permit moose hunter residency and success, 1986-91.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[a] resident	Nonlocal resident	Nonres.	Total	(%)	Local[a] resident	Nonlocal resident	Nonres.	Total	(%)	
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

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

LOCATION

Game Management Unit: Subunit 1C (6,500 mi^2)

Geographical Description: Southeast Alaska mainland from Cape Fanshaw to the latitude of Eldred Rock

BACKGROUND

Moose were first documented in western Subunit 1C on the Bartlett River during 1962. Moose were observed in the Chilkat Mountain range in 1963; these moose probably came from the Chilkat Valley 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 Adams Inlet (Glacier Bay) by then, because sightings were recorded at 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 occur on the Whiting and Speel rivers south of the Taku River; these animals may have come from the Taku River herd, the Whiting River, or from some other source.

Moose did not occur naturally in Berners Bay. Fifteen calves from the Anchorage area were released there in 1958. Six more calves were released in 1960. In June 1960, three cows with a single calf each were observed, indicating that the cows had bred at about 16 months old. The first limited open hunting season was held in 1963, when four bulls were killed. Since then, the annual harvest has ranged from 5 to 23 animals.

MANAGEMENT DIRECTION

Management Objectives

The following objectives have been identified 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% in the Taku River area by 1994.

Berners Bay: Maintain a posthunting population of 90 moose, an annual harvest of 8, and a hunter success rate of 80% in the Berners Bay area by 1994.

Chilkat Range: Maintain a posthunting population of 150 moose, an annual harvest of 10, and a hunter success rate of 15% in the Chilkat Range area by 1994.

METHODS

Aerial surveys were not conducted throughout most of southeast Alaska in fall 1989. An early snow was followed by rain, and later attempts were confounded by wind, fog, or unavailability of survey aircraft. We conducted an aerial survey of the Berners Bay area in late November 1990 (see Table 1). Incisors were collected from moose taken from Berners Bay and from successful hunters elsewhere in the subunit who voluntarily brought in jaws. Data collected from registration permits included the length of hunt, hunter residency, kill date and location, and transport means.

RESULTS AND DISCUSSION

Population Status and Trend

Moose numbers are being maintained near the estimated carrying capacity for the Berners Bay area (i.e., about 100 animals) with selective harvests to adjust the bull:cow ratio. In the Taku River area, some evidence suggests the Taku River herd 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 herd, but harvest levels and anecdotal comments from hunters in the field indicate that moose numbers have probably been stable. An increased harvest in the Chilkat Range in 1990 probably reflects increased effort. How the effects of this harvest level combined with the effects of moose immigrating from Adams Inlet have influenced the area's moose population is presently unknown.

Population Size: In Berners Bay the number of moose observed in fall and winter surveys has remained low since 1986 (Table 1). An estimated 90-100 moose inhabit Berners Bay.

Survey data are not as complete for the Chilkat Range as for other portions of Subunit 1C (Table 2). As noted above, no surveys were completed outside of Berners Bay in 1989 or 1990. The Endicott River portion of the Chilkat Range may support 50 moose, and the entire Chilkat Range may support 150 moose. In the past, animals from this area emigrated to Adams Inlet in Glacier Bay, where willow communities have pioneered following recent glacial retreat. Moose from Adams Inlet may now be moving back to the east, supplementing the herd along the west side of Lynn Canal.

If moose sightability is similar in the eastern portion of Subunit 1C as it is in the Haines and Yakutat areas, the population between Taku River and Cape Fanshaw probably numbers 150 animals. Animals from upriver in Canada possibly supplement the Taku herd, but the harvest in Canada has increased in recent years.

Population Composition: No surveys were conducted in Subunit 1C in 1989. In 1990 a fall survey in Berners Bay found 14 bulls, 53 cows, and 18 calves, for a (26 bulls:100 cows, 34 calves:100 cows). No other areas in Subunit 1C were surveyed during 1990.

Mortality

Harvest:

Season and Bag Limit.

Unit 1C, Berners Bay drainages only.	15 Sept.-15 Oct.	One bull by drawing permit. Up to 5 permits issued to Alaska residents only.
Unit 1C, except Berners Bay drainages.	15 Sept.-15 Oct.	One bull by registration permit only.

Hunter Harvest. The Berners Bay drawing permit hunt has been managed for a harvest of 5 moose for the last 5 years (Table 3). The ratio of male:female moose established for the harvest was based on aerial survey data. With no 1987 survey data and low numbers in the 1988 survey, the 1989 quota was left at 5 bulls. All 5 permittees filled their permits in 1989. With no 1989 survey, the 1990 harvest quota remained at 5 moose, and all permittees were successful. We believe poaching in Berners Bay is minimal because it is near Juneau and the number of people who spend considerable amounts of time there.

The balance of Subunit 1C is managed under a registration permit with no hunt quota. The known Taku River area harvest has ranged from 15 to 24 since 1986 and the take in the Chilkat Range has ranged from 6 to 24 (Table 3). The 1989 total of 37 moose for Subunit 1C other than Berners Bay drainages is the highest take in the 5-years before that season, and the 44 moose taken outside of Berners Bay in 1990 was the highest number since 1972. There is a striking change in the contribution made by hunt areas to the total harvest, with the role of the Chilkat Range increasing enough to more than compensate for the decreased harvest from Berners Bay drainages over the past decade.

In the Taku River area, some moose harvest claimed by Alaskan hunters is probably 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 does in the Endicott drainage and other sites in the Chilkat Range.

Permit Hunts. Between 200 and 600 applications were submitted for the Berners Bay moose drawing over the previous 5 years. The proximity to Juneau explains the popularity of this hunt. In 1989, 342 hunters applied for 5 bull permits for a 1.5% success rate. In 1990, 445 hunters applied for 5 bull permits, for a success rate of 1.1%.

Since the registration permit format was instigated for the remainder of Subunit 1C, (Hunt 956), over 200 permits have been issued annually (Table 4). A record high of 331 permits were issued in 1990. The number of people obtaining permits and hunting in the subunit increased substantially during the 1989 and 1990 seasons. The number of applicants actually hunting ranged from 138 to 223, testifying to the popularity of moose hunting in the Juneau area. In 1989, 192 applicants hunted, and this increased to the high of 223 in 1990. Reporting compliance has remained high for this hunt.

Hunter Residency and Success. Most moose harvested in Subunit 1C are killed by local residents (Table 5). In 1989 and 1990, 41 of 42 moose (98%) and 44 of 49 moose (90%) respectively were taken by local residents. Because hunt areas are not easily accessible via highway vehicle, nonlocal Alaska residents have more opportunities to hunt moose closer to their homes. The Berners Bay hunt is restricted to Alaska residents. In 1989 and 1990, 27% and 28% respectively of all hunters in Subunit 1C were successful.

Harvest Chronology. During the 1989 moose season in this subunit, 51% of the harvest came in the first week of the season. In 1990, however, harvest was strong during both the first and last weeks of the season (34% of the harvest in each). Variable weather greatly influences harvest chronology, as prolonged periods of rain discourage hunters from going afield and winds can prevent access to hunting areas.

Transport Methods. Boats are the most common transportation that area moose hunters use. This is not surprising, as hunting areas are removed from highway access points, seasons close before it snows, and aircraft landing sites are limited. In 1989, 74% of the successful area hunters used boats for access, and in 1990, 59% used boats (Table 7).

Other Mortality: No natural mortality was documented this report period. However, the extended cold winter in early 1989, coupled with deep snows, exacerbated poor nutrition and enhanced predation. Heavy snow accumulations during the 1990-91 winter probably had a similar effect.

Habitat

No assessment or enhancement activities were accomplished during this report period.

CONCLUSIONS AND RECOMMENDATIONS

Fall and winter surveys suggest a low, stable Berners Bay moose population and a reduced moose population in the Taku River drainage. We believe that continuing the permit registration system should accommodate current population objectives. In Berners Bay, some increase in the quota may be possible, since the herd seems near the area's carrying capacity. Rising effort and harvest in the Chilkat Range increase the importance of acquiring survey data on moose there.

Throughout the subunit, jaws should be collected for age analysis of harvested moose. Areas supporting winter browse should be analyzed, even cursorily, in cooperation with land managers to determine if vegetation manipulation is in order. Once population and carrying capacity estimates are made for the Taku and Endicott river populations, we can consider revising management objectives for those areas.

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Table 1. Subunit 1C. Berners Bay historical moose survey data, 1986-1990.

Date	No. Bulls	No. Cows	No. Calves	Unknown Sex/Age	Total Sample	Males/ 100 FF	Calves/ 100 FF	Percent Calves	Count Time/hr.	Moose/ Hour
1986	15	46	7	0	68	33	15	10	1.6	41
1987	No survey									
1988a	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

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

Table 2. Subunit 1C other than Berners Bay. Historical moose survey data, 1986-1990.

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									

[a] Chilkat Range
[b] Taku
[c] Late winter survey, sex and age ratios unreliable.

Table 3. Subunit 1C. Annual moose harvest by hunt area, 1986-1990.

	Reported				Estimated		
Year	Berners Bay	Taku	Chilkat Range	Sub-Total	Unreported	Illegal	Total
1986	5	15	10	3	0	0	30
1987	5	13	6	24	0	0	24
1988	4	17	11	32	0	0	32
1989	5	24	13	42	0	0	49
1990	5	20	24	49	0	0	49

Table 4. Subunit 1C. Moose harvest data by permit hunt, 1986-1990.

Hunt No.	Year	Permits Issued	Did Not Hunt	Unsuccessful Hunters	Successful Hunters	Bulls	Cows	Total
901	1986	7	0	2	5	5	0	5
	1987	5	0	0	5	5	0	5
	1988	5	0	1	4	4	0	4
	1989	5	0	0	5	5	0	5
	1990	5	0	0	5	5	0	5
956	1986	241	69	145	26	26	0	26
	1987	222	70	132	20	20	0	20
	1988	215	76	110	28	28	0	28
	1989	305	109	159	37	37	0	37
	1990	331	108	179	44	44	0	44
1989 Totals Both hunts		310	109	159	42	42	0	42
1990 Totals Both hunts		336	108	179	49	49	0	49

Table 5. Subunit 1C. Moose hunter residency and success, 1986-1990.

Year	Successful				Unsuccessful			
	Local Res.[a]	Nonlocal Res.	Nonres.	Total	Local Res.	Nonlocal Res.	Nonres.	Total
1986	28	3	0	31	134	11	1	146
1987	23	0	2	25	164	20	1	185
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

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

Table 6. Subunit 1C harvest chronology, 1986-1990.

Year	9/15- 9/21	9/22- 9/28	9/29- 10/5	10/6- 10/15
1986	19	7	4	16
1987	13	4	3	5
1988	14	8	2	8
1989	22	7	5	8
1990	15	6	8	15

Table 7. Subunit 1C successful hunter transport methods, 1986-1990.

Year	Airplane	Boat	3- or 4- wheeler	Snow- machine	ORV	Highway Vehicle
1986	9	20	0	0	0	1
1987	1	24	0	0	0	0
1988	8	24	0	0	0	0
1989	8	31	0	0	0	3
1990	12	29	0	0	0	8

LOCATION

Game Management Subunit: 1D (2,600 mi^2)

Geographical Description: Southeast Alaska mainland 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. This area contains 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 in the Chilkoot, Katzehin, and Warm Pass river valleys, and along Lynn Canal's western shore.

Moose immigrated to the Chilkat River valley from Canada around 1930. Chilkat Valley moose populations peaked in the mid-1960s when up to 700 animals may have been present. By the early 1970s the moose population had declined sharply to 400-500 animals, possibly because of range overutilization. Survey data collected during the mid-1980s suggested a further decline, with approximately 400 moose remaining in the Chilkat drainage. Recent surveys suggest that the moose population is no longer declining.

Residents of Subunit 1D have expressed concern about the decrease in moose numbers, the subsequent decline in hunting opportunity, and the "stampede" quality of the hunt. Harvest objectives were formulated based on survey data and harvest trends. Efforts were made to introduce measures (e.g., a spike-fork requirement) to slow the pace of the hunt, but these were pre-empted when a Tier II subsistence hunt was implemented for the area by the Board of Game in the 1990-1991 regulatory year.

MANAGEMENT DIRECTION

Management Objectives

Management objectives for moose in the Chilkat River valley by 1994 include a post-hunt population of 450 and a post-hunt bull:cow ratio of 26:100; 250 hunters would expend 500 hunter days and kill 30 moose, for a hunter success rate of 12%. These objectives, formulated from existing biological data along with public input, are in the Strategic Plan for Management of Moose in Region I, Southeast Alaska 1990-94 (ADF&G 1991).

METHODS

We flew aerial surveys of the Chilkat River valley on 30 November 1989, 15 December 1990, and 22 March 1991. The survey covered 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. Harvest data was gathered from registration permit returns for the 1989 hunt and Tier II permit returns from the 1990 hunt. Successful hunters were asked to retain the front portion of the lower moose jaw to determine age.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: A late winter survey flown in excellent viewing conditions in December, 1988 resulted in a population estimate of 400 moose in the Chilkat River valley. However, because of this survey's timing, bulls had begun to shed their antlers and a reliable sex ratio estimate was not possible. This survey led us to believe that moose numbers may have stabilized, and might be increasing slightly. We conducted three additional surveys which produced much lower total counts, but all were hampered by poor weather and/or viewing conditions. Therefore, the reduced numbers of moose reported in Table 1 should be interpreted with caution. A complete survey made in good conditions after the report period indicated a herd size closer to the 400 animal estimate made in 1988 than to the 1990-1991 survey results. While heavy snow accumulations in winter of 1990-1991 probably decreased overwinter calf survival and may have affected adult numbers, we do not know how substantial a decrease in moose numbers took place.

Population Composition: Because of their timing, surveys in the two years before the report period did not produce estimates for sex composition and produced only limited estimates for age composition. Early winter surveys flown in November 1989 and December 1990 did yield sex and age 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 average (21) for the previous 10 years. As this was a later survey, antler drop may have affected the estimate.

In 1989, 22 calves:100 cows were seen, which is the highest figure for the 5 years preceding the report period (calves made up 14% of the sample, compared to the 5-year average of 12.4%). In the deep snow of 1990 only 9 calves:100 cows were present, the lowest ratio since 1975 (calves comprised 7% of the sample).

Survey results were affected by weather and moose using forested habitats in deep snow, making them difficult to see. However, if we assume the survey data are somewhat representative of the moose population in the Chilkat River valley, then the potential for reproduction improved in recent years. Despite this, poor calf survival because of snow, predators, or other factors may eliminate recruitment in some years.

Mortality

Harvest:

Season and Bag Limit.

1989-1990 Regulatory Year

Subunit 1D	1 Sep. - 10 Sep.	One bull by registration permit only: 15 bull quota. Subsistence hunt only, limited to residents of Subunit 1D.

1990-1991 Regulatory Year

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

During the 1989-1990 regulatory year the hunt in Subunit 1D was managed through a registration permit, using a harvest quota to limit the take. Despite good compliance with a request for early reporting, the quota was exceeded by four, for a total kill of 19 moose. The quota was probably met before noon on the first day of the season.

In 1990-1991, harvest was under a Tier II permit system. Of 20 permittees, 19 took moose. Because permittees were assured they could take a moose anytime during the season, the timing of hunting changed markedly from previous years (see Table 3).

Board of Game Actions and Emergency Orders. In 1989 an emergency order was used to close the registration permit hunt in Subunit 1D once the hunt quota was reached. This action was anticipated and had been planned for. In 1990, all Alaska residents became eligible to participate in subsistence hunts. To prevent overharvest of the Chilkat moose population the hunt in Subunit 1D was made a Tier II permit hunt.

Permit Hunts. All moose hunting within the subunit is conducted under a permit system. In 1989 the registration permit hunt drew 272 applications. When the Tier II subsistence permit went into effect for 1990, 104 applications were received for 20 available permits.

Hunter Residency and Success. During this report period, the moose hunt in Subunit 1D was limited to Subunit 1D residents. During the registration hunt held in 1989, 272 permits were issued. Two-hundred-twenty-six hunters participated in the hunt, and 19 moose were taken, for a success rate of 7% (Table 2). In 1990, 20 Tier II permits were issued for the hunt in Subunit 1D. Nineteen permittees took moose (95% success rate).

Harvest Chronology. Following the pattern of previous years, in 1989 all moose were harvested on the first day of the season. The hunt quota of 15 moose was exceeded by four when the season was closed by emergency order. In 1990, the Tier II permit system took competition out of the field and put it into the application process. Permittees were not forced to take a moose on opening day and the kill was distributed over the entire season (Table 3).

Transport Methods. Boats were the primary transport method for most moose hunters in Subunit 1D, with highway vehicles as the secondary transport means used (Table 4).

Other Mortality: Discussions with area sportspeople suggest that the brown bear population has increased in recent years, and predation may be partly responsible for poor recruitment observed. Data supporting this contention are not available. Deteriorating range conditions (Hundertmark et al., 1983) may also factor into low calf production and survival. An estimated 3-5 moose are killed by highway vehicles in the area each winter. Poaching probably occurs, but the extent of poaching loss of moose is unknown.

Habitat

Nearly all moose habitat in this subunit lies within the state forest, and is 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 (i.e., approximately 300 to 580 acres). Timber harvests occurred during the report period in the Chilkat River valley above Wells Bridge in areas which do not contain important moose winter range. While some benefits may accrue for moose through increased browse production in logged areas, 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.

Habitat changes in non-forested areas are also of concern. Research done in the early 1980s showed a low proportion of young willow plants in shrub stands in the Chilkat River valley, and postglacial land uplift is suspected as causing permanent habitat change. Removal of decadent alder and cottonwood overstories to release willow, red-osier dogwood, and other browse species may counteract long-term changes for awhile.

CONCLUSIONS AND RECOMMENDATIONS

The harvest objectives contained in the Strategic Plan for Management of Moose in Region I, Southeast Alaska 1990-94 (ADF&G, 1991) 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 by radio-collaring calves in spring was rejected because of cost and practicality, and mentions diversionary feeding as a possible way to deflect predators from calves during their early lives. Methods to ascertain the extent of predation should be considered.

McCarthy (ADF&G, 1990) 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 also be pursued, and tried on a pilot basis. Volunteer efforts may accomplish enough so that browse growth and moose use could be monitored before engaging in any large scale habitat enhancement efforts. 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 difficulty of obtaining good survey information for this area in the past 5 years, it is important to conduct surveys here to better understand population status and trend.

Based upon the heavy snow accumulations in 1990-1991, the low numbers of calves observed, and the inability to obtain complete survey data, we recommend closing the Tier II hunt for moose in Subunit 1D for the 1991-1992 regulatory year.

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Table 1. Subunit 1D historical moose survey data, 1986-1990.

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
02/1/88[a]	--	--	29	186	215	--	--	13	57
12/30/88[a]	15	--	31	206	252	--	--	12	40
11/30/89	18	45	10	0	73	40	22	14	48
12/14/90	18	67	6	0	91	27	9	7	35
03/22/91[a]	--	--	1	27	28	--	--	4	10

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

Table 2. Subunit 1D moose harvest data, 1986-1990.

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

[a] No open season

Table 3. Subunit 1C harvest chronology, 1986-1990.

	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

[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 (%), 1986-1990.

Year	Airplane	Boat	ORV	Highway[a] 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

[a] No open season

LOCATION

Game Management Unit: 5A and 5B (6,235 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 moose documented on the Malaspina Forelands west of Yakutat Bay by the 1950s. The westward movement of this moose population was believed curtailed by 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 moose. The population began making downward adjustments to a more realistic carrying capacity in the mid-1960s. Poor reproductive success and 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 are 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.

	Current 1990	Objective 1994
Subunit 5A Yakutat Forelands		
Post-hunt moose numbers	1,000	1,000
Annual hunter kill	57	70
Number of hunters	178	250
Hunter-days of effort	602	1,025
Hunter success	32%	28%
Subunit 5A Nunatak Bench		
Post-hunt moose numbers	30	50
Annual hunter kill	--	5
Number of hunters	--	10

Hunter-days of effort	--	60
Hunter success	--	50%
Subunit 5B Malaspina Forelands		
Post-hunt moose numbers	N.A.	250
Annual hunter kill	14	25
Number of hunters	35	50
Hunter-days of effort	133	200
Hunter success	40%	50%

METHODS

We conducted aerial surveys in Subunit 5A between mid-November and mid-December 1990. Under the terms of the registration permit, hunters submitted moose incisors for use in age determination. Other data collected included the number of days hunted, hunter residency, kill date and location, and transportation type used to access the hunt area.

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 be near the habitat's carrying capacity. Evidence suggests the Subunit 5B population may have declined in recent years. It is unknown if the Nunatak Bench moose herd has re-established after the retreat of the Hubbard Glacier and the waters of Russell Fiord subsided in 1986.

Population Size: Population estimates are based on aerial surveys. A 1977 mark/recapture study in Subunit 5A indicated that 50% of 40 animals equipped with visual collars were observed on a subsequent aerial survey. Therefore, we assumed that moose counted in a survey comprise no more than 50% of those present in the area surveyed.

Aerial surveys made before the report 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 preceding years (Table 1A). No surveys were completed in 1989. A fall survey in 1990 found 445 moose in Subunit 5A, at a sighting rate higher than in 1988. The moose population probably continues to exceed 1,000 animals.

The Nunatak Bench herd was also surveyed this report period. Before the 1986 flooding of this herd's winter range, caused by the blockage of Russell Fiord by Hubbard Glacier, an estimated 50 moose inhabited this area. Because the saltwater levels have receded in the fiord, moose have begun to reoccupy the Nunatak Bench. A survey on 19 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 on Nunatak Bench.

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

Population Composition: Composition counts made in Subunit 5A (not including Nunatak Bench) between mid-November and mid-December 1990 showed bull:cow and calf:cow ratios of 14:100 and 30:100, respectively (Table 1A). The bull:cow figure was substantially below the average for the preceding 5 years (26:100), while the calf:cow ratio was very similar to previous years (28:100 five-year average). We do not know the reasons for the apparent decline in the bull:cow ratio.

In the Nunatak Bench area, the bull:cow ratio was 25:100 and the calf:cow ratio was 50:100. The small sample size (14 moose) should be taken into account when interpreting these data, but indications are good that this area supports a growing number of moose. No composition information was obtained within Subunit 5B during the report period.

Mortality

Human Harvest: From 1982 through 1989, the Yakutat and Malaspina forelands hunts were managed for quotas of 50 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 10 moose until it was closed in 1986. The total harvest for Unit 5 has been fairly constant, ranging from 46 to 63 moose between 1985 and 1989 (Table 2). With an increase in the 1990 harvest in Subunit 5A after liberalizing the hunt quota, the harvest reached a 5-year high of 71. Table 3 presents data for all three Yakutat hunts for the past 5 years.

Season and Bag Limit.

Regulatory Year 1989:

Unit 5A, except Nunatak Bench	Subsistence Season 15 Oct.-15 Nov.	One bull by registration permit; 50 bulls may be taken; season will close west of Dangerous River when 25 bulls are taken in that area
	General Season 22 Oct.- 15 Nov.	
Unit 5A, Nunatak Bench	No open season.	

Unit 5B	1 Sep. - 15 Nov.	One bull by registration permit;25 bulls may be taken.
Regulatory Year 1990:		
Unit 5A, except Nunatak Bench	15 Oct.-15 Nov.	One bull by registration permit; 60 bulls may be taken; season will close west of Dangerous River when 30 bulls are taken
Unit 5A, Nunatak Bench	No open season.	
Unit 5B	1 Sep. - 15 Nov.	One bull by registration permit; 25 bulls may be taken.

Board of Game Actions and Emergency Orders. In 1990, the Board of Game increased the hunt quota in Subunit 5A from 50 to 60 bulls and raised the harvest limit west of the Dangerous River from 25 to 30. The board eliminated the provision restricting hunting during the first week of the season to local residents. This provision was later reinstituted on federal lands by the federal government after it took control of subsistence hunting.

Hunter Residency and Success: Table 4 presents data on hunter residency and success for Unit 5. Local residents hunt primarily in Subunit 5A on the Yakutat Forelands. From 1987 through 1989 local residents hunted the first week of the season before the area opened to nonlocal residents. This first week accounts for most of the Subunit 5A harvest and in 1989, local hunters took 71% of the Subunit 5A kill during the first week of hunting. During 1990 hunt results were similar even though local residents did not have the first week of the hunt to themselves; 39 of 57 (68%) Subunit 5A moose were taken that week, and only two moose were taken by nonresidents during the entire season.

Nonlocal Alaskans took an average of 17 moose from 1986 to 1990, only 9 (16%) in 1989, and 19 (27%) in 1990. Nonresidents averaged 2.8 moose during the 5-year period.

Permit Hunts: Current regulations provide for two registration permit hunts in Unit 5: Hunt 961 in Subunit 5A (Yakutat Forelands) and Hunt 962 in Subunit 5B (Malaspina Forelands). The Nunatak Bench in Subunit 5A (Hunt 960) has been closed since 1986.

For Hunt 961, only local residents could hunt during the first week of the 1989 season. Two-hundred-thirteen permits were issued, compared to the 5-year mean of 229 (Table 3). Forty-five bull moose were taken, five short of the quota. In 1990, the first week of the hunt was not restricted to local hunters and the hunt quota was increased to 60. Again, 213 permits were issued and 57 moose were harvested.

In Subunit 5B, 65 permits were issued in 1989 for Hunt 962; 12 moose were killed. This is above the mean of 57 permits issued from 1986-1990 (Table 3) In 1990, 60 permits were issued, and 14 moose harvested. The quota for Hunt 962 was 25 bulls in both years.

Divisions of Commercial Fisheries and Fish and Wildlife Enforcement staff continued to issue permits and monitor these permit hunts. Few permittees submitted harvest reports late in 1989 and 1990, partially because the area biologist was assigned to another duty station and this method of hunt monitoring became a lower priority.

Harvest Chronology: The early season moose harvest in Unit 5 is relatively low, partly because only Subunit 5B is open from 1 September through 14 October (Table 5). Nine of 57 (16%) moose harvested in the unit were taken before 1 October during the 1989 season. In 1990, 11% of the harvest was taken before October.

Most Subunit 5A harvest occurs during the first week of the season. In 1989, 13 of 45 moose (29%) were taken on opening day, and 32 (71%) by the end of the first week. During 1990, 25 moose were killed on opening day out of a total kill of 39 during the first week of the season. Although in both 1989 and 1990 the season continued for the entire time authorized, the quota was never attained.

Transport Methods: Transport methods used during 1989 and 1990 seasons were similar to those used in recent years (Table 6). Most successful Unit 5 hunters used aircraft to access both Subunits 5A (51% in both 1989 and 1990) and 5B (83% in 1989 and 64% in 1990). Aircraft use for accessing hunt areas ranged from 41% to 65% over last 5 years. Boat access was the second most popular access means for Unit 5 hunters, with an average of 25% of all successful hunters using boats. Although Table 6 indicates a drop in 3- and 4-wheeler use in 1989, a rise followed in 1990. Every fish camp has one or more of these machines. Although ORVs have been used in Yakutat for many years, more hunters are using them more as a primary form of access. Rutted meadows from wheeled vehicles are a common sight in Subunit 5A.

Other Mortality: Reports of natural mortality during the report period were similar to most recent years. Anecdotal information and apparent increases in wolf harvest might suggest that mortality from wolf predation has increased. However, considering the increased number of moose seen in surveys throughout Subunit 5A, we do not believe that a higher percentage of moose are being taken by predators at this time.

Habitat

Assessment: A cursory evaluation of winter browse close to Yakutat by USFS and DWC staff indicated that moose browse could benefit from treatment. Willow with large amounts of dead and decadent wood, large basal diameters, little amount of current annual growth, and shrubs exceeding 12 feet in height are common. Consideration was given to several methods of rehabilitation, including fire, crushing, chaining, and cutting by hand. The last option seems the most likely to succeed.

Enhancement: A USFS study of browse response to mechanical treatment, located near Harlequin Lake, concentrated on removal of conifers to evaluate methods of forestalling progression to climax conditions. All spruce and hemlock 20 inches in diameter at breast height (dbh) or less were cut and removed to brush piles. The Forest Service may monitor this study area to determine future response. Although spruce/hemlock is the climax habitat throughout much of the Forelands, such an approach will not address the apparent reduction of browse species vitality.

DWC and USFS staff have taken preliminary steps toward treating 200 acres of winter willow browse between Yakutat and the mouth of the Situk River. Range experts have been consulted and the literature reviewed. At this time, rough boundaries have been established and contracts to perform the work will be advertised by the USFS.

CONCLUSIONS AND RECOMMENDATIONS

Complete fall sex and age composition counts should be conducted for all Unit 5 moose herds. The department should continue to cooperate with the USFS in investigating various browse treatments for their effectiveness in stimulating food production. Treatment of willow and cottonwood stands near the coast by Yakutat and evaluation of the spruce stand thinning near Harlequin Lake should be included.

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Table 1A. Yakutat Forelands, Subunit 5A moose survey data, 1986-1991.

Year	No. bulls	No. cows	No. calves	Unknown sex/age	Total sample	MM/ 100 FF	Calves/ 100 FF	Percent calves	Count time	Moose/ hour
1986/87 F	34	166	60	0	260	20	36	23	11.3	23
1987/88 W	--	--	83	239	322	0	0	26	11.2	29
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	65.6

F= fall count W = winter count

Table 1B. Nunatak Bench, Subunit 5A moose survey data, 1986-1991.

Year	No. bulls	No. cows	No. calves	Unknown sex/age	Total sample	MM/ 100 FF	Calves/ 100FF	Percent calves	Count time	Moose/ hour
1986/87	No survey									
1987/88	No survey									
1988/89	No survey									
1989/90	No survey									
1990/91 W	2	8	4	0	14	25	50	29	0.25	56

F= fall count W = winter count

Table 1C. Malaspina Forelands, Subunit 5B moose survey data, 1986-1991.

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									

Table 2. Unit 5 annual harvest 1986-90 and subunit harvest for 1989 and 1990.

Year	Reported Harvest	Estimated Total Harvest
1986	63	63
1987	46	46
1988	58	59
1989		
Subunit 5A	45	45
Subunit 5B	12	12
Total	57	57
1990		
Subunit 5A	57	57
Subunit 5B	14	14
Total	71	71

Table 3. Unit 5, harvest data by permit hunt, 1989-1990.

Hunt no.	Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows
960	1986	5[a]	5	0	0	0	0
Nunatak	1987	No open season					
Bench	1988	No open season					
	1989	No open season					
	1990	No open season					
961	1986	271[b]	73	144	54	54	0
Yakutat	1987	242	43	161	38	38	0
Forelands	1988	206	48	108	47	47	0
Subunit 5A	1989	213	40	128	45	45	0
	1990	213	28	122	57	57	0
962	1986	42[b]	0	33	9	9	0
Malaspina	1987	60	36	16	8	8	0
Forelands	1988	58	18	29	11	11	0
Subunit 5B	1989	65	21	32	12	12	0
	1990	60	24	21	14	14	0
1990 totals all hunts		273	52	143	71	71	0

[a] Season closed prior to hunting effort.
[b] Subunits 5A and 5B permits combined; all did-not-hunts coded to 961.

Table 4. Unit 5, hunter residency and success, 1986-90.

Year	Successful				Unsuccessful			
	Local res.[a]	Nonlocal res.	Nonres.	Total	Local res.[a]	Nonlocal res.	Nonres.	Total
1986	25	33	5	63	104	65	9	178
1987	32	11	3	46	121	65	9	195
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

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

Table 5. Unit 5, harvest chronology, 1986-90.

Year	Sept 1-15	Sept 16-30	Oct 1-15	Oct 16-31	Nov 1-15
1986	0	4	23	36	0
1987	1	2	4	37	2
1988	1	4	19	34	0
1989	2	7	13	35	0
1990	2	6	31	32	0

Table 6. Unit 5, successful hunter transport methods, 1986-90.

Year	Airplane	Boat	3- or 4-wheeler	ORV	Highway vehicle
	N %	N %	N %	N %	N %
1986	41 (65)	14 (22)	0	0	8 (13)
1987	19 (41)	16 (35)	2 (4)	4 (9)	5 (11)
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)

LOCATION

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

Geographical Description: Prince William Sound and North Gulf of Alaska Coast

BACKGROUND

Moose populations in most of Unit 6 came from transplants completed between 1949 and 1958 when 24 calves were released on the western Copper River Delta in Subunit 6C (Burris and McKnight 1973). This population rapidly expanded eastward, first occupying Subunit 6B and then advancing by the late-1960s to the Bering River in Subunit 6A. Moose may have reached Subunit 6A through dispersal westward from the Malaspina Forelands in Subunit 5A. The introduced population reached a high of 1,500 in 1988 (Griese 1990). The only moose endemic to Unit 6 were small populations in Subunit 6D near Valdez and at the head of Kings Bay. These populations never expanded their range south of the Chugach Mountains and probably number less than 40 animals today.

Data collection for managing Unit 6 moose populations included aerial surveys and harvest monitoring. Surveys allow us to estimate observed moose/mi^2 and population composition. However, annual collection of ratio data on sex and age was 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 1990 was 2,734. Total harvest during the same period in Subunit 6D was approximately 32 moose.

Population density objectives were 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 (Rausch 1977). In 1987, density objectives were increased to 1.8-2.0 moose/mi^2.

MANAGEMENT DIRECTION

Management Objectives

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

METHODS

We conducted aerial surveys during late November through early January to estimate moose population density and composition. A Piper, PA-18 aircraft was used to search moose habitat at 1.4-2.2 minutes/mi^2. Sex and age ratio estimates were obtained only from surveys conducted before mid-December because after that time significant numbers of bulls have shed antlers which makes results unreliable. Survey quality was rated as fair, good, or excellent, primarily based upon the adequacy of snowcover.

Total number in most populations was estimated based on densities observed during aerial surveys, percentage of wintering habitat surveyed, and quality of survey conditions. Assessments of survey quality were used to increase population estimates by increments. "Excellent" conditions produced 1.1-1.2 times the observed number of moose; "good" conditions produced 1.2-1.4 times the count; and "fair" produced 1.4-1.7 times the count. These estimate factors were subjective. When surveys were not completed, population estimates were based upon historic trends.

During regulatory year 1989/90, we surveyed Subunits 6B (9 January 1990) and 6C (2 January 1990). Survey conditions were excellent, but no reliable sex and age ratio data could be collected. In regulatory year 1990/91, we completed surveys in Subunits 6A West (31 January 1991), Subunit 6B (13 December 1990), and Subunit 6C (20 November 1990). Conditions were good in Subunit 6A West, excellent in Subunit 6B and fair in Subunit 6C. We obtained reliable sex and age ratios only in Subunit 6B and 6C surveys.

Hunters participating in drawing or registration permit hunts were required to report effort and were sent up to two reminder letters. Hunters participating in general moose hunts were sent one reminder letter if they failed to return their original hunt report. Hunter success and effort were recorded by uniform coding unit. We collected the lower front teeth of moose from successful hunters.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: The Unit 6 population was estimated at 1,440-1,685 moose in January 1991. The largest concentration was in Subunit 6A East, and the smallest in Subunit 6D. Moose density observed during 1990-91 surveys was 1.4-1.7 moose/mi^2 (Table 1).

We obtained a similar moose population estimate in January 1989 and a slightly lower total count in December 1987. Griese (1990) felt the population had reached record highs in 1988 as a result of good calf survival and reduced hunter harvest.

Most moose populations in Unit 6 were stable the past two years (Table 1). Possible exceptions were in Subunits 6A East (east of Suckling Hills) and 6D where moose numbers increased. Surveys were not completed in Subunit 6A East during this report period, but calf survival was good and harvests were low. We did not survey Subunit 6D, but anecdotal observations suggested a slowly growing population of 25-35 moose.

Population Composition: Number of calves in the population was the only composition information consistently obtained. These data indicated calf survival to 6 months was good. Last year calves comprised 18% of the moose population in Subunit 6A. During the last two years, calves comprised 13% and 18% of the moose in Subunit 6B, and 12% and 15% of moose in Subunit 6C. Over the past 5 years, calves averaged 18% of the population in Unit 6. During 1990 yearlings comprised 18% and 12% of moose in Subunits 6B and 6C, respectively. Bull:cow ratios in Subunits 6B and 6C were 31:100 and 28:100, respectively, in 1990. Values for these two subunits in 1987 were 39:100 and 24:100, respectively. In Subunit 6A West the ratio was 36:100 during 1988.

Mortality

Harvest:

Season and Bag Limit. The season in Subunit 6A for resident and nonresident hunters was 1 September to 31 December during 1989, and 20 August to 31 December during 1990. The bag limit was 1 moose during both years. Harvests in Subunits 6B and 6C were regulated by permit hunts. The season in both subunits for resident hunters only, was from 1-30 September, with a 1 moose bag limit. In Subunit 6B, take of up to 30 antlered moose was authorized by registration permit; harvest of up to 25 antlerless moose was allowed under drawing permits. 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.

Board of Game Actions and Emergency Orders. The Board of Game made changes in the regulations for Subunit 6A for regulatory years 1989/90 and 1990/91 in a continuing attempt to increase harvest overall and achieve better harvest distribution between eastern and western portions of Subunit 6A. The moose population had grown rapidly, and ADF&G was concerned that the range's carrying capacity could be exceeded, resulting in damaged habitat and excessive overwinter mortality.

For the two years before 1989, hunting for either sex in Subunit 6A East opened 20 August and closed 31 December, while Subunit 6A West opened 1 September and closed 15 October. We intended to maintain liberal seasons overall to entice additional hunters into the subunit's more lightly hunted eastern portion. The Board also adopted a registration permit hunt during 1988 for Subunit 6A West to monitor the bull harvest closely. These actions failed to influence harvest significantly, and a simpler regulatory approach was adopted in 1989, with additional modification the following year.

The Board of Game changed regulations for 1989 in Subunits 6B and 6C. In Subunit 6B, the number of drawing permits for antlerless moose was increased from 10 to 25. In Subunit 6C, a drawing permit hunt for antlerless moose was adopted, with up to 20 permits authorized.

Emergency orders were issued in 1989 (15 September) and 1990 (8 September) to close the registration permit hunt for antlered moose in Subunit 6B. The purpose was to limit harvest to 30 animals. These were normal management actions for this hunt.

Hunter Harvest. The moose harvest for Unit 6 was 131 in 1989 and 174 in 1990 (Table 2). The number of moose harvested in 1989 was a 5-year low, while the following year was a 5-year high. Harvest from Subunit 6A West accounted for most Unit 6 differences between years. The harvest of 24 animals in 1989 was the lowest in 8 years. In 1990, it increased to 61, which was more consistent with historical harvest levels. Regulation changes did not appear to influence harvest in this subunit. The ability of local hunters to access this area was probably the most important factor influencing harvest.

An upward trend in harvest occurred in Subunit 6B. The additional drawing permit hunt for antlerless moose in 1989 accounted for most of the increase, however, the bull harvest was also higher.

The reported harvest for Unit 6 was 73% males and 27% females during 1989, and 67% males and 33% females during 1990. The proportion of cows in the harvest in 1989 was the lowest in 5 years. The source of that difference was Subunit 6A, where very few cows were harvested in Subunit 6A East (18%) and Subunit 6A West (10%).

Permit Hunts. Each year, 1 drawing and 1 registration permit hunt were conducted in Subunit 6B and 2 drawing permit hunts were conducted in Subunit 6C (Table 3). Success was very high in most of the drawing hunts (57%-90%) because of the type of hunt (i.e. drawing with very limited participation) and good accessibility. The exception was the Subunit 6B antlerless hunt in 1989, where success was 33%. For the registration hunt in Subunit 6B, 211 permits were issued in 1989 and 179 in 1990. The success rate was 15% in 1989 and 17% the following year. Harvest for all permit hunts was as expected and administration presented no unusual problems.

Hunter Residency and Success. Local residents were 76% and 70%, respectively, of all hunters in Unit 6 who reported residency during 1989 and 1990 (Table 4). Alaska residents from other parts of the state were 17% and 18% of total hunters during each year, while nonresidents were 7% and 12%, respectively. These proportions were not different from previous years and did not vary substantially among subunits.

Hunter success during 1989 and 1990 in Unit 6 was 39% and 47%, respectively. This was lower than 1986 (71%) and 1987 (66%). The lower rate over the past 2 years was a result of the registration permit hunt in Subunit 6B in which hunter participation increased significantly without increasing the harvest. Hunter success did not change noticeably in other subunits.

Harvest Chronology. Most Unit 6 harvest during the past 2 years occurred during September (Table 5). During 1989, 83% of the moose were taken during September, and 78% in 1990. Opportunity to hunt was limited to September in all subunits except Subunit 6A, where the extended season allows 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, prevailed because of opportunity in the registration permit hunt in Subunit 6B. The use of highway vehicles remained low because opportunity to hunt is limited by permits in road-accessible areas.

Other Mortality: Two cow mortalities were documented during spring 1991 in Subunit 6C. One cow died of unknown causes, and the other was probably killed by a brown bear (Tom Stephenson, pers. comm.). The animals were radio-collared as part of an on-going USFS study of movements and habitat use.

CONCLUSIONS AND RECOMMENDATIONS

Management objectives for moose were achieved in most of Unit 6. Moose densities were stable near the desired 1.8 to 2.0 moose/mi^2 in all subunits except Subunit 6A East and Subunit 6D. In Subunit 6A East, moose density may approach 3.5 moose/mi^2, which could exceed habitat carrying capacity and damage the winter range. In Subunit 6D, moose density is low because of very limited habitat.

Success in achieving desired bull:cow ratios was difficult to evaluate because survey timing seldom allowed collection of ratio data. However, limited data indicated the objective of 30:100 was achieved in Subunits 6B and 6C.

The harvest strategy was effective in most subunits and should be continued. The exception was Subunit 6A East where desired harvests were not achieved. The liberal season should be continued there and the ADF&G should direct hunters there whenever possible. That direction should include special articles in hunting issues of the ADF&G magazine and public information given to hunters who inquire about hunting opportunity.

Population objectives for Unit 6 need to be revised. Density levels need to be reevaluated and specific values established for each subunit. This is particularly true for Subunits 6B and 6C where significant new information about carrying capacity of the range is expected from studies being completed by the USFS and where demands on the moose population are increasing. Objectives for bull:cow ratios should be deleted because of the difficulty in obtaining reliable estimates.

Moose aerial survey methods should be changed to improve the reliability of population estimates. Methods used in the past were appropriate, but they are not adequate to meet future needs. Aerial search intensity should be increased to at least 4 minutes/mi^2, confidence intervals need to be calculated for estimates, a reliable sightability correction factor needs to be applied, and methods should be strictly repeatable. These improvements can be achieved through application of methods developed by Gasaway et al. (1986). Improved moose survey methods will be particularly important in Subunits 6B and 6C where the most intensive management schemes are being applied.

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Table 1. Unit 6 fall/winter moose composition counts and estimated population size, 1986-91.

Subunit	Regulatory year	Calves (%)	Adults	Total Moose Observed	Moose /hour	Density	Estimated Population size
6A East	1986/87	--	--	--	--	--	--
	1987/88	19	244	302	97	2.8	420-510
	1988/89	20	294	369	92	3.5	465-515
	1989/90	--	--	--	--	--	--
	1990/91	--	--	--	--	--	480-575[b]
6A West	1986/87	28	183	254	71	1.4	--
	1987/88	19	172	213	45	1.1	300-360
	1988/89	22	293	375	75	2.1	440-480
	1989/90	--	--	--	--	--	--
	1990/91	18	236	286	59	1.4	345-400
6A Total	1986/87	28	183	254	71	1.4	--
	1987/88	19	416	515	66	1.8	720-870
	1988/89	21	603	767	81	2.6	905-995
	1989/90	--	--	--	--	--	--
	1990/91	--	--	--	--	--	825-975
6B	1986/87	13	132	152	39	1.0	--
	1987/88	12	205	234	50	1.3	260-290
	1988/89	22	229	296	76	1.7	310-345
	1989/90	13	245	283	63	1.5	311-340
	1990/91	18	250	305	67	1.7	335-365

Table 1. (cont'd.)

Subunit	Regulatory year	Calves (%)	Adults	Total Moose Observed	Moose /hour	Density	Estimated Population size
6C	1986/87	--	--	--	--	--	--
	1987/88	13	103	118	36	1.0	200-235
	1988/89	21	182	231	57	1.6	255-280
	1989/90	12	226	258	55	1.8	285-310
	1990/91	15	156	183	34	1.3	255-310
6D	--	--	--	--	--	--	--[a]
Total	1986/87	22		406	54	1.2	--
	1987/88	16		867	55	1.5	1,195-1,425
	1988/89	22		1,294	74	2.1	1,490-1,650
	1989/90	13		541	59	1.6	--
	1990/91	17		774	52	1.5	1,440-1,685

[a] Subunit 6D population estimated at 15-30 during 1987/88, 20-30 during 1988/89 and 25-35 during 1990/91.

[b] Not surveyed

Table 2. Unit 6 moose harvest and accidental death, 1986-91.

		Hunter Harvest							
		Reported			Estimated				
Subunit	Regulatory year	M (%)	F (%)	Total[a]	Unreported	Illegal	Total	Accidental Death	Total
6A East	1986/87	22 (63)	13 (37)	35	4	3	7	0	42
	1987/88	25 (64)	14 (36)	39	6	3	9	0	48
	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	20 (83)	4 (17)	24	5	2	7	0	31
6A West	1986/87	33 (49)	34 (51)	67	6	2	8	0	75
	1987/88	28 (67)	14 (33)	42	7	1	8	0	50
	1988/89	19 (49)	20 (51)	39	3	1	4	0	43
	1989/90	19 (90)	2 (10)	21	2	1	3	0	24
	1990/91	36 (67)	18 (33)	55	4	2	6	0	61
6A Total	1986/87	55 (54)	47 (46)	102	10	5	15	0	117
	1987/88	53 (65)	28 (35)	81	13	4	17	0	98
	1988/89	37 (57)	28 (43)	65	13	5	18	0	83
	1989/90	37 (86)	6 (14)	43	7	4	11	0	54
	1990/91	57[a](72)	22 (28)	80	9	4	13	0	93
6B	1986/87	9 (100)	0 (0)	9	0	1	1	0	10
	1987/88	9 (100)	0 (0)	9	0	0	0	0	9
	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
6C	1986/87	21 (57)	16 (43)	37	0	1	1	0	38
	1987/88	14 (56)	11 (44)	25	0	2	2	1	28

Table 2. (Cont'd.)

Subunit	Regulatory year	Hunter Harvest: Reported M (%)	Reported F (%)	Reported Total[a]	Estimated Unreported	Estimated Illegal	Estimated Total	Accidental Death	Total
	1988/89	9 (100)	0 (0)	9	0	2	2	2	13
	1989/90	16 (50)	16 (50)	32	0	1	1	0	33
	1990/91	18 (58)	13 (42)	31	0	2	2	0	33
6D	1986/87	0 (0)	0 (0)	0	0	0	0	0	0
	1987/88	2 (100)	0 (0)	2	0	2	2	0	4
	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
Total	1986/87	85 (57)	63 (43)	148	10	7	17	0	165
	1987/88	78 (67)	39 (33)	117	13	8	21	1	139
	1988/89	71 (66)	36 (34)	107	14	9	23	2	132
	1989/90	86 (73)	32 (27)	118	7	6	13	0	131
	1990/91	105 (67)	52 (33)	158	9	7	16	0	174

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

Table 3. Unit 6 moose harvest data by permit hunt, 1986-91.

Subunit/ Hunt No.	Regulatory Year	Legal moose	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls(%)	Cows(%)	Total Harvest
6A West 965	1988/89	Either sex	R-123	51	17	32	19 (49)	20 (51)	39
6B/966	1986/87	Bull	D-15	0	40	60	9 (100)	0 (0)	9
	1987/88	Bull	D-15	20	20	60	9 (100)	0 (0)	9
	1988/89	Antlerless	D-10	0	10	90	1 (11)	8 (89)	9
	1989/90	Antlerless	D-30	10	57	33	0 (0)	10 (100)	10
	1990/91	Antlerless	D-30	3	40	57	0 (0)	17 (100)	17
6B/964	1988/89	Antlered	R-163	36	51	13	21 (100)	0 (0)	21
	1989/90	Antlered	R-211	27	57	15	31 (100)	0 (0)	31
	1990/91	Bull	R-179	25	59	17	30 (100)	0 (0)	30
6C/967	1986/87	Bull	D-20	0	0	100	20 (100)	0 (0)	20
	1987/88	Bull	D-15	7	7	87	13 (100)	0 (0)	13
	1988/89	Bull	D-10	10	0	90	9 (100)	0 (0)	9
	1989/90	Antlered	D-20	10	10	80	16 (100)	0 (0)	16
	1990/91	Antlered	D-20	10	0	90	18 (100)	0 (0)	18
6C/968	1986/87	Cow	D-20	10	5	85	1 (6)	16 (94)	17
	1987/88	Cow	D-15	7	13	80	1 (8)	11 (92)	12
	1988/89	Cow	D-0	--	--	--	--	--	--
	1989/90	Antlerless	D-20	20	0	80	0 (0)	16 (100)	16
	1990/91	Antlerless	D-20	10	25	65	0 (0)	13 (100)	13

Table 4. Unit 6 moose hunter residency and success, 1986-91.

		Successful				Unsuccessful				
Subunit	Regulatory Year	Local[a] resident	Nonlocal resident	Nonresident	Total(%)[b]	Local[a] resident	Nonlocal resident	Nonresident	Total(%)[b]	Total hunters
6A East	1986/87	9	12	10	34 (67)	--	--	2	17 (33)	51
	1987/88	6	12	21	39 (66)	4	9	7	20 (34)	59
	1988/89	4	8	10	26 (48)	4	13	11	28 (52)	54
	1989/90	1	8	3	22 (59)	1	10	4	15 (41)	37
	1990/91	1	5	18	24 (60)	3	11	2	16 (40)	40
6A West	1986/87	53	4	6	66 (73)	--	--	6	25 (27)	91
	1987/88	30	6	6	42 (64)	10	9	5	24 (36)	66
	1988/89	27	6	6	39 (60)	12	9	4	26 (40)	65
	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
6A Total	1986/87	62	16	16	100 (71)	--	--	8	42 (30)	142
	1987/88	36	18	27	81 (65)	14	18	12	44 (35)	125
	1988/89	31	14	16	65 (55)	16	18	15	54 (45)	119
	1989/90	7	8	14	43 (62)	6	21	5	26 (38)	69
	1990/91	32	16	32	80 (63)	16	21	9	46 (37)	126
6B	1986/87	9	0	--[c]	9 (60)	--	--	--[c]	6 (40)	15
	1987/88	7	2	--[c]	9 (75)	2	1	--[c]	3 (25)	12
	1988/89	28	2	--[c]	30 (26)	77	6	--[c]	84 (74)	114
	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
6C	1986/87	34	3	--[c]	37 (97)	--	--	--[c]	1 (3)	38
	1987/88	24	1	--[c]	25 (89)	3	0	--[c]	3 (11)	28
	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

Table 4. (Cont'd.)

Subunit	Regulatory Year	Successful: Local[a] resident	Successful: Nonlocal resident	Successful: Nonresident	Successful: Total(%)[b]	Unsuccessful: Local[a] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Total(%)[b]	Total hunters
6D	1986/87	0	0	0	0 (0)	--	--	0	11 (100)	11
	1987/88	1	0	0	2 (15)	5	5	1	11 (85)	13
	1988/89	3	0	0	3 (15)	10	5	0	17 (85)	20
	1989/90	1	1	0	2 (11)	9	6	1	16 (89)	18
	1990/91	0	0	0	0 (0)	7	1	0	8 (100)	8
Total	1986/87	105	19	16	146 (71)	--	--	8	60 (29)	206
	1987/88	68	21	27	117 (66)	24	24	12	61 (34)	178
	1988/89	70	17	16	107 (41)	95	29	15	155 (59)	262
	1989/90	76	14	14	118 (39)	142	35	7	184 (61)	302
	1990/91	104	22	32	158 (47)	129	38	9	176 (53)	334

[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, 1986-90.

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	1986/87	3	37	34	9	11	6	0	35
	1987/88	10	15	13	26	15	13	8	39
	1988/89	8	17	0	4	50	13	8	24
	1989/90	--	19	38	10	14	19	0	21
	1990/91	0	17	38	17	21	8	0	24
6A West	1986/87	2	30	38	11	14	6	0	64
	1987/88	--	35	28	35	3	--	--	40
	1988/89	--	8	74	13	0	5	0	39
	1989/90	--	43	24	24	10	0	0	21
	1990/91	0	26	35	24	6	4	6	54
6A Total	1986/87	2	32	36	10	13	6	0	99
	1987/88	5	25	20	30	9	6	4	79
	1988/89	3	11	46	10	19	8	3	63
	1989/90	--	31	31	17	12	10	0	42
	1990/91	0	24	35	22	10	5	4	79
6B	1986/87	--	78	22	--	--	--	--	9
	1987/88	--	67	33	--	--	--	--	9
	1988/89	--	83	17	--	--	--	--	30
	1989/90	--	98	2	--	--	--	--	41
	1990/91	--	77	21	2	--	--	--	47
6C	1986/87	--	59	41	--	--	--	--	37
	1987/88	--	64	36	--	--	--	--	25

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
6C	1988/89	--	67	33	--	--	--	--	9
	1989/90	--	63	34	3	--	--	--	32
	1990/91	--	52	45	3	--	--	--	31
6D	1986/87	--	0	0	--	--	--	--	0
	1987/88	--	50	50	--	--	--	--	2
	1988/89	--	33	67	--	--	--	--	3
	1989/90	--	0	100	--	--	--	--	2
	1990/91	--	0	0	--	--	--	--	0
Total	1986/87	1	42	37	7	9	4	0	145
	1987/88	3	37	25	21	6	4	3	115
	1988/89	2	37	37	6	11	5	2	105
	1989/90	--	62	21	9	4	3	0	117
	1990/91	0	45	33	12	5	3	2	157

Table 6. Unit 6 moose harvest percent by transport method, 1986-91.

Subunit	Regulatory Year	Airplane	Boat	3- or 4-wheeler	ORV	Highway vehicle	n
6A East	1986/87	62	15	15	3	6	34
	1987/88	76	5	18	0	0	38
	1988/89	78	9	9	0	4	23
	1989/90	72	11	17	0	0	18
	1990/91	92	0	8	0	0	24
6A West	1986/87	28	65	3	3	0	60
	1987/88	36	62	0	3	0	39
	1988/89	36	56	8	0	0	39
	1989/90	62	29	0	10	0	21
	1990/91	55	45	0	0	0	53
6A Total	1986/87	40	47	7	3	2	94
	1987/88	56	34	9	1	0	77
	1988/89	52	39	8	0	2	62
	1989/90	67	21	8	5	0	39
	1990/91	66	31	3	0	0	77
6B	1986/87	0	89	0	0	11	9
	1987/88	11	78	0	0	11	9
	1988/89	5	81	0	0	14	21
	1989/90	10	76	0	0	15	41
	1990/91	11	76	2	0	11	45
6C	1986/87	3	21	3	0	74	38
	1987/88	0	44	0	4	52	25
	1988/89	0	44	0	0	56	9
	1989/90	0	53	0	0	47	32
	1990/91	0	39	0	3	58	31

Table 6. (Con't.)

Subunit	Regulatory Year	Airplane	Boat	3- or 4-wheeler	ORV	Highway vehicle	n
6D	1986/87	0	0	0	0	0	0
	1987/88	100	0	0	0	0	2
	1988/89	33	33	0	0	33	3
	1989/90	50	0	50	0	0	2
	1990/91	0	0	0	0	0	0
Total	1986/87	28	43	6	2	22	141
	1987/88	41	39	6	2	12	113
	1988/89	36	48	5	0	11	95
	1989/90	27	49	4	2	18	114
	1990/91	37	46	2	1	15	153

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 several severe winters. The population has fluctuated at low levels since then as forest habitats matured and wolf density increased. Since 1980, bark beetles have killed 36,000 acres of spruce forest. Another 9,000 acres of forests and shrublands within the Chugach National Forest have been enhanced for moose using controlled burning (Dan Logan/USFS, pers. comm.). Reduction of old-growth forests was beneficial to the moose population by enhancing the nutritional quality and availability of winter food plants.

MANAGEMENT DIRECTION

Management Objective

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

METHODS

Aerial surveys were conducted in November and December of both years in selected trend count areas to determine sex and age composition of the population. Annual moose harvest data were collected through the statewide harvest report system. A moose census has not been conducted in Unit 7. Terrain features and mature spruce forest prevented application of the technique described by Gasaway et al. (1986).

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: Census data was unavailable for Unit 7. Harvest trend and results from aerial surveys conducted to determine herd composition suggested that the moose population has remained stable since the mid-1980s. Winters have been normal and hunting opportunities remained unchanged. I believe the moose population has remained stable at approximately 1,000 animals. The severe winter of 1989/90, that reduced moose survival in adjoining Subunit 15A, did not extend into Unit 7.

Population Composition: Five of 32 count areas in the unit, excluding the Portage and Placer river drainages, were surveyed during 1990 fall sex and age composition surveys. Three hundred fifty-five moose were classified with ratios of 22 calves:100 cows and 39 bulls:100 cows. Three of these count areas were also surveyed in 1989, resulting in 28 calves:100 cows and 39 bulls:100 cows. Yearling bulls:100 cows remained the same both years at 13:100 while calves declined from 17% in 1989 to 14% in 1990 (Table 1).

Mortality

Harvest:

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

Board of Game Action and Emergency Orders. No Board action was taken during this report period. The most recent regulatory change was taken in 1987 with introduction of the spike-fork/50 inch bag limit and a 1-20 September season.

Hunter Harvest. In September 1990, 69 bull moose were harvested by 454 hunters during the general season (Table 2). Unit 7 harvest and hunter effort has increased each year since 1987, when the selective harvest program began. Twenty-nine (42%) hunters reported taking spike/fork bulls (less than 35 in) compared to 40 (58%) hunters who harvested bulls with an antler spread of at least 50 in or having 3 brow tines on at least 1 antler. Twenty-eight (41%) harvested bulls had antler spreads of 50 inches or larger. Successful hunters averaged 5.5 days hunting, the same as all hunters combined.

Permit Hunts. Permit hunt results for Unit 7 were included in the management report for Subunit 14C. Harvest data for the remainder of Unit 7 were included in this report.

Hunter Residency and Success. Hunter success was 15%. Twenty-three (33%) successful hunters were unit residents, 40 (58%) were nonunit residents and 6 (9%) were nonresidents (Table 3). Residences reported for unsuccessful hunters were: unit residents, 175; nonunit residents, 194; nonresidents, 8; and unspecified residency, 8.

Harvest Chronology. The 1-20 September season has existed since 1987 as a general hunt in portions of Unit 7. Harvest chronology suggests that the highest percentage of hunting occurred during the first 5 days of the season (Table 4). In 1988 and 1990 the second highest percentage of harvest occurred during the third 5-day period, suggesting a trend of beginning hunts either the first or second 10 days of the season.

Transport Methods. In 1990, 41% (n=28 of 69) successful and 67% (n=257 of 385) unsuccessful hunters reported highway vehicles as their means of transportation (Table 5). The second most common transportation means for successful hunters were horses (23%), and for unsuccessful hunters, boats (10%). Hunters using either aircraft or ATVs accounted for 16% of the reported harvest and 11% of all hunters. The 1989 transportation results were similar with 38% (n=22 of 58) using highway vehicles.

Other Mortality: At least 34 moose were killed in Unit 7 by motor vehicles (25) or trains (9). Approximately 75% of these animals were salvaged for human use. Crippling loss by hunters is unknown but is believed to be less than 10% of the reported harvest.

The impact of predation by wolves and bears is unknown. There are about 50 wolves in the unit, a predator-prey ratio of about 1 wolf:20 moose. If this ratio truly exists the impact of wolf predation alone should prevent the moose population from increasing. Black bear are abundant throughout the unit and brown bear are common in all drainages supporting salmon. These ursids exert additional predation pressure on moose in Unit 7.

Habitat Assessment

Moose habitat in Unit 7 remained relatively stable because of lack of large wildfires or other enhancement efforts. However, reduction of some old-growth forest from spruce bark beetle infestations and prescribed burning by the USFS will probably benefit moose. These enhanced areas (70 mi^2) comprise only 2% of the 3,520 mi^2 in Unit 7.

CONCLUSIONS AND RECOMMENDATIONS

Winter conditions in Unit 7 during 1989/90 and 1990/91 were moderate. Overwinter survival was probably normal. Human-caused moose mortality, including 34 road or train kills and 69 harvested, represented 10% of the estimated moose population of 1,000. The harvest has increased steadily since the decline to 36 bulls in 1987 when the selective harvesting began. The 1990 harvest was exceeded only once since 1980 and that was in 1984 when 75 bulls were harvested. The bull:cow ratio has exceeded the management objective since 1987. Unit 7 season length or bag limit should not be altered until similar changes are recommended for Unit 15. If sex ratios continue to improve in Unit 15, a proposal to increase season length in both units may be presented in spring 1993.

LITERATURE CITED

Gasaway, W. C., S. D. Dubois, D. J. Reed and S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biological Papers of the Univ. of Alaska, Inst. Arctic Biology, No. 22. 108pp.

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Table 1. Unit 7 fall aerial moose composition counts and estimated population size, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1986/87[a]								
1987/88	29	10	33	20	208	267	61	1,000
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

[a] No data available.

Table 2. Unit 7 moose harvest[a] and accidental death, 1986-91.

	Hunter Harvest										
Regulatory	Reported				Estimated			Accidental death			Grand
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	total
1986/87	58	0	0	58			20	7	--	7	85
1987/88	36	0	0	36			20	6	--	6	62
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

[a] Excludes permit hunt harvest.
[b] Total includes unreported sex.

Table 3. Unit 7 moose hunter[a] residency and success, 1986-91.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total[c] (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	
1986/87	20	34	3	58	208	136	3	351	409
1987/88	17	16	3	36	153	98	4	259	295
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

[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, 1986-91.

Regulatory year	Harvest periods					n
	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	
1986/87[b]	62	33	--	--	5	58
1987/88	39	17	17	17	11	36
1988/89	42	12	24	20	2	50
1989/90	39	12	15	29	5	59
1990/91	33	13	29	19	6	69

[a] Excludes permit hunt harvest.
[b] 1986 season 1-10 September; 1-20 September season started in 1987.

Table 5. Unit 7 moose harvest[a] percent by transport method, 1986-1991.

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1986/87	9	17	16	0	0	0	55	3	58
1987/88	8	33	3	0	0	0	5	6	36
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

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit: 9 (33,600 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 have been 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 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 improved (ADF&G files). Brown bear predation on neonatal moose was the primary limiting factor of moose in Unit 9.

MANAGEMENT DIRECTION

Population Objectives

Population objectives for moose in Unit 9 are to: 1) maintain existing densities in areas with moderate (0.5-1.5 moose/mi^2) or high (1.5-2.5 moose/mi^2) densities; 2) increase low-density populations (where habitat conditions are not limiting) to 0.5 moose/mi^2 by 1995; and 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. We monitored harvests within the Naknek River drainage registration permit hunt held in December.

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 that moose populations in most of Unit 9 have stabilized or were declining at a much slower rate than had occurred earlier (i.e., 15-20 years ago). Within Subunit 9C there was a shift in winter moose distribution from the northern portion on the Naknek River drainage northward into the Branch River. Very low moose densities and unreliable snow conditions in Subunit 9A precluded efficient surveys for monitoring trends in population size or composition. Although no recent surveys have been specifically directed toward moose in Subunit 9D, incidental observations south of Port Moller showed no 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. = ± 16%) in the 1,314 mi^2 study area. Extrapolation of this census to the remainder of Subunit 9E provided a rough estimate of 2,500 moose. The area of Subunit 9C outside of Katmai National Park had 500-600 moose. There were approximately 2,000 moose in Subunit 9B. Subunits 9A and 9D probably contained less than 300 and 50 moose, respectively.

Population Composition: Table 1 provides a summary of sex and age composition data since 1986. Bull:cow ratios apparently stabilized at acceptable levels in all areas surveyed. Calf:cow ratios remained low, particularly in 1989.

Mortality

Harvest:

Seasons and Bag Limit. During 1989 in Subunit 9A, subsistence hunters (local rural residents) could hunt from 5-20 September, and the open season for all other hunters was 10-20 September. The bag limit was 1 bull for all hunters. The open season for nonresident hunters in Subunit 9B was 10-20 September and the bag limit was 1 bull. In Subunit 9B, the open season for subsistence and resident hunters was 5-20 September and 10-20 September, respectively, and 1-31 December. The subsistence and resident bag limit was 1 bull; however, antlerless moose were also legal in the Lake Clark drainages from 16-31 December. The open seasons for subsistence hunters in Subunit 9C, Naknek River drainage, were 5-20 September and 1-31 December. The open season for resident and nonresident hunters there was 10-20 September. The bag limit for the Naknek River drainage was 1 bull; however, antlerless moose could be taken in December by subsistence hunters with a registration permit only. The open seasons for subsistence, resident, and nonresident hunters in the remainder of Subunit 9C were 5-20 September and 1-31 December, 10-20 September and 1-31 December, and 10-20 September, respectively. The bag limit for subsistence and resident hunters in the remainder of

Subunit 9C was 1 moose; however, antlerless moose could be taken only in December. Nonresident hunters were limited to 1 bull. There was no open season in Subunit 9D. The open seasons for subsistence hunters in Subunit 9E were 10-20 September and 1-15 December; the season for resident and nonresident hunters was 10-20 September. The bag limit was 1 antlered moose; 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.

During 1990 in Subunit 9A the open season for all hunters was 1-15 September, and the bag limit was 1 bull. In Subunit 9B, the season was open to all hunters from 1-15 September and also to all Alaska residents from 1-31 December. The bag limit for all hunters was 1 bull. In Subunit 9C, the season was open, with a 1 bull bag limit, to all hunters from 5-15 September. The season was also open, with a 1 moose bag limit, to all Alaska residents from 1-31 December, however, within the Naknek River drainage a registration permit was required for the December season. We issued an emergency order in late November closing the area north of the Naknek River to the taking of antlerless moose because an aerial survey revealed fewer moose in the King Salmon-Pauls Creek area. There was no open season in Subunit 9D. In Subunit 9E, the season was open to all hunters from 5-15 September; and was also open to all Alaska residents from 1-15 December. The bag limit in Subunit 9E was 1 bull; however, moose taken from 5-15 September had to have at least 50 inch antlers.

Board of Game Actions and Emergency Orders. Survey results in 1989 showed the Lake Clark portion of Subunit 9B no longer had significantly higher calf:cow ratios than the rest of the unit. This decline in calf recruitment prompted ADF&G to withdraw support for continued antlerless moose hunting in this area. Two rulings by the State Supreme Court (one on exclusive guide areas and one on the rural priority for subsistence) caused the Board of Game to make several adjustments in the fall hunting seasons (as described above). Both rulings had the potential of increasing hunting pressure in Unit 9. To reduce the risk of overharvest the Board moved the fall season dates ahead. The effectiveness of these changes was unknown, as hunter effort and success did not change significantly. Nevertheless, local hunters preferred the earlier dates and the harvest has remained stable at the desired level.

Hunter Harvest. During 1989 hunters reported killing 235 moose, including 10 cows and 226 bulls. In 1990 the reported harvest was 254, including 6 cows and 248 bulls (Table 2). The Unit 9 moose harvests have been relatively stable from 1988-90, after a substantial drop from the 1987 harvest. We estimated the unreported subsistence harvest in Unit 9 at slightly over 100 moose per year.

Permit Hunts. Board action in 1987 restricted the December Naknek River drainage registration hunt, Number 972, to subsistence users only. The level of participation and harvest in 1989 was average (Table 3). Two major events altered the results of this hunt in 1990. First, the state supreme court ruling on rural residency resulted in this hunt being open to all Alaska residents. This action increased the number of permits issued by 35%.

Secondly, there was a shift of moose distribution from the upper King Salmon Creek-Pauls Creek area into the Branch River drainage. The cause of this movement, which apparently affected over one-half the moose present, was speculative. However, the shift coincided with a significant increase in the number of caribou and caribou hunters (using ATVs and snowmobiles) in the area. As a result of this redistribution, an emergency order closed the area north of the Naknek River to the taking of cows. Consequently the 1990 harvest consisted of more bulls and fewer cows than normal.

Hunter Residency and Success. The number of nonresident hunters tripled from 1983 to 1987, while the number of nonlocal residents remained relatively stable until 1989 when the number dropped by about 30% (Table 4). The number of local hunters has remained stable; however, some subsistence hunters did not get moose harvest tickets and consequently were not represented in the local resident category. Since 1986 the success rates have been stable, with nonresidents having higher success (52%, range 49-60%) than either residents of Unit 9 (35%, range 32-39%) or other Alaska residents (36%, range 32-40%). These success rates were substantially below the average success rate (74%) for all hunters reported from 1967 to 1973.

Harvest Chronology. The 1988 fall season was reduced for all hunters because of increased harvest and dropping bull:cow ratios in Subunit 9B. Only subsistence hunters could participate from 5-9 September, and all moose hunting ended on 20 September. The shortened season and the new legislative restrictions on "outfitters" effectively reduced the bull harvest, compared with that for the previous year (Table 2). Several subsequent adjustments to season dates within Unit 9 have shifted the chronology of the harvest to earlier in September. 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. Despite heavy snowcover in Subunits 9B and 9C during 1989-90, winter mortality appeared insignificant, and the calf cow ratios within the Naknek River drainage did not reflect any suppression of calf production.

CONCLUSIONS AND RECOMMENDATIONS

Hunting regulations have been restricted in all subunits, except the Branch River drainage in Subunit 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 three subunits to maintain bull:cow ratios at prescribed levels. Harvests have been relatively stable since 1988.

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 survivals. ADF&G has placed a priority on managing bears in Unit 9, and any drastic reduction in 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, 1986-90.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1986/87	34	5	27	17	432	518	64	1,000
1987/88	36	8	18	12	577	653	62	1,000
1988/89	38	6	32	19	555	684	66	1,000
1989/90	35	8	13	9	721	792	68	1,000
1990/91	36	9	25	15	232	274	39	1,000

Table 2. Unit 9 moose harvest[a] and accidental death, 1986-90.

Regulatory year	Hunter Harvest										Grand total
	Reported				Estimated			Accidental death			
	M	F	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	
1986/87	222	13	4	239	--	--	100	--	--	--	339
1987/88	285	15	0	300	--	--	100	--	--	--	400
1988/89	217	16	0	233	--	--	100	--	--	--	333
1989/90	226	10	3	239	--	--	100	--	--	--	339
1990/91	248	6	0	254	--	--	100	--	--	--	354

[a] Includes permit hunt harvest.

Table 3. Subunit 9C 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
972	1986/87	78	23	78	22	23	77	0	13
	1987/88	61	16	69	31	50	50	0	16
	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

Table 4. Unit 9 moose hunter[a] residency and success, 1986-90.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	
1986/87	39	74	112	239 (44)	80	116	104	308 (56)	547
1987/88	47	89	152	300 (47)	97	135	102	345 (53)	645
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

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

Table 5. Unit 9 moose harvest[a] chronology percent by time period, 1986-90.

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	12/10-12/31	n
1986/87	0	14	32	29	13	6	5	239
1987/88	0	12	35	33	9	2	9	300
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

[a] Excludes permit hunt harvest.

Table 6. Unit 9 moose harvest[a] percent by transport method, 1986-1990.

Regulatory year	Percent of harvest Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	n
1986/87	70	--	17	7	1	2	3	239
1987/88	70	--	15	6	6	0	2	300
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

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit: 11 (12,782 mi^2)

Geographical Description: Chitina Valley and eastern Copper River Basin

BACKGROUND

Moose numbers in Unit 11 were considered low from the early 1900s until the 1940s. Moose populations increased during the 1950s and peaked in the early 1960s. When moose were abundant, between 85 and 120 moose/hour were observed during fall composition counts. The moose population declined from the late 1960s until 1979, when the population reached its lowest and only 12 moose/hour were observed during fall counts. Moose numbers stabilized and began to increase in Unit 11 during the early to mid-1980s. Moose numbers peaked again in 1987, when 55 moose/hour were observed.

Moose harvests in Unit 11 averaged 164 (123-242) per year from 1963 until 1974. Either sex bag limits were in effect until 1974, and up to 40% of the harvest was cows. During this period, hunting seasons were long, and they were split to provide for fall and winter hunting. The moose harvest, number of hunters, and hunter success rate, peaked in the early 1970s. In response to declining moose numbers, the 1974 fall moose season was shortened, the winter season was closed, and cow harvests were prohibited. Harvests have averaged 45 bulls per year since the current seasons were established in 1975.

Most of Unit 11 was included in Wrangell-St. 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 (ANILCA).

MANAGEMENT DIRECTION

Management Objective

The moose management objective for Unit 11 is to maintain 1987-88 population levels with a posthunting sex ratio of no less than 15 adult bulls:100 cows.

METHODS

We conducted an aerial survey during late fall to determine sex and age composition and population trends in a count area on the western slopes of Mount Drum. National Park personnel flew additional surveys in 1991. We monitored harvests and hunting pressure through a harvest ticket reporting system. The average reported antler spread in the harvest was also monitored. Predation and overwinter mortalities were monitored in the field when possible and by reports from hunters and trappers.

Plant growth, composition, and utilization were monitored periodically in a large burn with the highest moose population in the unit. Other methods of addressing moose habitat issues included monitoring land use patterns and evaluating and responding to proposals affecting moose habitat.

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, stabilized for 3 years (1988-90), then declined (Table 1). The moose/hour figure decreased from 51 in 1990 to 29 in 1991. We assumed that the observed decrease in moose/hour represents a decline in the number of moose in CA 11. However, movements could also account for the decline and additional data will be necessary to evaluate population changes. Moose counts were conducted by personnel of the National Park Service (NPS) on two old ADF&G count units in Unit 11 for the first time since 1974. Moose per hour figures for the NPS count areas were similar to CA-11, averaging 35 moose/hour. Because these were the first counts in 17 years on these areas, one located in northern Unit 11 and in the lower Chitina Valley, trends of moose numbers were not determined. Moose/hour figures in these areas were higher than observed in 1974 when ADF&G personnel conducted the surveys.

Population Size: A population estimate is not available for Unit 11 because a moose census was never conducted. Moose numbers observed during fall composition counts in CA 11 yielded a density estimate of 0.4 moose/mi^2 in 1991, a 43% decline from the 0.7 moose/mi^2 observed in 1990. Density estimates of from 0.1 to 0.4 moose/mi^2 were obtained in 1986 during late winter stratification surveys in which 20% of the estimated 5,200 mi^2 of moose habitat in the unit was surveyed. The lowest estimated moose densities were south of the Chitina River Valley, while the highest were in CA 11. If actual moose densities this year approached the estimates obtained during the 1986 stratification flights, the unit moose population is between 2,000 and 3,000 animals.

Population Composition: A bull:cow ratio of 91:100 was observed in CA 11 in 1991, up from the previous year's ratio of 63 bulls:100 cows (Table 1). Although the bull:cow ratio increased, the total number of bulls observed declined (35%) from 77 to 50 bulls. Numbers of cows observed declined to an even greater extent (55%). Movement, natural mortality, and lack of recruitment are causes of the observed decline. Few bulls and no cows were taken by hunters in this portion of Unit 11. The total number of bulls counted in 1991 is similar to the number observed during the early 1980s. We observed 86 adult bulls:100 cows, and 5 yearling bulls:100 cows. This adult bull:cow ratio exceeds the management goal of maintaining no less than 15 adult bulls:100 cows. The bull:cow ratio in northern Unit 11 was 40 bulls:100 cows; with 56 bulls:100 cows along the Chitina Valley. Both areas had increased bull:cow ratios from surveys in 1974 (34:100 and 30:100, respectively).

The observed calf:cow ratio in CA 11 was 18:100 in 1991. This was lower than 1988 (22:100), but above the 1990 ratio of 8:100. Calf production declined in CA 11 from 25 calves:100 cows observed between 1981 and 1986 to an average of 17:100. Calf production or survival was low in northern Unit 11 where 15 calves:100 cows were observed, but higher along the Chitina River, where 24 calves:100 cows were tallied.

Distribution and Movements: Data from past fall composition and winter stratification surveys, field observations, and reports from the public suggest that the greatest concentration of moose in Unit 11 occurs along the slopes of Mounts Sanford, Drum and Wrangell. Portions of Unit 11, south of the Chitina River, appear to have the lowest moose density, and the upper reaches of the Copper River in the northernmost portion of the unit have intermediate moose densities.

Fall rutting and postrutting concentrations occur in upland habitats as high as 4,000 ft. Migrations to lower elevations are initiated by snowfall. By late winter, moose numbers in riparian habitats along the Copper and Chitina rivers are at their highest for the year. Some moose from the western slopes of Unit 11 move west across the Copper River to winter in eastern Unit 13.

Mortality

Harvest:

Seasons and Bag Limit. Before 1990 the open season for resident and nonresident moose hunters in Unit 11 was 1-20 September with a bag limit of 1 bull. In 1990, the season was reduced to 5 days, from 5-9 September. The season remained open to nonresidents. A federal subsistence hunt for residents of Unit 11, residents of Unit 12 (along the Nabesna Road), and Unit 13(A-D) was established in 1990 on federal lands in Unit 11. The season dates were 1-20 September and the bag limit was 1 bull.

Board of Game Actions and Emergency Orders. Hunting regulations for moose in Unit 11 remained unchanged between 1975 and 1989. In 1990 a separate federal subsistence season was established because state subsistence regulations with a rural preference were declared unconstitutional by the State Supreme Court. The ANILCA requires rural preference for subsistence. Because the state was out of compliance with the act, the federal government assumed control of subsistence hunting in Wrangell-St. Elias National Park. The federal season coincided with the prior state season of 1-20 September. During 1990 the Board of Game also reduced the state moose season length from 20 to 5 days with dates from 5-9 September. This action aligned the season in Unit 11 with adjoining Unit 13. This shorter season length attempted to reduce moose harvests. Moose numbers were anticipated to have declined because of increased mortality during the severe 1989-90 winter. Snow packs reached record depths throughout southcentral Alaska that year. During the spring 1991 meeting the Board lengthened the Unit 11 moose season to 15 days from 1-15 September.

Hunter Harvest. Hunters reported killing 31 bull moose in 1990 (Table 2). This harvest was lower than the previous year (52) and the 5-year (1985-89) mean of 51 bulls. Seventeen moose were reported taken during the federal subsistence hunt for local rural residents. Only 147 hunters reported hunting in 1990, compared with 174 in 1989. Hunting pressure during the past 5 years (1985-89) has averaged 179 hunters per year. The decline in hunting pressure and harvest is attributed in part to the short season. The only time hunting pressure and harvests were comparable was 1979, when 72 hunters reported killing 21 moose. In 1979, Unit 11 was classified as a national monument and federal regulations made sport hunting there illegal.

The mean antler spread for bulls harvested during 1990 was identical to the 5-year (1985-89) mean of 44 inches. Approximately 60% of the harvest in 1990 was comprised of bulls with antler spreads of 40 inches or more. These data suggest hunting pressure in Unit 11 was not heavy enough to crop bulls before they matured and there were enough mature bulls for breeding.

Illegal and unreported harvests of bulls and cows have been documented in Unit 11 and, may sometimes 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 as a result, enforcement efforts in the area have also increased.

Hunter Residency and Success. Local residents took 53% of the moose harvest in 1990, nonlocal Alaska residents took 40%, and nonresidents took 7% (Table 3). Hunter residency in 1990 favored local, rural residents as the federal subsistence season was 15 days longer than the general state season for nonlocals and nonresidents. During the federal season and the closed state season, 42% of the 1990 harvest (13) was taken by subsistence hunters. In addition to a longer season, hunter success rates were influenced by NPS regulations allowing only local residents to hunt in those portions of the unit designated as "park." Nonlocal residents and nonresidents were excluded from much of the unit because they could hunt only on preserve lands.

The hunter success rate in 1990 was 22%, substantially lower than in 1989 (30%) and the 5-year (1985-89) mean of 29%. Successful hunters took an average of 4.8 days to kill a moose in 1990, while unsuccessful hunters averaged 5.4 days in the field. Between 1985-89, successful hunters averaged 6.6 days hunting and unsuccessful hunters averaged

6.5 days. The declines in hunting effort and success rate were attributed to the 15-day reduction of the general hunting season.

Harvest Chronology. More moose were taken during the second week of the season in 1990 than in prior years (Table 4). Hunting pressure was heavy because the state hunting season for Unit 11 was only 5 days long and fell during this week. If the state allowed increased hunting opportunity later in September, the harvest probably would increase. The federal subsistence harvest was high during the last week of the season. In previous years with a 20-day state season, the last 10 days contributed a substantial portion of the harvest. Fifty-nine percent (10) of the total 1990 federal subsistence take (17) occurred during the last 5 days of the season. Bull moose were more vulnerable the last week of the season because their movements increase as the rut approaches. Moreover, they were more visible to hunters because tree leaves have fallen by mid-September.

Transportation Methods. Transportation methods used by successful hunters were listed in Table 5. Aircraft, highway vehicles, and 3- or 4-wheelers were the most popular methods reported. Transportation methods were limited by NPS regulations. Aircraft could not be used in portions of the unit designated as park; all vehicles were restricted to existing trails unless a permit was obtained. These rules limited hunting opportunity in more remote portions of the unit.

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

Snow depths were recorded at two stations in Unit 11 throughout the winter. These stations at Dadina and Sanford Lakes were situated along the western slopes of Mounts Drum and Sanford. Snow depths from 1988 through 1991 were 133-197% greater than the 10-year average. Snow depths were high during the winters of 1989, 1990 and 1991 and resulted in winter severity classifications of "severe" for each year. Moose mortality increased during winters with prolonged deep snow. We assumed that natural mortality, especially of calves, was higher during these three winters than during the early and mid-1980s when the winters were milder.

Habitat Assessment

Fires occurred throughout much of Unit 11 before the mid-1940s, when the Bureau of Land Management instituted fire suppression activities. The beneficial effects of those early fires on moose habitat have long since passed. In the past 30 years only one fire, the Wilson Camp fire in 1981, has burned enough area (13,000 ac.) to produce a substantial amount of moose browse.

Currently, vast areas within the unit support stands of mature spruce, which are of limited value to moose. Habitat manipulation to benefit moose is not currently an option because most of the unit is included in Wrangell-St. Elias National Park and Preserve. Although NPS regulations prohibit habitat manipulation, Unit 11 is included in the Copper River Fire Management Plan, i.e., limited suppression category.

CONCLUSIONS AND RECOMMENDATIONS

Data from CA-11 along the western slopes of Mt. Drum during fall 1991 suggested a decline in moose numbers. Moose numbers appeared stable here from 1987 to 1990, after an increase in the early and mid-1980s. The reason for the decline was unknown but was perhaps because of a combination of increased winter mortality during the last three severe winters and increased predation. Conclusions about population status and trend of moose in count areas in northern Unit 11 and along the Chitina River can not be made until additional counts are completed. At this time we only have the two data points from the 1974 and 1991 counts. We can only conclude that more moose were counted in 1991 than 1974. Also, the bull:cow ratios in both CAs and the calf:cow ratio in the Chitina Valley were higher in 1991 but the calf:cow ratio in the northern area declined.

Hunting pressure and annual harvest were low. This occurred because of a 15-day reduction in the state season in 1990. Restrictive regulations by the NPS, limiting hunter participation and transportation in much of the unit, were important harvest limiters.

Current moose numbers in Unit 11 should support the level of harvest expected during a 15-day season from 1-15 September. The 1990 harvest of 31 bulls from a 5-day season was especially low. An average yearly harvest of 50 bulls was sustainable. Although the total number of bulls observed during the 1991 fall composition surveys in CA 11 decreased, the bull:cow ratio was high. The mean antler spread of bulls in the 1990 harvest was also large, indicating that most bulls were adult animals. It probably would take a substantial increase in the bull harvest to cause a decline in the bull:cow ratio. Cow hunts should be avoided because of low moose densities.

A research program should be established to investigate factors limiting moose population growth. Unit 11 could support more moose. Existing moose densities (i.e., 0.1 and 0.7 moose/mi^2) are some of the lowest currently observed in southcentral Alaska. We need to explore options available to managers to enhance the moose population consistent with NPS regulation and policy.

LITERATURE CITED

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Table 1. Count Area 11 fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calf %	Adults	Total moose	Moose /hour	Moose/mi^2
1986/87	78	12	14	7	155	167	41	0.6
1987/88	70	6	20	11	192	215	55	0.7
1988/89	56	6	22	12	170	194	52	0.7
1989/90[a]	--	--	--	--	--	--	--	--
1990/91	63	4	8	5	199	209	51	0.7
1991/92	91	5	18	9	105	115	29	0.4

[a] No survey

Table 2. Unit 11 moose harvest and accidental death, 1986-90.

Regulatory Year	Hunter Harvest							Grand total
	Reported				Estimated			
	M	F	Unk	Total[a]	Unreported	Illegal	Total	
1986/87	48	0	1	49	5	5	10	59
1987/88	58	0	0	58	5	5	10	68
1988/89	48	0	0	48	5	5	10	58
1989/90	52	0	0	52	5	5	10	62
1990/91[a]	31	0	1	32	5	5	10	42

[a] Seventeen moose reported under federal subsistence.

Table 3. Unit 11 moose hunter residency and success, 1986-91.

Regulatory Year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total(%)	Local resident	Nonlocal resident	Nonresident	Total[b]	
1986/87	20	23	2	45 (29)	69	39	1	109	154
1987/88	24	23	5	58 (32)	60	58	6	125	183
1988/89	17	23	4	48 (31)	46	54	5	109	157
1989/90	22	27	2	52 (30)	51	65	4	122	174
1990/91	16	12	2	32 (22)	63	47	4	115	147

[a] Resident of Unit 11

[b] Includes unspecified residency.

Table 4. Unit 11 moose harvest percent by time period, 1986-91.

Regulatory Year	Season dates	Week of Season				n
		1st	2nd	3rd	4th	
1986/87	1-20 Sept.	27	31	38	4	45
1987/88	1-20 Sept.	24	29	42	5	58
1988/89	1-20 Sept.	7	16	44	33	48
1989/90	1-20 Sept.	17	37	46		52
1990/91	5-9 Sept.a 1-20 Sept.b	7	48	16	29	32

[a] State hunt

[b] Federal subsistence hunt

Table 5. Unit 11 moose harvest percent by hunter transport method, 1986-90.

Regulatory Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1986/87	45	12	0	4	0	10	21	8	45
1987/88	36	10	3	5	0	16	16	4	58
1988/89	17	2	2	10	0	29	27	13	48
1989/90	33	4	2	19	0	11	27	4	52
1990/91	28	0	3	22	0	13	28	6	32

LOCATION

Game Management Unit: 12 (10,000 mi^2)

Geographical Description: Upper Tanana and White River Drainages

BACKGROUND

Moose were probably 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 also declined in surrounding areas. High predation by wolves and grizzly bears, several severe winters, and high localized antlerless moose harvests contributed to the population decline. Antlerless harvests were stopped after 1974, and the Nabesna Road moose season was closed from 1974 through 1981. In 1986, the Little Tok River drainage was closed to moose hunting because of low yearling recruitment and a deteriorating bull:cow ratio.

Wolf control in adjacent Subunits 20D (1980) and 20E (1981-83) and in extreme northern Unit 12 (1981-83) benefited moose in portions of Unit 12. Moose numbers increased rapidly in the Robertson River drainage and less dramatically in the upper Tanana River drainage as adult moose mortality was reduced and yearling recruitment increased through wolf control. Also, high wolf harvests in adjacent Unit 13 have benefited moose that annually migrate into the Tok River drainages during late fall. Moose in other portions of Unit 12 were not affected to any noticeable degree, and they continue to exist at relatively low densities. A larger, more productive moose population is needed to support moose predators and restore previous levels of human use.

MANAGEMENT DIRECTION

Management Goals

Management goals for Unit 12 are to: 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, and
- Maximum opportunities for the nonconsumptive use of moose.

Management Objectives

Management objectives for Unit 12 moose are to: 1) increase the moose population from an estimated 2,500-3,500 to 5,000-7,000 with an annual harvestable surplus of at least 3% by the year 2000; 2) increase the overall hunter success rate to at least 35% without reducing participation from current levels (400 hunters/year) by the year 2000; and 3) maintain a posthunting sex ratio of at least 40 bulls:100 cows.

Tetlin and Tok River Drainages:

- Maintain the present population of moose (1,200-1,500).
- Increase the (1) harvestable surplus to at least 3% by the year 2000, (2) proportion of males in the population to 40 bulls:100 cows by the year 2000, (3) proportion of resident moose in Unit 12 population to at least 50% by the year 2000, and (4) browse production on at least 100 acres/year for at least 10 years in known winter range in the Tetlin and Tok river drainages.

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

- Increase the (1) moose population from an estimated 400 to 800 moose by the year 2000, (2) posthunt proportion of males in the population to 40 bulls:100 cows along the north slope of the Alaska Range (bulls >5 years should compose no less than 20% of all bulls >17 months), and (3) browse production on at least 100 acres/year for at least 10 years in known winter range.

Eastern Unit 12 (Cheslina River to U.S.-Canada Border):

- Increase the (1) moose population from an estimated 1,200-1,300 to 2,200-2,500 by the year 2000 and (2) posthunt proportion of males in the upper Chisana River area to 40 bulls:100 cows and increase the proportion of bulls > 5 years in that population to at least 20% of all bulls > 17 months.

METHODS

We estimated sex and age composition in October and November using aerial-contour surveys. All moose observed were classified as either large bulls (antlers ≥ 50 inches), medium bulls (antlers larger than yearlings but < 50 inches), small bulls (spike, cerviform, or palmate-antlered yearling bulls), cows without calves, cows with one calf, cows with two calves, lone calves, or unidentified moose. We surveyed the same areas annually in a comparable manner. We estimated moose numbers in March 1989 in the main Tanana River and Tok River valleys and in October 1990 on the Tetlin National Wildlife Refuge using the population estimation (census) technique described by Gasaway et al. (1986). We determined harvest statistics through harvest reports. Overwinter browse use by moose was determined by standard ADF&G transect surveys.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: Based on data collected during annual moose contour surveys and two area-specific censuses, the moose population in Unit 12 increased from 1982 until 1989 but has either stabilized or declined slightly during the past two years (Fig. 1). Calf survival declined and moose/hour counts and yearling bull:100 cows ratio have stabilized during the past 3 years. The current population estimate in Unit 12 is 2,500-3,500 moose. The unit has about 6,000 mi^2 (15,500 km^2) of suitable moose habitat and a density of 0.42 to 0.58 moose/mi^2 (160 to 226/1,000 km^2), a low density compared with what existed in the mid-1960s and what current habitat conditions could support. I do not expect the population in Unit 12 to increase substantially from present levels because of the amount of federal and private land and associated access restrictions and predator management.

We conducted a census during March 1989 in 1,204 mi^2 of northwestern Unit 12. This supported 0.53 moose/mi^2 (253/1,000 km^2). Within the census area, we found 1.07 moose/mi^2 (462/1,000 km^2) in the Tok River drainage, but only 0.19 moose/mi^2 (100/1,000 km^2) in the Tanana Valley near Tok and Tanacross. Many moose in the Tok River drainage in March are migrants from Unit 13 and are not available to residents of Unit 12 during the hunting season. We conducted a second census on the Tetlin National Wildlife Refuge (the northeast portion of Unit 12) during fall 1990. This area supported 0.32 moose/mi^2 (124/1,000 km^2). Densities within this area ranged from 0.035 moose/mi^2 (10/1,000 km^2) in the Tanana River flats to 2.3 moose/mi^2 (888/1,000 km^2) along the north side of the Nutzotin Mountains.

Population Composition: Staff flew moose composition surveys in Unit 12 between 27 October and 18 November 1991; 1,472 moose were classified during 33.2 survey hours (44 moose/hour). The moose/hour count exceeded the 5-year average of 41 but has remained fairly consistent during the past 4 years. The bull:cow and calf:cow ratios were 49:100 and 24:100, respectively (Table 1). The bull:cow ratio is slightly lower than the 5-year mean but has been stable the last 3 years. The number of large bulls (>50 inches) has also remained stable. The calf:cow ratio was lower than the 5-year mean of 27:100. This decline has been more apparent the past 3 years. The yearling bull:cow ratio was 12:100 which approximates the 5-year mean of 13:100.

There are problems with the bull:cow ratio in portions of Unit 12. The average bull:cow ratio is 26:100 within the Robertson River, Alaska Range, Tok River, and the Dry Tok Creek count areas, substantially below the minimum objective of 40:100. Also, the age structure has problems with only 1 to 5 large bulls (> 50 inches) counted in these areas. I expect the bull:cow ratio to decline further, considering the recent decrease in yearling recruitment, unless an antler restriction is placed on the harvest.

Distribution and Movements: Moose occur throughout Unit 12 below an elevation of about 4,000 feet. The total 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 may be found 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.

Mortality

Harvest:

Season and Bag Limit.

	Resident	Nonresident
That portion lying east of the Nabesna River and south of the winter trail running southeast from Pickerel Lake to the Canadian border.	1 Sep.-30 Sep.	Sept. 1-Sept.30
Remainder of Unit 12: Resident Hunters: One bull.	1 Sep.-15 Sep.	
Nonresident Hunters: One bull with 50-inch antlers.		5 Sep.-15 Sep.

Board of Game Actions and Emergency Orders. At the March 1990 meeting, the Board of Game shortened the moose season by five days for residents and nonresidents in Unit 12 except for the area east of the Nabesna River and south of the winter trail running from Pickerel Lake to the Canadian border. The season dates became 1 September to 15 September for residents and 5 September to 15 September for nonresidents. Also, at that meeting the board reestablished land-and-shoot hunting of wolves.

During the spring 1991 meeting, the board reestablished a hunt in the 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 season dates of 1 September to 15 September for residents and 5 September to 15 September for nonresidents.

At the October 1991 meeting, the board adopted a regulation that prohibits land and shoot hunting of wolves after 1 July 1992. For statewide wolf management, the board passed a strategic wolf management plan that uses a zone system to manage the state in ways to accommodate different public demands for the use of wolves, their prey, and habitat.

Hunter Harvest. Total reported harvest in Unit 12 during the fall 1990 season was 98 moose (94 bulls and 4 unknown), exceeding the 5-year average of 88 (Table 2). The harvest was higher than expected considering the 5-day shorter season. The reason for the higher harvest was more hunters in the field, exceeding the 5-year average by 66. The success rate remained about normal.

The reported harvest represented about 3% of the population and probably had little impact. 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 may account for 15 to 20 more. The total annual human-induced harvest could be closer to 5% of the population including localized high harvest of cow moose. At this harvest level, moose populations around human settlements are kept low.

The Tanana River drainage received the greatest harvest (24 bulls), followed by the Chisana River (19), the Tok River (17), the Nabesna River (11), the White River (8), the Tetlin and Mansfield rivers (5), and the Robertson River (3). Four successful hunters did not report a specific harvest location.

Antler sizes reported for 91 bulls resulted in a mean of 46.2 inches. Mean antler size increased each of the last 3 years. Twelve bulls were considered yearlings (antlers < 30 inches), 40 were 2-4 years old (antler spread 30.0-49.9 inches), and 39 were mature bulls (antler spread > 50 inches). Antler spreads estimated for 340 bulls observed during posthunting aerial surveys and age composition was 25% yearlings, 44% 2-4 year-olds, and 31% mature bulls. Mature bulls were harvested in greater proportion than what they represent in the bull population, which indicates hunter selection.

Hunter Residency and Success. In Unit 12, local residents, nonlocal residents, and nonresidents accounted for 53%, 35%, and 7% of the moose hunters, respectively. Five percent of the hunters did not report residency. Local hunters harvested 47 (48%), nonlocals 22 (22%), and nonresidents 17 (17%) of the 98 bulls reported (Table 3).

During 1990, 429 hunters reported hunting moose in Unit 12, exceeding the 5-year average of 363. I thought the increase in hunters was because of shortening the moose season in Unit 13; however, the number of nonlocal hunters, the group that should have been displaced from Unit 13, actually was lower than the 5-year mean. Instead, the number of local hunters increased by 22% over the 5-year mean. I do not know if this increase is real or if more local hunters began complying with harvest report regulations. The overall success rate was 23%, slightly lower than the 5-year mean of 24%.

Harvest Chronology. Twenty-five moose were taken during the week ending 7 September; 45 the week ending 14 September; 10 the week ending 21 September; and 6 the week ending 29 September (Table 4). Hunters harvested 8 bulls before 1 September. Harvest date was unknown for four bulls. Harvest timing was different in 1990 compared with the past five years, reflecting the change in season dates.

Transport Methods. Highway vehicles were used by many hunters (39%), followed by boats (17%), airplanes and 3- or 4-wheelers (10%), horses (6%), and other ORVs (6%). Transport method was unknown for 47 hunters. Most moose were harvested by hunters using highway vehicles (25%), but their overall success rate was the lowest (14%) of all the transport methods (Table 5). Boats were used by 23% of the successful hunters, exceeding the 5-year average of 14%. Boats have not been an efficient transport means for hunting moose in Unit 12 because of crowded hunting conditions along major rivers. Hunters using horses had a 58% success rate and aircraft users had a 38% success rate.

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-1960s. In contrast to other areas that contain sympatric moose, wolf, and grizzly bear populations, research found that wolves were the primary predator on moose calves in the Northway-Tetlin Flats. Wolf predation also appeared to be the greatest source of adult mortality. However, in other areas of Unit 12, fall composition data indicate that grizzly bear predation on moose calves to 5 months of age is high.

The wolf population has increased in Unit 12 during the past 5 years. There were approximately 229 wolves in a minimum of 28 packs during the 1990-91 winter. Before 1989, except in the southeast corner of Unit 12, moose were the primary prey species for wolves year around. Since 1989, tens of thousands of Nelchina and Mentasta caribou have wintered in Unit 12, greatly expanding the prey base for wolves. The effect of this large seasonal food source is an inflated winter wolf population. How this may affect the unit's moose population during spring and summer when the caribou are not available is not known, but I expect that mortality because of wolf predation has increased. In the areas most impacted by the increase in caribou and wolves, the moose composition counts have shown a substantial decline ($\underline{n}$ = 2, $\underline{x}$ = 63%) in calf survival. Because there is no fast acting negative feedback mechanism on wolf populations (Gasaway et al. 1983), the impact of wolf predation on the unit's moose population may continue to be higher as long as the caribou keep wintering there in high numbers.

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 added an estimated 2 million pounds browse each year for wintering moose. In eastern Unit 12, the USFWS has done prescribed burns that will benefit moose on the Tetlin National Wildlife Refuge. Browse studies have shown that use of preferred browse species is low in relation to their availability and that 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 97,000 acres of primarily decadent black spruce muskeg in the Tetlin Hills and the adjacent Tok River lowlands. This fire is expected to improve moose winter browse supplies for the next 15 to 20 years.

CONCLUSIONS AND RECOMMENDATIONS

Moose are far less numerous in Unit 12 than they were in the 1960s. The population was growing during the late 1980s but appears to have stabilized or declined slightly the past 2 years. Presently, annual harvests and hunter success are about half of what they were in the 1970s, and demands for consumptive and nonconsumptive uses are not being met. Habitat is not limiting, but predation and possibly illegal hunting in certain areas are prohibiting moose population growth. At the current growth rate, the moose population and harvest objectives will not be met by year 2000.

The bull:cow ratio is below the population objective minimum in some of the most popular hunting areas of Unit 12. A temporary antler restriction will be necessary to improve this ratio and the age structure of the bull population. The northwest corner of the unit should have a temporary spike-fork regulation adopted.

Wolf numbers are increasing in Unit 12, and in most years, harvest is not high enough to regulate wolf numbers. The existing moose population objectives depend on some type of predator management in order to be met. During the spring 1992 Board of Game meeting, the board will delineate areas to receive different levels of wolf management. After the first round of public meetings, it appears that the public would like to see most of Unit 12 managed primarily as a natural ecosystem. Under this system, I expect that there will no significant changes in the moose, caribou, and wolf populations or in opportunities for consumptive use of those species. If this management scenario is adopted, the moose population objectives for Unit 12 will need to be changed.

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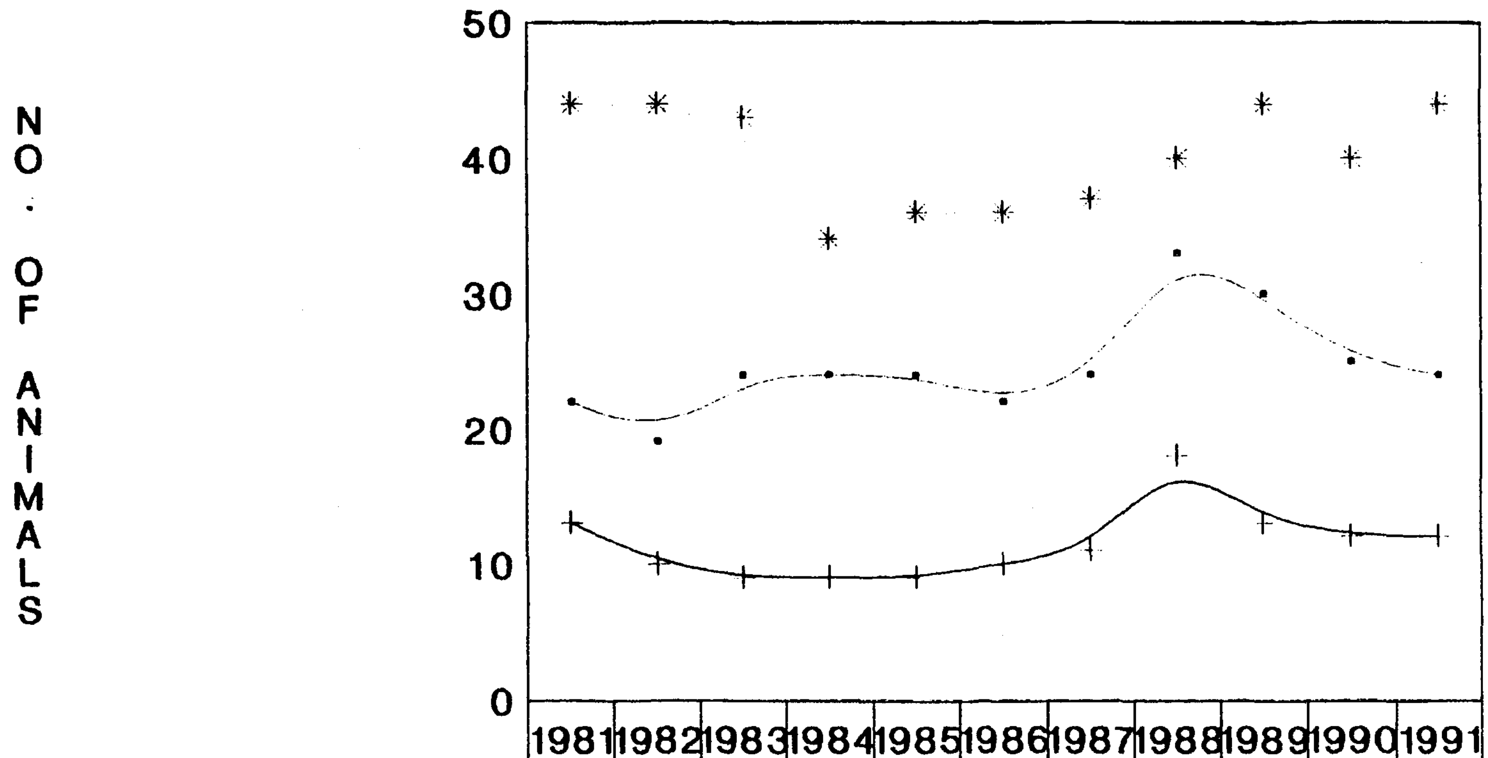
Figure 1. Moose ratios and moose/hour counts in Unit 12, 1981-1991.



	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Calves/100 Cows	22	19	24	24	24	22	24	33	30	25	24
Yrl Bulls/100 Cows	13	10	9	9	9	10	11	18	13	12	12
Moose/Hr	44	44	43	34	36	36	37	40	44	40	44

YEAR

Table 1. Unit 12 aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1986-87	41	10	22	177	13	1,135	1,312	36
1987-88[a]	55	11	24	119	13	778	897	37
1988-89	64	18	33	189	17	943	1,133	40
1989-90	50	13	30	223	17	1,094	1,317	44
1990-91[b]	47	12	25	185	15	1,071	1,256	40
1991-92	49	12	24	200	14	1,264	1,472	44

[a] Tok and Dry Tok were not surveyed. These survey areas normally yield a sample of 400+ moose.
[b] Includes 546 moose classified in eastern Unit 12 moose census not used for moose/hour.

Table 2. Unit 12 moose harvest and accidental death, 1986-91.

Regulatory year	Harvest by Hunters							Accidental death			
	Reported				Estimated						
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1986-87	105 (100)	0	0	105	15-20	30-40	45-60	4-5		4-5	154-170
1987-88	79 (100)	0	1	80	15-80	30-40	45-60	4-5		4-5	129-145
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

Table 3. Unit 12 moose hunter residency and success, 1986-91.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total[b](%)	Local[a] resident	Nonlocal resident	Nonresident	Total[b](%)	
1986-87	31	54	20	105 (26)	172	126	2	300 (74)	405
1987-88[c]	--	--	13	80 (24)	--	--	14	252 (76)	332
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

[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.

[c] Sixty-seven successful resident hunters and 238 unsuccessful resident hunters did not specify locality of residence.

Table 4. Unit 12 moose harvest chronology by time period, 1985-91.

Regulatory year	Harvest periods					Total
	9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	
1985-86	21	21	20	5	1	68
1986-87	21	29	39	7	0	96
1987-88	17	26	31	5	0	79
1988-89	39	37	15	2	1	94
1989-90	33	21	14	5	1	74
1990-91	25	45	10	6	0	86

Table 5. Unit 12 moose harvest percent by transport method, 1985-91.

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1986-87	17	7	13	11	1	18	33		105
1987-88	25	11	13	7		12	32		80
1988-89	12	18	11	8		24	27		81
1989-90	17	22	8	13		10	30		76
1990-91	18	16	23	12		6	25		98

LOCATION

Game Management Unit: 13 (23,376 mi^2)

Geographical Description: Nelchina and Upper Susitna Rivers

BACKGROUND

Although moose densities in Unit 13 were low during the early 1900s, they began to increase during the 1940s. Moose were abundant through the 1950s and early 1960s, and the population peaked in the mid-1960s. Moose numbers declined during the late 1960s and early 1970s, because of severe winters, increased predation, and large human harvests of bulls and cows. The population low probably occurred in 1975, when 41 moose/hour and 15 bulls:100 cows were observed during fall surveys. The number of moose counted during fall surveys began increasing in 1976 and followed this trend until 1988.

Unit 13 historically has been important 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 1971, 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 1980 through 1989 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 Subunit 13A West.

MANAGEMENT DIRECTION

Management Objective

The Unit 13 moose management objective is to maintain 1987-88 population levels with a posthunting sex ratio of no less than 15 adult bulls:100 cows by controlling human harvests.

METHODS

We conducted aerial surveys during fall to learn sex and age composition and population trends in count areas throughout the unit. Censuses have been conducted periodically in different portions of the unit to obtain population estimates. Harvests were monitored by requiring permit and harvest ticket reports from all hunters. Natural calf mortality was monitored in late-winter by conducting survival surveys. Habitat conditions have been monitored periodically by examining browse use transects in different portions of the unit. Although no active habitat manipulation has been conducted, Unit 13 is in the Copper River Fire Management Plan. Large portions of the unit are included in a limited suppression category, in which wildfires would be allowed to burn once ignition occurs. Staff evaluated and responded to land-use proposals that could affect moose habitat.

RESULTS AND DISCUSSION

Population Status and Trend

The number of moose/hour counted during annual fall moose sex and age composition counts has declined by 26% since 1987 (Table 1). This decline follows a 9-year period (1978-87) when moose counted per hour increased at an average annual rate of 5%, from 53 to 78 moose per hour. Moose density estimates obtained during 1987 through 1991 fall sex and age surveys showed a similar (30%) decline. The current density estimate of 1.4 moose/mi^2 was the lowest obtained in Unit 13 since 1983. Moose count surveys flown on established count areas at the same search intensity each fall indicate trends in moose numbers.

Analysis of fall moose count data indicates a large decline in the number of moose/hour in 3 subunits since 1987. Moose/hour counts in Subunit 13B declined from 81 in 1987, to 64 in 1991, down 21%. The greatest reduction occurred in Subunit 13C, which declined 37% from 110 to 69 moose/hour. Subunit 13E declined 35% from 88 to 57 moose/hour. In Subunit 13D a decline occurred between 1989 and 1991 when the moose/hour figure dropped 30%, from 47 to 33 moose/hour. In Subunit 13A however, a downward trend was not observed.

Population Size: A census conducted over a 1,877 mi^2 area in western Subunit 13A during November 1987 produced an estimate of 5,913, ± 725 moose (C.I.=90%), or 3.1 moose/mi^2. During November 1989, we censused 1,962 mi^2 of Subunit 13C and produced a population estimate of 3,096, ± 461 moose (C.I.=90%), for a density of 1.6 moose/mi^2. The latest moose census in Unit 13 (2,428 mi2) was conducted in Subunit 13B during November 1991. The population estimate for Subunit 13B in November 1991 was 4,644, ± 512 moose (C.I.=90%) for a resulting density estimate of 1.9 moose/mi^2.

Population Composition: Population composition data collected during fall sex and age composition counts from 1986 to 1991 are presented in Tables 1 and 2. The bull:cow ratio in Unit 13 declined 19% from 1988 to 1989, but has been stable since then. The number of yearling bulls declined 50% and the unitwide yearling bull:cow ratio declined from 12 yearlings:100 cows in 1988 to 6:100 in 1991. There were 19 large (i.e., older than 1 year) bulls:100 cows observed. This exceeded the management objective of 15 adult bulls:100 cows for the unit. The calf:cow ratio also declined dramatically in Unit 13 (Table 1). In 1988, we observed 28 calves:100 cows but this ratio has declined by 39% to 17 calves:100 cows.

The 1991 composition survey data for each subunit are presented in Table 2. Since 1984, bull:cow ratios in Subunit 13A increased 129% (17:100 to 39:100). The bull:cow ratios in Subunits 13B, 13C, and 13E were similar, with 19-22 bulls:100 cows. These three subunits have had appreciable declines (ranges 15-30%) in the bull:cow ratios since 1988. Subunit 13D had 72 bulls:100 cows; this ratio has remained stable the past few years.

In Subunit 13A the adult bull:cow ratio was 32:100. Large bulls currently comprise 82% of the bull population in Subunit 13A, compared with only 16% in 1984. This increase was largely attributed to the spike-fork regulation. Under this regulation, only a portion of yearling bulls were legally harvested, and older bulls were protected. Subunits 13B, 13C, and 13E, were near the management objective of 15 adult bulls:100 cows. Subunit 13D, at 61 adult bulls:100 cows, also had a high (85%) proportion of adults in the bull population. Yearling bulls:100 cow ratios within the subunits ranged from 5 to 11.

Annual fluctuations in calf:cow ratios indicated calf production or survival varied between subunits among years. In past years, Subunits 13B and 13E had higher calf:cow ratios than Subunits 13A, 13C and 13D. However, calf production or survival decreased during the last 3 years. Larger calf:cow ratio declines occurred in Subunits 13E and 13B with 71% and 39% respective decreases during 1988 and 1991. The calf:cow ratio also declined by 20% in Subunit 13A and 16% in Subunit 13C. Subunit 13D increased from 16 calves:100 cows in 1988 to 18:100 (13%) in 1991.

Composition data for 1991 also showed decreased numbers of cows counted in every subunit except Subunit 13D and in all but two count areas (CAs 7 and 15). The magnitude of the decline in the cow base was not as great as the decline in the number of bulls or calves. Cows declined by 15% in Subunits 13A, 13B, and 13E, and 28% in 13C. For the unit as a whole, when data were compared for only those areas counted every year, the number of cows observed during fall surveys declined by 10% from surveys in 1987. The number of bulls counted declined by 27% and calves by 46%.

Distribution and Movements: Data from fall composition surveys, censuses, and stratification flights suggested that 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 move down from fall postrutting areas in winter as snow depths increase. Known winter concentration areas include the upper Susitna River, Lake Louise Flat, and the Tulsona Creek burn.

Mortality

Harvest:

Season and Bag Limit. Before 1990, open season for resident and nonresident hunters in Unit 13 was 1-20 September; a subsistence season opened from 25 August-20 September. In 1990, the fall sport and subsistence moose seasons were reduced by 15 and 20 days, respectively, with season dates from 5-9 September. Unit 13 was closed to nonresident moose hunting and the Board of Game established a winter Tier II subsistence hunt with season dates of 1-31 December. The bag limit for the fall season in Subunit 13A west of Lake Louise road, Lake Louise, Lake Susitna, and Tyone River was 1 bull with spike-fork antlers. The fall bag limit for the rest of Unit 13 was 1 bull with ≥ 36-inch antlers. The Tier II winter subsistence hunt limit was 1 bull with any size antlers. A federal subsistence hunt for unit residents was established in 1990 on federal lands in Unit 13 with season dates of 25 August-20 September and a bag limit of 1 bull.

Board of Game Actions and Emergency Orders. During the 1988 spring board meeting, cow moose seasons were authorized in Subunits 13A West and Subunit 13E; 50 drawing permits were available in each subunit. One-half the permits in each area were reserved for unit residents. The cow moose drawing hunts were reauthorized in 1989 but cancelled by emergency order in late April in response to winter mortality. In November 1987 the board made land-and-shoot wolf hunting and trapping illegal in Unit 13. This action resulted in reduced wolf harvests during the report period. Few wolves were taken from remote portions of the unit, where access by snowmachine is difficult.

Major changes in moose hunting regulations were made during the summer 1990 Board of Game meeting. A decline in moose numbers prompted a 15-day cut in the general moose season, with season dates of 5-9 September. The board eliminated all nonresident moose hunting in Unit 13. A winter Tier II subsistence hunt was established, and the drawing permit hunts in Subunit 13A West were cancelled. These actions provided a subsistence preference and complied with state subsistence laws. Board of Game actions during the spring 1991 meeting were limited to increasing the length of the 1991 moose season by 2 days (Sept. 5-11) and cancelling the Tier II winter hunt.

Hunter Harvest. In 1990, the reported harvest for Unit 13 was 521 moose from the combined sport and subsistence seasons (Table 3). This represented a 56% decline in the harvest from the previous year's take of 1,178, and 51% below the 5-year (1985-89) mean (1,072). This was the lowest moose harvest ever reported in Unit 13. The only time the Unit 13 moose harvest approached this level was in 1980, the first year of the 36-inch regulation, when only 557 moose were killed. During 1990, 2,665 hunters reported hunting in Unit 13. This was a 39% decrease from 1989 (4,362 hunters) and 36% below the 5-year (1985-89) mean (4,193 hunters).

The sport season harvest in 1990 (382) was the lowest ever reported in Unit 13 and 57% lower than the previous year (891) (Table 4). Hunting effort in 1990 was down 45%, with only 2,015 sport hunters reporting compared to 3,631 in 1989.

Included under the general sport harvest were moose taken in the western half of Subunit 13A, where a spike-fork regulation has been in effect since 1985. This limited the harvest to a portion of the yearling bull population, thereby protecting larger bulls. Harvests for 1985, 1986, 1987, 1988, 1989 and 1990 were 70, 117, 71, 91, 99 and 47 spike-fork antlered bulls, respectively. The current low harvest reflects the decreased short season hunting effort and a decline in the number of spike-fork bulls because of poor recruitment. Some illegal and unreported moose harvests were documented in Unit 13, but information was too sparse to estimate the number.

Permit Hunts. A State subsistence moose hunt was conducted by a registration permit (913W) in Unit 13, except Subunit 13A West, between 1983 and 1989. Any antlered bull was legal. Only Unit 13 residents were eligible and beginning in 1987, only one permit was issued per household. In 1989, 821 permits were issued. The highest subsistence harvest occurred in 1989 when 215 moose were harvested. Hunter success was 35% in 1989. With the high success rate, the harvest would have been larger had the board not limited the number of permits to one per household. The mean antler spread of subsistence-killed bulls was 36 inches. Of bulls harvested, 53% had antlers less than 36 inches and would not have been legal under the 36-inch minimum for the sport hunt.

A federal subsistence hunt replaced the State subsistence hunt 913W in 1990. This action was a result of federal management of subsistence hunting following the McDowell decision by the State Supreme Court. The Bureau of Land Management (BLM) assumed management on federal land and issued registration permits to 593 applicants who were rural residents of Unit 13 (Table 4). Permits were issued in Glennallen and rural communities by BLM representatives. Only 1 permit was issued per household. Seventy-four bulls were taken on federal lands under this hunt. Hunters killed 57 bulls in the Denali Land Block (Subunits 13B, 13C, and 13E) and they took 13 in the Tiekel Block (Subunit 13D). Hunter success rate was 22%, while 35% of the permittees did not hunt.

Drawing permit Hunt No. 912 was established in 1987 (previously Hunt No. 914) to allow for a controlled harvest of large bulls in the spike-fork area (Subunit 13A West). In 1988 the hunt area was reduced to that portion of Subunit 13A West south of Black River. Any antlered bull could be taken. There were no residency restrictions. This hunt was cancelled in 1990 because subsistence regulations do not allow drawing hunts when they restrict subsistence uses. During 1989, 100 permits were issued and 42 bulls were harvested (Table 4). The mean antler spread was 45 inches with 77% of the bulls having antler spreads greater than 35 inches.

Drawing permit Hunt No. 914 was held during 1988 and 1989 then cancelled by the Board of Game in 1990. Moose drawing permit hunts in Unit 13 were determined illegal under State subsistence regulations. Hunt No. 914 was for any antlered bull in Subunit 13A West, but hunters were restricted to the area north of the Black River. This portion of Subunit 13A was in the spike-fork area, but had received little hunting pressure since 1985 because access was difficult. One hundred permits were issued each year, but only 44 permittees hunted in 1988 and 46 in 1989. Hunters harvested 26 bulls in 1988 and 30 in 1989. Hunter success was 65% in 1989. The mean antler spread was 50 inches in 1989 and every bull taken had antlers larger than 35 inches. This hunt provided the best opportunity for a hunter to take a trophy bull in Unit 13.

In 1990, the Board of Game established a Tier II subsistence hunt (900T) with a season from 1 to 31 December and a harvest quota of 75 bulls. There were 804 applications for the 500 available permits. Sixty-five bulls were taken for a hunter success rate of 20%. The mean antler spread was 40 inches, with 89% having an antler spread greater than 35 inches. This hunt did not have local support, 34% of the permittees reported they did not hunt, and local advisory committees petitioned to close the hunt.

Four drawing-permit hunts for cow moose were established in Unit 13 in 1988. Two hunts (915W and 917W) were for unit residents only, while two hunts (916 and 918) were open to any applicant. Hunts 915W and 916 were in Subunit 13A West, while hunts 917W and 918 were in Subunit 13E between the Susitna River and Brushkana Creek. Harvest data for these hunts are in Table 4. Cow hunts were popular; 1,312 applicants tried for the 76 available permits. Permittees harvested 18 and 8 cows in Subunits 13A and 13E, respectively. These hunts were cancelled in 1989 because of winter mortality.

<u>Hunter Residency and Success</u>. Unit 13 residents, nonlocal residents, and nonresidents accounted for 21%, 69%, and 9% of the 1989 moose harvest, respectively (Table 5). In 1990, the success rate increased to 24% for Unit 13 residents and 76% for nonlocal residents because nonresidents were excluded from hunting moose in Unit 13. Average harvest between 1983 and 1985 for unit residents was 124 moose per year. Between 1986 and 1989, harvest by locals increased by 90% to an average of 235 moose per year because of increased permits issued for subsistence hunting. Between 1985 and 1989, bull harvests increased by 43%, then declined by 56% in 1990.

The hunter success rate for moose in Unit 13 was 27% during 1989; down from the 29% success rate in 1988 but higher than the 5-year (1984-88) mean of 25%. Subsistence hunters had a success rate of 35%, while sport hunters averaged 25%. Successful moose hunters spent an average of 5.5 days hunting, compared with 6.1 days for unsuccessful hunters. Successful subsistence hunters averaged 4.3 days, compared with the 6.0 days required for sport hunters. In 1990 the overall success rate dropped to 20%. Subsistence hunters had a success rate of 22% compared to 19% for sport hunters. Successful moose hunters spent 4.3 days afield to take a moose in 1990. We attributed this 22% decline in effort to the 5-day-long general moose season. Subsistence hunters spent 6.4 days afield to take a moose compared to 3.9 days for sport hunters.

Harvest Chronology. More moose were killed in the first part of the hunting season during 1986 and 1987. In 1988 and 1989 the majority of the harvest occurred in the second-half of the season (Table 6). This suggested a shift in hunting effort. Traditionally hunting pressure was greater early in the season but success rates were lower. Apparently more hunting occurred later in the season, when bulls became more susceptible because of autumn leaf-drop and the approaching rut. Chronology data had little meaning in 1990 because the fall season was 5 days long.

Transport Methods. Most successful hunters used off-road vehicles. Highway vehicles, 3- and 4-wheelers, and aircraft were also popular transport methods (Table 7). Highway vehicles were the most important (39%) transportation method for subsistence hunters. Hunters also used ORVs (20%), 3- and 4-wheelers (18%), and aircraft (11%). Highway vehicles were most frequently used by all cow moose hunters. During the winter Tier II hunt, 40% of the successful hunters used highway vehicles and 38% used snowmachines.

Other Mortality: Brown bear and wolf predation 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 in Unit 13 are considered abundant for an Interior population. Brown bear harvests by sport hunters have increased over the last 10 years and bears have probably been reduced in 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 resulted in increased moose calf survival is unclear. Research to determine the effects of increased brown bear harvests on moose calf survival has not been conducted. One observation is that along with increased bear harvests, moose numbers increased between 1980 and 1987. This increase occurred when wolves were more abundant and presumably taking more moose.

Wolf numbers in Unit 13 have increased since 1988, and wolf predation has become an important factor affecting moose abundance. Before 1988, spring wolf estimates in Unit 13 after the hunting and trapping season, averaged 150 wolves. This increased (60%) to 240 wolves in spring 1991. Wolf densities in portions of Subunit 13B reached 23.2/1000 km^2 in 1990, and field observations of wolf predation on moose increased notably.

Mortality attributed to deep snow conditions increased during winters from 1988 to 1991. These winters were classified as severe. Snow depths well above the 25-year average were recorded in Subunits 13B, 13C and 13E. Subunits 13A and 13D had less snowfall, and conditions for moose were better. Moose calves were most susceptible to deep snow; dead calves were often visible by mid-winter. The percentage of calves in the population dropped from 15% in fall 1989, to 7% in April 1990. Adult mortality, attributed to deep snow, was also observed during aerial surveys in March and April. The cumulative effect of three winters with deep snow was a decline in moose numbers.

Habitat Assessment

Wildfires occurred in much of Unit 13 before 1950 when fire suppression activities began. Since then little acreage has burned. The most significant fire in recent years occurred in 1991, when 5,500 acres burned on the west side of Tazlina Lake in Subunit 13D. This fire was ignited by lightning in an area classified for "limited suppression;" initial attack did not occur and a let-burn policy was followed. This was the first wildfire allowed to burn under the Copper River Fire Management Plan. This plan, established several years ago, has been largely ignored and all wildfires have been suppressed, even when occurring in designated "limited suppression" areas. Fire suppression has reduced the amount of seral habitat available as moose browse and 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 could withstand the level of use occurring at that time.

Unit 13 has numerous areas where habitat improvement could enhance browse conditions for moose. The size and remoteness of much of the unit make wildfire the only feasible tool for extensive habitat improvement projects. To promote the use of fire, the Copper River Fire Management Plan allows wildfires to burn in remote areas. Prescribed fires may be used to create moose habitat, however, the climate limits the use of fire to the driest years. Mechanical methods such as crushing are planned for riparian habitats as an alternative to burning. To be effective, mechanical treatment must be done where moose concentrate during winter. This limits mechanical treatment in Unit 13 to areas along rivers. Mechanical treatment is expensive and limited to small areas near roads where access is available for equipment. Current enhancement sites being considered include riparian willow stands on the Copper River between Gakona and Slana in Subunit 13C.

CONCLUSIONS AND RECOMMENDATIONS

Moose numbers in Unit 13 apparently declined by 20 to 30% between 1988 and 1991. Moose numbers generally increased between 1980 and 1988 because of mild winters, reduced predation, and restricted human harvests. Surveys before 1988 suggested moose numbers in more favorable habitats were approaching the level observed during the late 1960s, before the large population decline of the early 1970s.

The current decline in moose numbers is primarily attributable to decreased calf recruitment. Severe winters the last three years were the main causes of poor calf recruitment. Calves are the most vulnerable to deep snow conditions, followed by bulls and lastly, adult cows. This is supported by survey data. In addition to directly causing natural mortality, deep snow conditions make moose more vulnerable to predation. During the last 3 years, wolves have been more numerous than any time since the mid-1970s, assuring increased predation rates on moose.

The human predation rate of bulls coupled with decreased yearling bull recruitment lowered bull:cow ratios throughout the unit. Although a substantial decrease in season length reduced the bull harvest by 50% or more, the bull:cow ratios declined. Some decline in the bull:cow ratio could be expected without any 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. Large bulls were protected in Subunit 13A West and the bull:cow ratio declined slightly. In Subunits 13B, 13C, and 13E, hunting pressure remained heavy and bull:cow ratios declined. On federal lands, subsistence hunting for any bull negated the effect of the 36-inch minimum antler regulations, and large declines were observed. Bull:cow ratios were near management objectives in Subunits 13B, 13C, and 13E. If the number of bulls continues to decline in these subunits, harvests should be reduced further. The short season (5-11 September) should effectively maintain a low harvest and stabilize bull:cow ratios if calf recruitment improves. If further harvest reductions are necessary in Subunits 13B, 13C, and 13E, I recommend limiting harvest by permit hunts rather than further reductions in season length. If calf recruitment increases substantially next year, the 1993 season could be lengthened.

Bull harvests should be increased in Subunit 13A West to take some large bulls and relieve hunting pressure on bulls in other heavily hunted portions of the unit. The problem facing management is how to increase the bull harvest safely. That portion of Subunit 13A West, south of the Black River, is readily accessible by a well developed ORV trail system. The terrain is relatively open and visibility is much better than in timbered areas. The area receives additional heavy hunting pressure because the Nelchina caribou herd frequents the area during September. Because of these conditions, hunting pressure has been high. North of the Black River, access is limited and overharvesting is less probable. Before the spike-fork regulation, the bull:cow ratio in Subunit 13A West was the lowest in Unit 13. The permit hunt management option protects from overharvests and allows increased bull harvest from all age classes. This area was hunted under two drawing permit hunts during 1988 and 1989 and the hunts worked well. The number of bulls harvested could be adjusted each year by varying the number of permits issued. The bull harvest was distributed between all age classes. Permittees have a quality hunt where any bull can be harvested. In contrast, a harvest strategy with a minimum 50-inch antler requirement targets only adult bulls.

Management actions taken to stop or reduce the observed decline in moose numbers include eliminating cow moose hunts, reducing bull harvests by shortening the hunting season, and increasing the wolf harvest to reduce predation on the moose calves. However, moose numbers will always decline in Unit 13 after severe winters. As long as an adequate cow base is maintained and predation is reduced to allow calf survival, moose numbers should increase during years with mild or moderate winters. The current unitwide cow base declined 10-15% and is at a level similar to that observed during the early 1980s. Population recovery should proceed when snow depth subsides and recruitment improves. Close monitoring of moose population trends should continue at current levels to determine trends on a yearly basis. Given the demand for consumptive use of Unit 13 moose, bull harvests should be restricted only when necessary to maintain the minimum sex ratio objective.

LITERATURE CITED

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Table 1. Unit 13 fall aerial moose composition counts and estimated population size, 1986-91.

Regulatory Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves %	Adults	Total moose observed	Moose /hour	Density moose mi^2 (range)
1986/87	27	12	30	19	5,323	6,582	70	1.6 (0.5-3.1)
1987/88	28	12	26	17	5,723	6,892	78	2.0 (0.6-2.9)
1988/89	31	12	28	18	5,629	6,846	72	1.8 (0.5-3.0)
1989/90	25	10	21	15	5,371	6,279	65	1.6 (0.6-2.8)
1990/91	25	5	18	13	5,427	6,209	59	1.5 (0.5-2.8)
1991/92	25	6	17	12	5,556	6,295	58	1.4 (0.6-2.6)

Table 2. Unit 13 fall aerial moose composition counts, 1991.

Subunit	Bulls: 100 cows	Yearling bulls:100 cows	Calves: 100 cows	Calves %	Total moose observed	Moose /hour	Density moose mi2 (range)
13A	39	7	20	13	1,362	65	1.4
13B	19	5	19	14	2,477	64	1.6
13C	22	7	21	15	487	69	2.1
13D	72	11	18	10	219	32	0.6
13E	20	6	10	7	1,607	57	1.3

Table 3. Unit 13 moose harvest[a] and accidental death, 1986-91.

Regulatory Year	Hunter Harvest						Accidental			Grand total
	Reported			Estimated						
	M	F	Total[b]	Unreported	Illegal	Total	Road	Train	Total	
1986/87	1,120	3	961	25	10	35	30	--	30	1,205
1987/88	773	2	774	25	10	35	30	--	30	1,024
1988/89	955	28	963	25	10	35	50	--	50	1,344
1989/90	886	0	891	25	10	35	50	--	50	1,263
1990/91	381	0	382	25	10	35	50	--	50	606

[a] Includes permit hunt harvest
[b] Includes unknown sex.

Table 4. Unit 13 moose harvest data by permit hunt, 1986-91.

Hunt No.	Regulatory Year	Permits issued	Percent did not hunt	Percent Unsuccessful hunters	Percent Successful hunters	Bulls	Cows	Unk.	Total harvest
912	1987/88	99	19	64	36	29	0	0	29
	1988/89	100	18	38	62	51	0	0	51
	1989/90	100	24	45	55	42	0	0	42
	1990/91	--	--	--	--	--	--	--	--
914	1988/89	100	56	18	41	59	0	0	26
	1989/90	100	53	16	34	64	0	0	30
	1990/91	--	--	--	--	--	--	--	--
916[b]	1988/89	25	20	35	65	0	13	0	13
918[b]	1988/89	12	25	44	56	0	5	0	5
913W	1986/87	1,079	26	78	22	179	0	0	179
Subsistence	1987/88	767	26	72	28	155	1	0	156
	1988/89	797	25	67	33	184	0	0	193
	1989/90	821	24	65	35	214	0	0	215
	1990/91[c]	593	39	78	22	74	0	0	74
915W[b]	1988/89	25	26	64	36	0	5	--	5
917W[b]	1988/89	14	29	70	30	0	3	--	3
900T	1990/91	500	35	80	20	65	0	--	65
Totals for all permit hunts	1986/87	1,079	--	--	--	179	0	0	179
	1987/88	866	--	--	--	184	1	0	185
	1988/89	1,036	--	--	--	261	16	9	296
	1989/90	1,021	--	--	--	286	0	1	287
	1990/91	1,093	--	--	--	139	0	0	139

a Hunt not held.
b 1988 only.
c Bureau of Land Management Subsistence Hunt.

Table 5. Unit 13 moose hunter[a] residency and success for all hunts, 1986-91.

Regulatory Year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total[c] (%)	Local[b] resident	Nonlocal resident	Nonresident	Total[c] (%)	
1986/87	51	813	81	961 (26)	313	2,302	67	2,734 (74)	3,695
1987/88	43	604	77	774 (22)	241	2,272	89	2,782 (78)	3,556
1988/89	61	734	111	963 (27)	259	2,082	103	2,605 (73)	3,568
1989/90	34	737	106	891 (25)	161	2,464	79	2,740 (75)	3,631
1990/91	28	343	1	382 (19)	255	1,345	2	1,641 (81)	2,023

[a] Excludes hunters in permit hunts
[b] Residents of Unit 13
[c] Includes unknown residency

Table 6. Unit 13 moose hunter[a] residency and success for all hunts, 1986-91.

Regulatory Year	Successful				Unsuccessful			
	Local resident	Nonlocal resident	Nonresident	Total[a]	Local resident	Nonlocal resident	Nonresident	Total[a]
1986/87	230	813	81	1,140	936	2,299	67	3,355
1987/88	199	633	77	959	651	2,323	89	3,243
1988/89	263	821	113	1,259	665	2,138	104	3,070
1989/90	249	818	111	1,178	506	2,598	80	3,184
1990/91	123	397	1	521	622	1,520	2	2,144

[a] Includes unspecified residency.

Table 7. Unit 13 moose harvest chronology percent by time period, 1986-90.

Year	Season dates	Week of Season 1st	2nd	3rd	4th	5th	n
1986	1-20 Sep	41	30	29	--		1,205
1987	25 Aug--20 Sep	6	36	24	30	4	1,024
1988	25 Aug--20 Sep	2	13	36	30	19	1,344
1989	25 Aug--20 Sep	2	15	31	28	24	1,263
1990	25 Aug--20 Sep	2	2	71	7	5	
	1--31 Dec	4	4	3	1	1	606

Table 8. Unit 13 moose harvest percent by transport method, 1986-91.

Regulatory year	Percent of Harvest Airplane	Horse	Boat	3- or 4- wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1986/87	18	4	9	12	0	28	22	7	1,205
1987/88	16	5	7	15	0	32	19	6	1,024
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

Table 9. Unit 13 moose harvest[a], percent distribution of antler spread categories by age class.

Age	Antler Spread (inches)						
(years)	Spike/fork	29	30-35	36-39	40+	50+	60+
Calf	100						
1	26	67	7				
2	2	7	60	23	8		
3			16	30	43	11	
4			2	2	45	46	5
5+					20	73	7

[a] n = 295

LOCATION

Game Management Subunit: 14A (2,561 mi^2)

Geographical Description: Matanuska Valley

BACKGROUND

Moose in the Matanuska Valley have increased from low pre-1930 levels to numbers ranging between 2,000 and 6,000. Land clearing and fires during settlement in the 1930s increased 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 the subunit contained a wintering population of between 5,000-7,000 moose. Moose numbers declined in the early 1970s, following two hard winters and large cow harvests. Populations again peaked during the late 1980s.

In the 30 years since statehood (1959) hunters harvested more than 17,000 moose in Subunit 14A. Annual harvest levels in the first 12 years (1960-71) ranged from 200 to more than 1,300 moose. While the harvests have been predominantly bulls, averaging 350 annually, harvest of antlerless moose reached significant levels in peak 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 from 1972 to 1977, and the mean annual harvest of bulls declined to 251 (range=167-346). Antlerless seasons were reinstated in 1978/79. During the next 11 years, mean bull harvest was 311 (range = 201-454) and mean cow harvest was 113 (range = 53-150).

During the early 1980s, a construction boom in the Matanuska-Susitna Valley and a series of moderate snow depth winters resulted in significant conflicts between man and moose. Available 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 traffic. Motorists began hitting and killing more than 100 moose annually. Trains killed between 4 and 45 moose annually. Illegal harvest also increased in proportion to the human population. Nonhunting mortality accounted for up to 25% of annual moose mortality. With annual human-caused mortality killing 820 moose, population numbers seemed to stabilize at 5,000 moose.

Efforts to maintain adequate quantities of winter habitat during the 1980s included promoting timber sales, chaining or blading of overmature habitat, and establishing the Matanuska Valley Moose Range (MVMR) in 1984.

MANAGEMENT DIRECTION

Management Goals

Moose management goals for Subunit 14A are to: 1) provide for an optimum harvest of moose; 2) provide the greatest opportunity to participate in hunting moose; and 3) provide an opportunity to view, photograph and enjoy moose.

Population Objectives

The moose population objective for Subunit 14A is to maintain the existing (4,000-6,000) moose population with a posthunting sex ratio of no less than 20 bulls:100 cows.

METHODS

Aerial sex and age composition surveys were conducted between 30 October and 7 November 1989 in 7 of 13 count areas to determine population composition and trend. During March and April 1990 core wintering areas were sampled after deep snow winter conditions, to determine if substantial calf mortality had occurred and to locate evidence of adult mortality. We conducted a similar winter composition survey in 2 count areas during March 1991. A complete census was conducted at the MVMR in March 1991. In November 1991 we conducted a population census of the subunit by stratified random sampling (Gasaway et al. 1986). That portion of Subunit 14A $\leq$ 3,000 ft. elevation (1,591 mi^2) was subdivided into 119 sample units. Sample units were classified into 4 strata: 1) low; 2) medium; 3) high; and 4) super high. We censused a random sample of sample units within each stratum. During both censuses, we estimated sex and age composition.

Moose killed by hunters were monitored through harvest and permit reports. We obtained the general season bull from successful hunters by harvest reports. Drawing-permit reports were required of successful antlerless moose hunters. The Alaska Railroad Corporation provided numbers of moose killed by trains and the Department of Public Safety provided numbers of moose killed by highway vehicles, killed illegally, or killed in defense of life or property (DLP) incidents.

RESULTS AND DISCUSSION

Population Status and Trend

Moose densities during the late 1980s peaked during fall 1989. Deep snow and high mortality caused by trains and highway vehicles during 1984/85 caused a decline in numbers. Between 1986 and 1989 moose again increased. Winter 1989/90 was the most devastating winter for moose since 1971/72 as moose numbers declined 15-25%. Winter calf mortality was an estimated 60-70%; moose killed by trains and highway vehicles (339) and moose killed illegally or in DLP incidents (93) reached record levels. Harvest restrictions during subsequent hunting seasons allowed rapid population recovery. Fall 1991 census results indicated moose numbers again reached peak densities.

Population Size: The December 1991 census resulted in an estimate of 5,885 ± 706 (80% confidence intervals) which equated to a density of 3.7 moose/mi^2. The mean density within the super high stratum (44 mi^2) was 9.2 moose/mi^2, while the density in the low stratum (607 mi^2) was 1.3 moose/mi^2. Respective densities and areas for medium and high strata were 3.9 moose/mi^2 (573 mi^2) and 6.7 moose/mi^2 (367 mi^2).

The 1988 estimate, recalculated for comparing with the 1991 estimate, was 5,137 ± 895 (Table 1). The 1988 estimate, previously reported at 4,600 ± 700 (Grauvogel 1990), was recalculated using computer software and survey unit area estimates identical with those used for the 1991 census. One survey unit in the medium stratum for the 1988 census was also eliminated as was done in the 1991 census. The sightability correction factor was pooled across all strata because of inadequate data in the low and medium strata.

Moose populations in 1988 and 1991 were believed to be more similar than originally thought. The difference in the estimates were primarily the result of stratification error. The low stratum in 1988 contained 224 mi^2 more than in 1991, while the high stratum in 1991 contained 205 mi^2 more than in 1988. Refinement of the stratifications was a product of improved familiarity with moose density and distribution.

The MVMR was estimated to have 860 ± 63 moose during March 1991, comparable to the March 1989 estimate of 892 ± 120 moose. A stratified random sample of the MVMR during March 1986 produced a population estimate of 706 ± 280 (90% confidence intervals). Mean density of moose in 1991, corrected for sightability, was 4.0 moose/mi^2.

Population Composition: The fall 1989 composition survey produced a sample ratio of 26.6 bulls:100 cows. This relatively high ratio has been maintained in the population at least since 1987 (Table 1). Sample results before 1987 misrepresented population ratios because of low sample size, snow conditions, and other related environmental conditions.

The fall 1991 census produced a reduced ratio of 13.7 bulls:100 cows (Table 1). The reduction was caused by: 1) disproportionate winter mortality of mature bulls during 1989/90; 2) poor recruitment of yearling bulls from repeated years of high calf mortality; 3) reduced hunter harvest from the cow segment; and 4) a high bull harvest in 1991. Based on spring carcass counts and radio-tagged moose mortality in adjacent Subunit 14B, adult bull mortality during 1989/90 was estimated as high as 25% in Subunit 14A while estimated adult cow mortality was 10%. The ratio of 4.7 yearling bulls:100 cows, observed during fall 1991, was half the previous 4-year (1986-89) average of 8.8:100 (Table 1), which reflects below normal recruitment. Poor bull recruitment was produced by low calf survival as observed during late winter surveys. Age composition samples of moose in core wintering areas during March showed 17% (n = 393) and 14% (n = 606) calves in 1990 and 1991, respectively (Table 2). A similar survey sample from March 1989 counted 24% (n = 388) calves. The census within MVMR during March 1991 found 11% calves while a February 1989 census, following a "normal" winter, showed 21% calves. Hunter harvest of cows declined from an annual average of 150 to 0 in 1990/91 (Table 3) and 41 in 1991/92 (preliminary data). Harvest of up to 150 cows each year was believed sufficient to maintain high bull:cow ratios at current levels of harvest. Preliminary harvest estimates indicate that 500 bulls were killed during the 1991 season, the highest total since 1971.

Moose exhibited high recruitment through late fall. Although we did not conduct fall 1990 composition counts, alpine composition surveys in western Subunit 14A found 35-39 calves:100 cows (R. Modafferi pers. comm.). Comparable fall surveys during 1988 and 1989 were 39 calves:100 cows and 33 calves:100 cows, respectively. The fall 1991 census was 39 calves:100 cows or 26% of the sample.

Mortality

Harvest:

Season and Bag Limit. The 1989/90 open season for resident and nonresident hunters was 1-20 September. The bag limit was 1 moose; however, antlerless moose could be taken by drawing permit only; 400 permits were issued. The 1990/91 open subsistence season for resident and nonresident hunters was 1-10 September with a 1 bull bag limit.

Human-induced Mortality. The combined reported harvest of the general season and permit hunts for 1989/90 and 1990/91 were 624 moose (448 bulls, 173 cows, and 3 unspecified) and 259 (258 bulls, and 1 unspecified), respectively (Table 3). From 1986/87 through 1989/90 bull harvests increased 10% while cow harvests, under a consistent 400 permit system, increased 29%. The 50% reduction in hunting season and not issuing antlerless moose permits in 1990/91 effectively reduced the total harvest 58% and the bull harvest 42%. The reduced hunter harvest in fall 1990 partially compensated for higher than normal mortality from other sources during 1989/90.

Moose mortality caused by humans by means other than legal hunting, reached record levels during winter 1989/90. Unreported and illegal harvests and collisions with highway vehicles or trains (432) accounted for 41% of all moose killed by humans (Table 3). In the previous 3 years, the mean mortality from these causes was 213 moose, which was 27% of the total moose kill. During 1990/91 this mortality declined to 228 but was 47% of the total moose kill. Moose from Subunits 14B and 16A also winter in Subunit 14A (Modafferi 1990), complicating impact evaluation.

Hunter Residency and Success. During 1990/91 hunter participation (1,787 hunters) and hunter success (14%) declined from the previous 4-year trend (Table 4) because of reduced season length and availability of bulls. From 1986 to 1989 general season hunters (mean = 2,466) exhibited a mean success rate of 18%.

Composition of successful hunters shifted to favor local residents during 1990/91 (Table 4). Local residents accounted for a mean of 50% of the general season harvest during the previous 4-year (1986-89) period. In 1990/91 local residents took 57% of the harvest. Nonlocal residents experienced a disproportionate loss of success; successful hunters declined 53% from the previous 4-year mean of 200.

Permit Hunts. The number of successful hunters in antlerless moose permit hunts peaked during 1989/90 (Table 5). Between 1982 and 1989, 400 antlerless moose permits were issued annually. The number of moose harvested by permit holders had previously peaked at 143 in 1983/84, declined to 119 in 1986/87, and then increased steadily to 171 in 1989/90. Mean permittee participation during the 1986-89 period was 87%; the greatest participation was 89% during 1989/90. The number of permit applicants peaked during 1989/90 at 12,380, however, beginning in 1988 hunters could apply for up to 3 permit hunts for each species. Antlerless moose permit hunts were not authorized during 1990/91 because of high mortality during winter 1989/90.

Harvest Chronology. The abbreviated season length (10 days) during 1990/91 abnormally concentrated (81%) the general season harvest into the first week of the season (Table 6). The number of moose harvested during the first week of 1990/91 was within the range of the previous 4-year period. During the previous 4-year period 48% (mean) of the harvest took place during the first week.

Transport Methods. Highway vehicles and 3- or 4-wheelers were the predominant transport means among successful moose hunters because of the many roads and good trail access in much of the subunit. These methods accounted for over 50% of the moose harvest in the past 5 years (Table 7).

Natural Mortality: Total natural winter mortality during 1989/90 may have been 15-25%. Adult mortality observed in radio-tagged adults in the lower Susitna River area (Subunits 13E, 14A, 14B, and 16A) reached 38% through May 1990 (R. Modafferi pers. comm.). Because snow depths were shallower and reports of adult mortality were fewer in most of Subunit 14A, natural mortality for adults was assumed lower, perhaps at 10% to 20%. Aerial composition surveys in the core wintering area of Subunit 14A during March and April 1990 (Table 2) showed that calves declined to 13-16% of the observed population. Because calves comprised 24% of the preceding fall composition (Table 1) and adult mortality was 15%, calf mortality through April 1990 reached 60%. Winter calf mortality previously calculated for mild-moderate winters was 20-25%.

The following winter of 1990/91 was possibly less severe subunitwide, however, deep snow in the Matanuska River drainage caused calf mortality to exceed 50% again in sampled wintering areas. Aerial composition surveys in the alpine of north central Subunit 14A during October and November 1990 suggested that calves comprised 25% of the population (R. Modafferi pers. comm.). However, March 1991 aerial surveys showed only 12% calves in a sample of 1,348 moose (Table 2.). Assuming an original fall 1990 population of 4,800-5,000 moose and less than 10% adult mortality, calf mortality was estimated at 50-60%. Total population mortality was estimated at 15-20%.

Save the Moose. The high winter mortality of moose during 1989/90 prompted significant public and media reaction. Public reaction prompted release of emergency funds by the governor and private donations for a "Save the Moose" effort. Many citizens, private organizations, and state and federal agencies also contributed labor and resources. For a summary of efforts to reduce winter mortality through "Save the Moose," see the Game Management Subunit 14B management report.

Habitat Enhancement

Funds appropriated in the governor's declaration of emergency were used to improve moose habitat. Additional funds were appropriated through legislation to enhance moose habitat. As a result, 100 acres of deciduous forest in the MVMR were treated to enhance winter habitat for moose. Forty acres of 18-year-old vegetation were hydroaxed; 20 acres of 60- to 70-year-old vegetation were cleared by bulldozer blading. Another 40 acres of previously "chained" or clearcut areas were disked to promote denser sapling regrowth.

Some funds appropriated for the 1990 "Save the Moose" effort were committed to removing brush from highway right-of-ways (ROW) in Subunit 14A. Locations of high moose-vehicle accidents were identified and inspected for vegetation encroaching on the ROW. During August and September, 11 sites were cleared. Altogether, 1.9 linear miles were cleared. Approximately 5.2 linear miles of encroaching vegetation remained uncut because funds were depleted.

Board of Game Actions and Emergency Orders. In response to high winter mortality both natural and human-caused, ADF&G proposed, and the Board of Game adopted, a 75% reduction in the number of antlerless permits authorized for 1990/91. Within one month after the new regulation was adopted, the board met in emergency session and reduced the general hunting season to 10 days and cancelled the antlerless moose hunt by emergency order. ADF&G requested the change in response to additional indications of higher winter mortality. ADF&G estimated that a 10-day season would produce 210 bulls in the harvest and a posthunt ratio of 23 bulls:100 cows.

Based on the apparent strength of the fall 1990 calf and bull components, ADF&G proposed to lengthen the general bull season to 20 days and allow up to 200 antlerless moose permits to be issued. The Board of Game adopted the proposal but amended it to show that permits would be issued by drawing permits. Concern that calf mortality had again reached 50% or greater, prompted ADF&G to issue only 100 antlerless permits. ADF&G estimated that the 20 day season and 100 antlerless permits would produce a harvest of 350 bulls and 45 cows, and a posthunt composition of 17 bulls:100 cows.

CONCLUSIONS AND RECOMMENDATIONS

Recent analysis of 1988 and 1991 aerial census data suggested that the 1988 population estimate was low. When population objectives were being established, the moose population in Subunit 14A was thought to be close to 4,000. In retrospect, it was probably closer to 5,000. For that reason, a wide range (4,000-6,000) was recently identified as the population objective. New population estimates suggest that the population objective was met during 1989/90 and 1990/91.

Population composition objectives were achieved during 1989/90, but lack of fall composition data prevented a determination for 1990/91. The fall 1991 census indicated that the bull:cow ratio was below the objective level.

In response to increasing moose numbers, we should increase the number antlerless moose permits issued. To maintain a stable population with a 20 bull:100 cow ratio, 200-300 cows should be harvested by hunters each fall. We believe that restrictions to the general season will not be necessary at this time to reach composition objectives.

ADF&G should approach development activity proposed in the subunit as an opportunity to expand quantity and quality of moose winter range. Wildfires, controlled burns, abandoned agricultural sites, subdivision development, and properly treated commercial timber sales will be the most important factors affecting extent and quality of moose winter range. Habitat improvement by mechanical methods are not cost-effective. Locations selected for habitat enhancement should not be near or across major transportation corridors which attract moose.

Efforts to address moose mortality on subunit highways should be increased. During winter motorists should be reminded often that moose pose a real danger. Expanding the "Give Moose a Brake" program to the Matanuska-Susitna Valley may increase driver awareness and reduce moose-vehicle collisions. ADF&G should work closely with Department of Transportation staff to maintain visibility along the highway ROWs in high moose kill zones. ADF&G should be involved during early stages of transportation development planning. Upgrading activities on the Glenn Highway should include moose-vehicle accident reduction measures.

Population censuses should be conducted at least every 3 years in Subunit 14A. ADF&G has the opportunity to manage intensively a productive moose population with little controversy. Between census years, Becker surveys should be employed as they provide comparable estimates. The potential harvest of moose of both sexes can meet needs of most area hunters. To exploit that potential effectively, accurate knowledge about the population status must be current.

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Table 1. Subunit 14A fall aerial moose composition counts and censuses, 1986-1991.

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	Total moose observed	Moose/ hr	Estimated population size
1986/87	16	9	39	25	647	863	61.2(est)	4,000-6,000
1987/88	26	7	47	27	1,225	1,686	61.1	4,000-6,000
1988/89[a]	29	10	47	27	1,271	1,692	n/a	5,137±895[b]
1989/90	27	9	40	24	1,070	1,409	69.2	4,500-6,000
1990/91[c]	--	--	--	--	--	--	--	4,000-5,500
1991/92[d]	14	5	39	26	1,110	1,472	n/a	5,885±706[b]

[a] These data are from a November 1988 census of all of Subunit 14A.
[b] 80% confidence intervals.
[c] No surveys flown.
[d] These data are from a December 1991 census of all of Subunit 14A.

Table 2. Subunit 14A late winter aerial moose composition surveys, 1986-1991.

Regulatory year	Date	Area		Total moose	Calves	(%) Calves
1986/87[a]	---	---		---	---	---
1987/88[a]	---	---		---	---	---
1988/89	02/16	Palmer-Wasilla[b]		388	95	24
	02/28	MVMR[c]		593[d]	124	21
			Total	981	219	22
1989/90	03/15	Palmer-Wasilla[b]		93	13	16
	S.	Palmer-Wasilla[e]		300	51	17
			Total (March)	393	64	16
	04/10	MVMR[c]		43	4	9
	04/13	Knik River		84	15	18
		Palmer-Wasilla[f]		48	3	6
			Total (April)	175	22	13
1990/91	03/11	Palmer Wasilla[b]		282	45	16
	S.	Palmer-Wasilla[e]		324	39	12
			Subtotal	606	84	14
	03/04-07	MVMR[b]		742[d]	83	11
			Total	1,348	167	12

[a] No surveys conducted.
[b] North Palmer-Wasilla area in the vicinity of Schrock Road, Wasilla Fishhook and Palmer Fishhook.
[c] Matanuska Valley Moose Range.
[d] Composition data collected during census.
[e] South Palmer-Wasilla area in the vicinity of Fairview Loop, Trunk Road, Rabbit Slough and Matanuska River flood plain.
[f] Portions of both North and South Palmer-Wasilla areas.

Table 3. Subunit 14A moose harvest[a] and accidental death, 1986-91.

Regulatory Year	Reported			Estimated			Accidental deaths[e]			Grand total
	M	F	Total[b]	Unreported	Illegal[d]	Total	Road	Train	Total	
1986/87	401	134	555	28	26	54	112	22	134	743
1987/88	425	137	566	28	30	58	151	45	196	820
1988/89	454	150	612	31	18	49	129	20	149	810
1989/90	448	173	624	31	62	93	239	100	339	1,056
1990/91	258	0	259	20	35	55	151	22	173	487

[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, 1986-91.

Regulatory Year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonres	Unk	Total	Local[c] resident	Nonlocal resident	Nonres	Unk	Total[c]	
1986/87	223	203	6	4	436	1,969	45	10	20	2,044	2,480
1987/88	221	185	9	13	428	1,733	46	18	49	1,846	2,274
1988/89	231	192	5	17	456	1,950	53	20	84	2,107	2,563
1989/90	220	220	12	1	453	2,004	50	17	22	2,093	2,546
1990/91	148	97	8	6	259	1,466	22	14	26	1,528	1,787

[a] Does not include hunters participating in drawing permit hunts.
[b] Includes only residents of Subunits 14A and 14B.
[c] Includes all Unit 14 residents.

Table 5. Moose harvest data by permit hunt[a] in Subunit 14A, 1986-91.

Regulatory Year	# Applicants	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	Cows	Total
1986/87	7,491	400	15	65	35	3	116	119
1987/88	6,631	400	13	60	40	10	127	138
1988/89	10,864[b]	400	13	55	45	13	143	156
1989/90	12,380[b]	400	11	52	48	8	163	171
1990/91[c]	---	0	---	---	---	---	---	---

[a] Permit hunts 919 and 920 combined.
[b] Applicants could apply for both hunts; previous to 1988/89 they were limited to one application/species.
[c] Permit hunts discontinued for 1990/91.

Table 6. Subunit 14A moose harvest chronology[a], 1986-91.

Regulatory year	Before season opened	Weeks of season					After season closed	Unknown	Total
		1st	(%)	2nd	3rd	4th			
1986/87	6	167	(38)	97	131	-	7	28	436
1987/88	7	184	(43)	92	130	-	2	13	428
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

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

Table 7. Subunit 14A successful moose hunter transport methods[a] in 1986-91.

Regulatory Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Vehicle	Unk	Total all methods
1986/87	27	14	56	71	1	56	173	38	436
1987/88	25	14	59	70	0	45	173	43	428
1988/89	23	22	56	78	1	56	190	30	456
1989/90	35	21	73	86	0	40	168	30	453
1990/91	19	17	32	57	0	27	90	17	259

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

LOCATION

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

Geographical Description: Western Talkeetna Mountains

BACKGROUND

Moose populations in Subunit 14B increased from low densities before the mid-1900s and remained at high densities through the 1980s. Predator control and vegetation changes caused by human settlement were responsible for initial increases. 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 two consecutive deep snow winters (1971 and 1972) that caused high natural mortality produced an abrupt population decline. In spite of deep snow during 1984/85, mild winters during the early 1980s allowed population increases. A deep snow winter in 1987, however, initiated a decline.

Hunter harvest of moose fluctuated with population levels. From 1966 to 1970 hunters killed an average of 144 moose annually, predominantly bulls. A liberal season for cow moose caused the 1971 harvest to reach 372 (243 cows). Between 1972 and 1977, the years following the population decline, annual harvest averaged only 51. Liberalized cow seasons, beginning in 1978, allowed the mean annual harvest to exceed 150 moose through 1983. The moose harvest peaked at 534 in 1984, but declined by half the following year because of season and bag limit restrictions. Harvest peaked again at 347 moose in 1987, before a deep snow winter. The cow season was closed in 1988.

A portion of the resident moose of Subunit 14B share wintering range with moose from Subunits 13E, 14A and 16A (Modafferi 1990). While some moose attempt to winter near the alpine in mild to moderate winters, others move down to riparian zones or to shallower snow areas in Subunit 14A near Houston, Wasilla and Palmer. The riparian zones are associated with the Talkeetna and Susitna rivers. Alaska Railroad Corporation (ARC) tracks and the George Parks Highway parallel the Susitna River. Human settlement in this transportation corridor (TC) has produced attractive moose browse.

Because these wintering areas are associated with the main transportation route between Fairbanks and Anchorage, conflicts with trains and highway vehicles are many. Peaks in numbers of moose killed by trains and highway vehicles reflect deep snow winters and population highs. Recent high kill winters occurred during 1970/71, 1978/79, 1982/83, 1984/85, and 1987/88. In the two most recent peaks, combined numbers of kills by these means have been 261 and 216. As the human population in Alaska grows, conflicts with wintering moose will grow proportionally.

In 1989 critical post-rut and winter moose habitat on the west slope of Willow Mountain was designated by the legislature as the Willow Mountain Critical Habitat Area.

MANAGEMENT DIRECTION

Management Goal

The moose management goal for Subunit 14B is to provide maximum opportunity to participate in hunting moose.

Management Objective

The moose management objective for Subunit 14B is to maintain the existing moose population (2,500-3,000) with a post-hunting sex ratio of no less than 30 bulls:100 cows.

METHODS

During November of both 1989 and 1990, staff conducted Becker surveys, a modified version of the stratified random sampling census technique (Gasaway, et al. 1984). Becker surveys provided confidence intervals for estimates of observable moose excluding sightability correction factors (SCF). Sex and age composition was recorded during surveys; this allowed us to estimate observable moose by sex and age. During April 1990 we conducted aerial surveys along the border between Subunits 16A and 14B to identify live moose composition and location of moose winter mortality. Carcasses were checked for sex and age. During February staff conducted a complete census within the TC bounded by the west bank of the Susitna River and the ARC tracks between Willow and Talkeetna. We monitored moose harvest by hunters through harvest reports from any person who hunted in the subunit. The ARC provided numbers of moose killed by trains while the Department of Public Safety provided numbers of moose killed by highway vehicles, killed illegally, or killed in DLP incidents.

RESULTS AND DISCUSSION

Population Status and Trend

Winter 1989/90 had extremely deep snow that caused the Subunit 14B moose population to decline 35% between fall surveys. Moose populations were stable or decreasing slightly before this "severe winter" (Table 1).

Population Size: Consecutive Becker surveys during November 1989 and November 1990 suggested a population decline from 2,800 to 1,800 moose. The 1989 Becker survey produced an observable moose estimate of 2,126 ± 423 (80% confidence interval) moose. The observable moose estimate was 1,381 ± 190 during the 1990 survey. Applying a SCF of 1.3 (estimated for the 1987 stratified random census) to these estimates produced population estimates of 2,760 ± 550 and 1,795 ± 247 moose, respectively (Table 1). Estimated densities for the portion of the subunit below 3,000 ft. were 2.6 moose/mi^2 in 1989 and 1.7 moose/mi^2 in 1990.

Population Composition: Fall composition derived from Becker surveys showed a decline in the bull:cow ratio between 1987 and 1989 and a slight recovery during 1990 (Table 1). The 1987 census showed 37 bulls:100 cows. During fall 1989, only 24 bulls:100 cows were observed. This decline may have been caused by reduced numbers of cows in the harvest. The bull moose hunting season was closed for fall 1990, and that protection caused a slight rise in the observed ratio to 27 bulls:100 cows.

Calves represented 14-18% of population samples during the census and fall surveys (Table 1.). In 1987, 18% of the population were calves (30 calves:100 cows). However, the calf segment declined to 16% (26 calves:100 cows) in 1989 and then to 14% (20 calves:100 cows) in 1990. The severe winter's nutritional effects on pregnant cows may have contributed to reduced calf recruitment.

Mortality

Harvest:

Season and Bag Limit. During 1989/90 the open season for resident and nonresident hunters in Subunit 14B was 1-30 September; the bag limit was 1 bull. During 1990/91 the moose hunting season was closed.

Board of Game Actions and Emergency Orders. During 1986/87 the Board of Game set a bag limit of 1 moose east of the Anchorage to Fairbanks powerline intertie and 1 bull in the remainder of Subunit 14B; also, the hunting season was 1-20 September throughout the subunit. In 1987/88 the hunting season was lengthened to 1-30 September, and the either-sex bag limit east of the powerline intertie was retained. In 1988/89, the board eliminated all cow hunting seasons, but it retained the 1-30 September bull season. The same seasons and bag limit were retained for 1989/90 and initially retained for 1990/91. However, the board closed Subunit 14B to moose hunting in emergency session because of the extensive mortality which occurred during 1989/90.

Hunter Harvest. In 1989/90 the reported harvest was 174 bull moose, a slight increase from the 1988/89 harvest (Table 2). The 1989/90 harvest approached the mean bull harvest (182) for the previous 6-year period (Grauvogel 1990). No hunters reported killing moose during the closed season in fall 1990.

During winter 1989/90 moose mortality from other human causes reached record high levels. Trains and highway vehicles killed a record high 411 moose (Table 2). Long periods of deep powdery snow forced moose to travel on railroad tracks and highways. Radiotelemetry studies have shown that in some years up to 60% of moose killed by trains and highway vehicles in Subunit 14B resided in Subunits 16A or 13E (R. Modafferi pers. comm.). Up to 20% of moose killed similarly in Subunit 14A also resided in Subunits 14B and 16A. Therefore, moose killed by train and highway vehicles in Subunit 14B cannot be subtracted from any one population.

Other human-caused mortality brought the 1989/90 total kill to 639 moose (Table 2). Unreported fall harvest, illegal harvest and moose killed in DLP incidents were estimated at 54 moose. In recent years only during 1984/85 were more moose (862) killed by humans. During 1987/88, 625 total moose were killed. Both high kill years also had substantial (118-271) numbers of cows killed during the legal hunting season. Legal harvest of moose represented only 35% of the 1989/90 kill.

A 70% reduction of moose wintering along the TC in Subunit 14B and Subunit 16A and preventive actions taken by ARC caused a dramatic decline in moose killed by train and highway vehicles during 1990/91. Only 25 moose were killed by trains and vehicles (Table 2) during 1990/91. Pilot cars preceding most trains and a network of trails next to the tracks, packed and maintained by ARC, apparently reduced moose kills. However, a 70% decline in moose numbers wintering within the TC was probably the major factor. During a February 1991 census of the TC we counted 227 moose during standard searches. In comparison, 738 moose were observed on standard searches during a February-March 1984 stratified random census. Evidence suggests that the March 1984 TCA moose density was similar to that of 1989/90.

Hunter Residency and Success. Resident hunters of Subunits 14A and 14B accounted for 43% of the 1989/90 moose harvest, while other Alaskan residents killed 48% (Table 3.) The pattern of harvest by residency has remained unchanged since 1985.

Hunter success during 1989/90 increased to 20% (Table 3). During the last two years (1986/87, 1987/88) of either sex moose seasons, hunter success was 19-20%. However, during 1988/89 hunter success dropped to 13%. While 11 hunters reported hunting in Subunit 14B during the 1990/91 closed season, no moose were reported killed.

Harvest Chronology. The chronology of the harvest during 1989/90 differed little from the previous 2 years (1987-88) when season lengths were similar (Table 4). During all 3 years the percent of moose killed the first week ranged from 28-35%.

Transport Methods. During 1989/90 the only noticeable difference in transport methods used by successful hunters was the decline in use of 3- or 4-wheelers (Table 5). Between 1986/87 and 1988/89 this type of transportation accounted for 19-26% of the total harvest.

During 1989/90 they accounted for only 8%. The abbreviated season may have discouraged hunters from making the effort to reach alpine moose habitat.

Other Mortality: Natural mortality was estimated as the primary cause of mortality during 1989/90. Given the November 1989 population estimate (2,800) and the total estimated mortality (44%) 1,214 moose died. Humans were estimated to have caused 25% of the total mortality, leaving approximately 910 dying naturally. Natural mortality was estimated at 34%.

During winter 1989/90 natural mortality was 75-85% for calves, 20-30% for cows, and 25-35% for bulls. A sample of 88 carcasses, were checked in April within the TCA and were comprised of 50% calves (75% males and 25% females), 32% cows and 18% bulls. During April composition surveys within the TCA, 113 adult moose were counted and no calves were seen. However, during the following November survey, staff saw 80 yearling bulls. Natural mortality for calves during moderate winters in Subunit 14B approaches 30-50%, while adults experience 10-20% losses.

Natural mortality of moose during 1990/91 was estimated at 12-18% considering winter conditions. Snow accumulation reached 64 inches at Willow during mid-December and 47 inches at Talkeetna in January. In comparison, during 1989/90 snow depths reached 93-95 inches at Willow and Talkeetna in early March before receding.

The deep powdery snow during the winter 1989/90 produced record high moose mortality from accidents with trains or highway vehicles, illegal killings, DLP kills, and starvation. Public and media reaction to increasing moose deaths elicited emergency funds from the governor and private donations for a "Save the Moose" effort. Many citizens, private organizations, state and federal agencies contributed labor and resources.

Funds were expended primarily on packing escape trails next to the ARC tracks and major highways. ARC began preceding trains with a pilot car to chase moose from the tracks. Snowmachine owners and clubs also volunteered to create networks of trails to allow moose to move in search of food. The bulk of this effort occurred within the TCA of Subunit 14B between Willow and Talkeetna.

Funds were also spent to provide supplemental feeding of starving moose. Pelletized rations and hay (brome, fescue, timothy and alfalfa) were purchased and strategically distributed to reduce conflicts with vehicles and trains. The public was provided hay and it was suggested they could fell trees or cut brush for food.

Grauvogel and Collins (1991) recommended future preventive measures which included: 1) developing trails and clearing brush next to tracks and highways; 2) enhancing habitat away from transportation corridors; 3) establishing a cooperative agreement with ARC to maintain parallel trails and to continue to use pilot cars; and 4) organizing a working group to investigate methods to reduce fatal human-moose interactions.

A cooperative agreement between ARC and ADF&G was approved and signed in January 1991. The ARC agreed to: 1) remove brush from the track ROW; 2) brush parallel trails and maintain them in deep snow winters; 3) operate pilot cars when moose begin to concentrate during winters; 4) report and salvage all moose killed; 5) participate in a research and development (RD) committee; and 6) implement recommendations of the committee when feasible. ADF&G agreed to: 1) promote habitat enhancement away from the tracks; 2) participate in the RD committee; and 3) participate in brush clearing and trail making if funds are provided.

Habitat Enhancement

Enhancement of 145 acres was conducted in western Subunit 14B during 1991. Portions of funds released by the governor to Save the Moose were intended to enhance moose habitat away from the ARC tracks and highway corridor. Bulldozer blading of mature black spruce habitat was conducted on 100 acres east of the ARC tracks. In the Talkeetna Mountain foothills, 45 acres of clear-cut mixed forest type, resulting from recent timber sales, were disked.

CONCLUSIONS AND RECOMMENDATIONS

Becker surveys provided population estimates and composition results adequate to decide that population objectives were achieved during 1989/90 but not in 1990/91. Massive winter mortality, natural and human-caused, generated a 35% population decline, bringing the fall 1990 population estimate to less than 2,000 moose. Even with no open hunting season, the bull:cow ratio did not recover to objective levels.

I recommend that population objectives for bull:cow ratios be changed to (≥) 20 bulls:100 cows. Bull:cow ratio objectives recently established for Subunit 14B do not reflect management goals and objectives established in 1976 (Rausch 1977). These human use goals were to provide the greatest opportunity to participate in hunting moose. The management goal can be better met with a lower bull:cow ratio; a 20:100 ratio is frequently identified for units with similar goals.

Subunit 14B moose numbers should not exceed 3,500 unless significant increases in moose winter range occur. Except the TCA and recent commercial timber sales, little has happened to cause increases in moose winter range. Wintering areas are currently limited in Subunit 14B, and many moose winter in Subunit 14A where average fall densities exceed 3.5 moose/mi^2. We should encourage activities that increase winter habitat directly or indirectly.

We recommended a 10-day bull only hunting season for fall 1991 and expected hunters to harvest 35-50 bulls during that time. The post-hunt bull:cow ratio should be 20-28 bulls:100 cows. The expected post-hunt population level was 1,700-1,800 moose.

I recommend annual use of the Becker survey in Subunit 14B to allow establishment of suitable hunting seasons. Becker surveys provide population estimates and ratios that can be compared for significant changes but do not cost as much as a stratified random census. However, a census is necessary every 5-8 years, to verify stratification assumptions, and more frequently if major changes in the population or habitat occur.

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Table 1. Subunit 14B fall aerial moose composition counts and estimated population size, 1986-1991.

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Adults observed	Total moose observed	Observable moose/mi^2	Population estimate
1986/87[a]	--	--	--	--	---	---	--	---
1987/88[b]	37	9	30	18	906	1,097	2.6	2,814 + 248[c]
1988/89[a]	--	--	--	--	---	---	--	---
1989/90[d]	24	5	26	16	474	563	2.6	2,760 + 550[c]
1990/91[d]	27	9	20	14	609	754	1.7	1,795 + 247[c]

[a] No surveys conducted.
[b] These data were derived from a population census conducted in December 1987.
[c] 80% C.I.
[d] These data derived from "Becker Surveys" conducted in November. SCF estimated at 1.3.

Table 2. Subunit 14B moose harvest and accidental death, 1986-91.

Regulatory	Reported			Estimated			Accidental			Grand
year	M	F	Total[a]	Unreported[b]	Illegal[c]	Total	Road	Train	Total	total
1986/87	131	104	243	12	7	19	28	37	65	327
1987/88	227	118	347	17	25	42	43	173	216	605
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

[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 1986-91.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[a] resident(%)	Nonlocal resident(%)	Nonres	Unk	Total	Local[b] resident	Nonlocal resident	Nonres	Unk	Total	
1986/87	98 (40)	131 (53)	10	4	243	932	35	11	13	991	1,234
1987/88	133 (38)	182 (52)	8	24	347	1,312	50	23	54	1,439	1,786
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

[a] Includes only residents of Subunits 14A and 14B.
[b] Includes all Unit 14 residents.
[c] No open moose season.

Table 4. Subunit 14B moose harvest chronology, 1986-1991.

Regulatory year	Before season opened	Weeks of season 1st (%)	2nd	3rd	4th	After season closed	Unk	Total
1986/87[a]	1	97 (40)	66	63	0	3	13	243
1987/88[b]	0	115 (33)	47	56	116	2	11	347
1988/89[b]	0	49 (35)	19	24	41	3	4	140
1989/90[b]	1	48 (28)	24	36	62	0	2	173
1990/91[c]	0	-- --	--	--	--	--	0	0

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

Table 5. Subunit 14B moose harvest transport methods, 1986-91.

Regulatory year	Airplane	Horse	Boat	3-or 4-wheeler	ORV	Highway vehicle	Unk	Total all methods
1986/87	26	6	23	53	59	59	16	243
1987/88	45	5	27	90	76	83	21	347
1988/89	25	2	10	27	37	34	5	140
1989/90	28	4	17	14	31	43	6	173
1990/91[a]	--	--	--	--	--	--	--	0

[a] No open season.

LOCATION

Game Management Units: Subunit 14C and the Portage and Placer river drainages for Unit 7 (1,912 mi^2)

Geographical Description: 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 that were cut or burned while Anchorage and the Fort Richardson military reservation were developed. Numbers increased considerably during the early 1950s, and by the late 1950s and early 1960s they were abundant. The moose population has remained high the past 25-30 years.

Prime browse prevails in open-canopied, second-growth willow, birch, and aspen stands on burned-over military lands and on several hundred acres of Fort Richardson and Elmendorf Air Force Base (AFB), which were rehabilitated over the past 14 years. Fringe residential areas throughout 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 fluctuated dramatically over the past 25 years. A record harvest of nearly 500 moose (50% females) occurred in 1965 while only 18 moose were harvested in 1978. These large fluctuations were because of changes in seasons and bag limits rather than changes in moose population. After stabilizing in the early 1980s, the harvest has increased steadily since 1986; the 5-year mean harvest is 167 moose (35% cows).

MANAGEMENT DIRECTION

Management Objective

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 sex and age composition aerial surveys in 1989 and 1990 in the Portage area and Subunit 14C during fall and early winter. A population census was conducted on the two military reservations and upper Ship Creek in late fall 1989.

RESULTS AND DISCUSSION

Population Status and Trend

Moose populations remained relatively stable during the 1980s. Population stability was partially because of a series of mild winters beginning in 1979-80; however, because the quantity of critical winter browse has continued to decline, as a consequence of maturation and urbanization, a decline in the current population level appears probable. More severe winters could hasten a population reduction.

Population Size: We determined moose numbers in Subunit 14C and a portion of Unit 7 by composition counts conducted in the mountainous portions and by a census conducted on Fort Richardson-Elmendorf Air Force Base lands during December 1989. In the surveyed areas we estimated a population of 2,040 moose (Table 1). We estimate that an additional 100-150 moose inhabit unsurveyed areas.

Population Composition: In 1989 and 1990, 1,202 and 645 moose respectively, were classified in composition surveys; means of 36 bulls:100 cows and 35 calves:100 cows were observed. Population composition in Subunit 14C was relatively constant over the past 5 years (Table 1). The percentage of calves in the herd fluctuated between 20% and 26%. The bull:cow ratio ranged from 35:100 to 42:100.

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 open seasons for resident and nonresident hunters in that portion of Subunit 14C known as the Fort Richardson Management Area were 5 September-31 October and 15 December-15 January in 1989, and 4 September-15 November and 15 December-15 January in 1990. The bag limit was 1 moose by drawing permit. Hunting was limited to bow and arrow only except during the fall season when muzzleloading rifles were permitted north of Eagle River. Up to 150 permits for either sex moose were issued, 25 for muzzle-loading rifle hunters. There is no open season in that portion of Subunit 14C known as the Anchorage Management Area. The open season for resident and nonresident hunters in that portion of Subunit 14C known as the Eklutna Lake Management Area was 5-30 September in 1989 and 4-30 September in 1990. The bag limit was 1 moose by bow and arrow. The hunt was administered by registration permit. Up to 10 bulls and 5 cows could be taken. The open season for resident and nonresident hunters in the remainder of Subunit 14C was 5-30 September in 1989 and 4-20 September in 1990. The bag limit was 1 moose; Alaska residents could take antlerless moose by drawing permit only. The open season for the Portage area was 1-30 September in 1989 and 20 August-30 September in 1990. The bag limit was 1 moose by drawing permit with 30 permits for antlered moose and 40 for antlerless in 1989 and 40 for antlered and 60 for antlerless in 1990. Hunts were limited to Alaska residents.

Board of Game Actions and Emergency Orders. Several regulation changes occurred after the severe 1989-90 winter. The general season in Subunit 14C was shortened by 10 days to close on 20 September in 1990. This regulation was implemented in response to season reductions in adjacent units where moose experienced extensive winter mortality. Hunting pressure and harvests would have been excessive in Subunit 14C had it remained the only accessible southcentral unit with a season extending to September 30.

Other Board of Game action included: increasing drawing permit numbers on Fort Richardson from 90 to 125 in 1989; implementing the Elmendorf AFB permit drawing bowhunt in 1990; reauthorizing antlerless moose hunting and increasing drawing permit numbers for the Portage area hunts in both 1989 and 1990; and creating the Peters Creek Management Area either sex drawing permit bowhunt in 1990. No emergency orders were issued during the past 5 years.

Hunter Harvest. During the 1989-90 and 1990-91 seasons, 191 and 203 moose were harvested respectively, with averages of 123 bulls and 84 cows annually (Table 2). Nearly 30% of the bulls were taken during the general bull season. The remaining moose were taken in permit hunts.

Moose killed by vehicles and trains added substantially to total mortality. During 1988-89, 91 moose were killed by automobiles and 13 were killed by trains. Over the past 5 years a mean of 114 moose were killed in such accidents (Table 2).

Permit Hunts. During the 1989-90 season, 425 hunters were issued permits to hunt moose in Subunit 14C and the Portage drainages. Of these, 129 (33%) were successful. In the 1990-91 season, 479 permits were issued and 150 (31%) moose were killed (Table 4). Drawing permit hunts were very popular. In 1989, 6,145 applicants applied for 235 available drawing permits, and in 1990, 8,714 applicants applied for 320 permits. An additional 159 hunters in 1989 and 190 in 1990 obtained registration permits for the Eklutna Valley hunt.

Hunter Residency and Success. Residents of Subunit 14C accounted for 77% of the moose harvested in 1989 and 1990 (Table 3). Residents of other units or subunits accounted for slightly more than 21% of the total harvest; nonresidents, less than 2%.

Harvest Chronology. Because of variable opening days tied to the timing of Labor Day, harvest comparisons during the first week of September fluctuated substantially. Harvests during the second, third, and fourth weeks were comparable until 1990 when the season was shortened by 10 days (Table 5). In recent years, a winter archery hunt on military land has been held from mid-December through mid-January, after a large portion of the Fort Richardson-Elmendorf-Ship Creek moose population becomes accessible in lowland areas of Fort Richardson.

Transport Methods. Approximately 70% of all successful moose hunters reached their preferred hunting areas by highway vehicles (Table 6). Prohibiting motorized vehicles in most of Chugach State Park and the accessibility of lowland moose accounted for the high percentage of walk-in hunters. An additional 10-20% of successful hunters used boats, and 5-10% used horses.

Other Mortality: Significant natural mortality has been minimal in Anchorage area moose populations since their numbers began to increase in the mid-1950s. Moderate annual snowfall and relatively low numbers of predators account for this. Despite a severe winter in 1989-90 natural mortality appeared low.

Habitat Assessment

Large tracts of subalpine and riparian habitat are protected throughout the 500,000-acre Chugach State Park and on USFS lands from Girdwood to 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 private land from Knik River to Potter Creek. However, roads and trails associated with development provide movement corridors, which reduce energy loss for moose during years of heavy snowfall.

Extensive habitat enhancement on military, state, and municipal lands is neither desirable or economically feasible. Winter habitat will inevitably decrease over time as will the number of moose which depend on it.

CONCLUSIONS AND RECOMMENDATIONS

Major population objectives for the subunit were met. The bull:cow ratio exceeded 25:100, and approximately 2,000 moose occupied defined count units. An additional 100-150 moose probably reside in unsurveyed areas.

Existing management programs were developed over the past decade during which numerous consultations were held with staffs from Fort Richardson 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 population in an area where a number of land management agencies have limited modes of access. Nuisance moose in residential areas remain a significant problem. Public education regarding moose behavior and biology may improve public tolerance and reduce conflict situations.

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Table 1. Subunit 14C fall aerial moose composition counts and estimated population size, 1985-1991.

Area	Regulatory Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves %	Total moose observed	Moose/ hr.	Estimated population size
Portage	1986/87	22	18	44	27	176	65	
	1987/88	30	13	50	28	189	57	
	1988/89	33	16	80	37	294	113	
	1989/90	27	15	38	23	303	92	
	1990/91	44	20	60	29	333	101	350
Hillside	1986/87	37	22	35	19	83	66	
	1987/88	62	26	35	18	130	41	
	1988/89	48	19	35	19	148	53	
	1989/90	47	20	31	18	171	53	
	1990/91	81	27	31	15	110	60	250
Fort Richardson	1986/87	37	22	60	31	366	--	
Elmendorf	1987/88	36	17	42	24	385	28	
Off Base Ship Cr.	1988/89	40	19	48	26	426	35	
	1989/90	26	11	40	24	459	36	
	1990/91	--	--	--	--	--	--	600
Eagle River	1986/87	--	--	--	--	--	--	
	1987/88	44	16	27	16	109	39	
	1988/89	--	--	--	--	--	--	
	1989/90	--	--	--	--	--	--	
	1990/91	--	--	--	--	--	--	170
Peters Creek	1986/87	8	8	46	30	40	47	
	1987/88	14	6	39	25	55	39	
	1988/89	17	6	40	26	74	44	
	1989/90	12	5	37	25	64	28	
	1990/91	18	14	47	29	84	61	100

(cont'd)

Table 1. (cont'd.)

Area	Regulatory Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves %	Total moose observed	Moose/ hr.	Estimated population size
Eklutna	1986/87	45	16	23	13	104	41	
	1987/88	47	11	22	13	86	27	
	1988/89	43	14	33	19	135	36	
	1989/90	41	15	35	20	116	39	
	1990/91	32	2	35	21	104	23	200
Bird-Indian	1986/87	--	--	--	--	--	--	
	1987/88	--	--	--	--	--	--	
	1988/89	49	20	24	14	85	43	
	1989/90	--	--	--	--	--	--	
	1990/91	--	--	--	--	--	--	120
Hunter Creek	1986/87	41	15	49	26	152	91	
	1987/88	51	14	40	21	147	77	
	1988/89	44	17	55	28	187	94	
	1989/90	44	23	--	18	148	57	
	1990/91	29	11	--	15	194	58	250
Subunit 14C Total	1986/87	39	18	48	26	1,029	56	
	1987/88	42	17	38	21	1,210	37	
	1988/89	41	17	50	26	1,434	49	
	1989/90	35	15	34	20	1,202	41	
	1990/91	37	12	38	22	645	53	2,050

Table 2. Subunit 14C moose harvest and accidental death, 1986-91.

Regulatory Year	Reported M	Reported F	Reported Total	Estimated Unreported	Estimated Illegal	Estimated Total	Accidental Road	Accidental Train	Accidental Total	Grand total
1986/87	88	33	121	10	10	20	105	3	108	249
1987/88	106	52	158	10	10	20	105	28	133	311
1988/89	120	44	164	10	10	20	91	13	104	288
1989/90	120(63)	71(37)	191	10	10	20	108	17	125	336
1990/91	106(52)	97(48)	203	10	10	20	91	11	102	325

Table 3. Subunit 14C moose hunter residency and success in, 1986-91.

Regulatory Year	Successful Local[a] resident	Successful Nonlocal resident	Successful Nonresident	Successful Total (%)	Unsuccessful Local resident	Unsuccessful Nonlocal resident	Unsuccessful Nonresident	Unsuccessful Total[c] (%)	Total hunters
1986/87	101	17	0	118	310	62	0	372	
1987/88	97	22	0	119(24)	282	84	3	369(76)	488
1988/89	121	29	8	158(27)	342	89	6	437(73)	595
1989/90	138	37	2	177(28)	368	82	5	455(72)	632
1990/91	134	38	4	176(27)	355	117	2	474(73)	648

[a] Residents of Subunit 14C.

Table 4. Subunit 14C 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	Total Harvest
910, 911	1986/87	20	--	--	9	9	0	9
Portage	1987/88	20	5	47	53	10	0	10
	1988/89	20	15	35	65	11	0	11
	1989/90	70	13	38	62	19	19	38
	1990/91	100	6	34	66	26	36	62
924, 925, 927	1986/87	15	0	67	33	5	0	5
Fort Richardson	1987/88	90	7	28	72	24	36	60
(archery)	1988/89	90	7	36	64	22	32	54
	1989/90	125	3	38	62	25	30	55
	1990/91	125	13	59	41	12	31	43
922, 923	1989/90	25	4	25	75	10	8	18
Fort Richardson	1990/91	25	12	36	64	4	10	14
(Muzzleloader)								
975	1986/87	183	15	90	10	29	5	14
Eklutna	1987/88	204	32	92	8	36	7	13
	1988/89	146	23	93	7	38	0	8
	1989/88	190	35	94	6	5	2	7
	1990/91	159	14	93	7	6	3	9
941	1986/87	15	20	67	33	--	4	4
Hunter-Knik	1987/88	15	7	69	31	--	4	4
	1988/89	15	20	75	25	--	3	3
	1989/90	25	8	61	39	--	9	9
	1990/91	15	27	36	64	--	7	7

Table 4. (cont'd.)

Hunt No. /Area	Regulatory Year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	Cows	Total Harvest
942 Elmendorf A.F.B.	1990/91	5	7	0	93	8	6	14
942 Ship	1986/87	20	20	88	12	--	2	2
	1987/88	20	30	86	14	--	2	2
	1988/89	20	15	65	35	--	6	6
	1989/90	0	--	--	--	--	--	--
	1990/91	0	--	--	--	--	--	--
943 Peters[b]	1986/87	15	14	83	17	--	2	2
	1987/88	15	40	67	33	--	3	3
	1988/89	15	20	83	17	--	2	2
	1989/90	15	27	82	18	--	2	2
	1990/91	15	20	92	8	--	1	1
Totals for all	1986/87	268	--	--	--	--	--	36
	1987/88	364	--	--	--	--	--	92
	1988/89	306	--	--	--	--	--	84
	1989/90	450	--	--	--	--	--	129
	1990/91	444	--	--	--	--	--	150

Table 5. Subunit 14C moose harvest[a] percentage by time period, 1986-91.

Year	9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	n
1986	30	25	25	16	4	59
1987	2	24	22	34	19	62
1988	18	31	14	28	9	79
1989	18	17	18	26	20	68
1990	38	42	20	--	--	49

[a] Excludes permit hunt harvest

Table 6. Subunit 14C moose harvest percentages by transport method, 1986-91.

Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Off-road vehicle	Highway vehicle	n
1986	1	8	12	7	0	4	68	119
1987	1	8	9	3	0	4	75	138
1988	6	9	5	1	1	4	74	148
1989	1	9	19	3	0	4	129	165
1990	6	15	34	5	0	1	107	168

LOCATION

Game Management Subunit: 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 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 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 a stable population trend in the range of 3,014-3,850 moose.

In the last two decades no large forest fires similar to the 1947 and 1969 Kenai Peninsula burns 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. 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 intensified the necessity for cooperative interagency management of renewable resources. ADF&G 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 a variety of cooperative moose management programs. These include support of the ADF&G Moose Research Center near Sterling, cooperative management of Skilak Loop as a wildlife viewing area and recent attempts to provide increased access for hunters using wheelchairs. We need to continue this pattern of close coordination and cooperation whenever possible.

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 is scheduled for completion.

MANAGEMENT DIRECTION

Management Objectives

Management objectives for Subunit 15A (except the Skilak Loop Wildlife Management Area) include maintaining a healthy moose population with a posthunting bull:cow ratio of at least 15:100.

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 their behavior 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. The bull:cow ratio will be increased to at least 40 bulls:100 cows. Resident moose in excess of 130 will be available for harvest. In addition to the resident population, moose from surrounding areas commonly winter in SLWMA. Winter numbers can reach 300 animals and the habitat will be managed to provide for 130 resident moose plus up to 170 additional wintering moose.

METHODS

We conducted aerial surveys in November and December of each year in selected trend count areas to ascertain sex and age composition. In 1989, 2 of 13 count areas in Subunit 15A were surveyed while the following year 9 of 13 count areas were examined. We developed a population estimate for Subunit 15A 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 did not strictly compare with the 1990 estimates. A few sample units containing unexpectedly high densities of moose were not flown in 1987 because of poor weather. The 1987 calculation subsequently underestimated the Subunit 15A moose population (Taylor 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 3,014-3,850 moose was more accurate. The number of moose in the subunit probably did not change between 1987 and 1990. No population estimate was developed in 1990/91.

Population Composition: In 1990, 1,580 moose were observed in fall composition surveys, compared with 1,737 in 1989 (Table 1). Calves comprised 22% of the 1990 sample at a ration of 35:100 cows. The 1990 and 1989 calf composition data were virtually identical. We observed 23 bulls:100 cows, 1 bull higher ratio than in 1989. Yearling bulls observed declined from 7:100 in 1989, to 3:100 in 1990, following the highest annual snow accumulation since severe winters of the 1970s.

Mortality

Harvest:

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

Board of Game Actions and Emergency Orders. A proposal establishing a selective harvest strategy for bull moose was adopted during the 1987 spring Board of Game meeting. This proposal, specifying a legal bull as one with specific antler size, was adopted for 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) lead to skewed sex ratios favoring females and a male age structure favoring young bulls. Heavy harvest limited opportunities to view and photograph mature bulls.

The Board of Game initiated a spike-fork/50-inch restriction, a 2-29 August archery-only season, and a 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 1990, 97 moose (93 bulls, 2 cows, and 2 of unspecified sex) were harvested by 998 hunters during the general season (Table 2). The 1990 harvest declined by 46% compared to the 1989 harvest of 181 moose. This reduction in harvest reflects heavy winter losses sustained by the Subunit 15A population in deep snows of the 1989/90 winter.

Results of a 25-29 August archery season were included in the 1990 total harvest figures for Subunit 15A. Information requested on archery harvest ticket reports did not include when a person hunted 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 archery hunters participated during the 25-29 August 1990 archery only hunt in Subunit 15A. They reported killing 5 bulls compared to 18 taken during the same season in 1989. Archers did not report harvesting any bulls with 50-inch antlers or larger category in either year. The 1989 harvest of 18 bulls was reported by approximately 400 archers. The reduced effort in 1990 was attributed to a new mandatory bow hunter education course. Many archers had not completed the course before the season. Archers were required to follow the same antler restrictions imposed on hunters during the general season.

Of the 93 bulls harvested in 1990, 91 (98%) 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 < 30 inch antlers met the yearling (spike-fork) requirement and ≥ 30 inch antlers were mature bulls (having 3 brow tines or an antler spread > 50 inches). Sixty-six percent (N=60) of the harvest were spike-fork bulls and 34% (N=31) were mature bulls. Eleven percent (N=10) of the reported harvest were bulls with an antler spread ≥ 50 inches. In 1989, 75% (125) of the harvest were yearlings and 25% (41) were mature bulls.

Permit Hunts. We received 1,588 applications for 20 permits issued to hunt antlerless moose in SLWMA during 1990. Sixteen permittees hunted and 7 were successful (Table 3). Three permittees reported they did not participate in the hunt and 1 person did not return a report. All moose harvested were females and ranged in age from 1 to 18 years with a mean age of 7 years. The 1990 reported harvest and effort compared closely with 1989 figures when 8 moose were harvested.

Hunter Residency and Success. The 1990 hunter success rate was 10% compared to 17% in 1989. In 1990, 77 (79%) successful hunters were unit residents, 14 (14%) were non-unit residents, and 3 (3%) were nonresidents. Three (3%) successful hunters failed to report their residency. Residency reported for unsuccessful hunters was: unit residents, 662; non-unit state residents, 199; nonresidents, 18; and unspecified residency, 22 (Table 4). Successful hunters averaged 5.3 days compared to 6.1 days for all hunters. Archers averaged 1.4 days hunting with a range of 1 to 2 days for successful hunters.

In 1989, 159 (88%) successful hunters were unit residents, 18 (10%) were non-unit residents and 2 (1%) were nonresidents (Table 4). Two (1%) successful hunters failed to report their residency. Residencies reported for unsuccessful hunters in 1989 were: unit residents, 753; non-unit residents, 140; nonresidents, 14; and unspecified residency, 10. Successful hunters averaged 4.5 days afield compared to 6.1 days for all hunters. Archers averaged 2.3 days hunting with a range of 1 to 5 days for successful hunters.

Transport Methods. During 1990, 56% (n=54) of successful hunters and 64% (n=580) of unsuccessful hunters reported highway vehicles as their means of transportation. Boats were the second most common (13%) means of transportation. Hunters using aircraft, ATVs, and horses accounted for 17% of the reported harvest by transportation means and 10% of all hunters. The 1990 transportation data compared closely with 1989 when 64% of the successful hunters reported using highway vehicles (Table 5).

Chronology of Harvest: Thirty-eight percent (65) of the 1989 harvest and 41% (37) of the 1990 harvest occurred during the season's first 5 days (Table 6). The second highest harvest period in 3 of the past 4 years was during the last 5 days of the season.

Other Mortality: The amount of crippling loss by hunters using rifles and loss to predation was unknown. In 1990/91, 119 moose were reported killed in Subunit 15A by vehicles; 69% (82) were calves; 21% (25) were adult females; 8% (10) were adult males; and 2% (2) were of unreported age. The 1990 reported kill by vehicles was reduced by 42% compared to 205 killed in 1989 (Table 4). A public awareness program to reduce automobile/moose collisions began in 1990 (del Frate and Spraker 1991) and may have reduced number of collisions that year.

Habitat

Assessment: The 1969 burn (85,000 acres) still provides browse for most 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 because of 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 because of the small size of the burn. Substantial statewide publicity about the beneficial effects of wildfire for forest succession wildlife was derived from the Pothole Lake fire.

CONCLUSIONS AND RECOMMENDATIONS

A preliminary review of the selective harvest strategy in Subunit 15A reveals the following trends. The bull: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 increase during the next 3 years (1988-90).

If we observe a similar increase in the bull:cow ratio during the 1992 fall survey, I recommend an increase in season length to 1-30 September, however, only spike/fork bulls would be 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.

Increased numbers of bulls enhanced the opportunity for viewing and photographing. Public perception of improved moose population health and public support to continue the program has also grown.

During this report period, the 1989-90 winter was most severe and exerted significant mortality on segments of the Subunit 15A moose population, particularly calves of the year. This winter-caused mortality was observed in the reduced number of yearlings during fall 1990 composition surveys. Decreased hunter success in 1990 was also probably related to very few yearling moose being available. The number of moose killed by automobiles declined substantially from the severe winter of 1989/90 to the following winter. The reduction may have been partially caused by weather conditions and reduced moose population size. However, the ADF&G 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 reduced roadside moose kills in 1990/91.

No emergency reduction in the 1990/91 moose season or bag limit was necessary because of effects of the previous severe winter. The conservative nature of the spike/fork-50 inch antler bag limit on the Kenai Peninsula allowed ADF&G to continue offering the same recreational opportunity as in previous years. The 1990/91 moose harvest declined substantially (46%) because of reduced availability of yearlings compared to the 1989/90 season. However, approximately the same number of hunters reported hunting in Subunit 15A both seasons. I recommend no changes in management objectives or seasons and bag limits at this time.

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Table 1. Subunit 15A aerial moose composition counts and estimated population size, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1986/87[a]								
1987/88	16	6	38	25	784	1,026	46	2,702
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

[a] No data available.

Table 2. Subunit 15A moose harvest[a] and accidental death, 1986-91.

	Hunter Harvest										
Regulatory	Reported				Estimated			Accidental death			Grand
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	total
1986/87	285	22	29	366			40	112		112	518
1987/88	131	3	16	150			40	114		114	304
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

[a] Excludes permit hunt harvest.

Table 3. Subunit 15A moose harvest data by permit hunt, 1986-91.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Total Bulls (%)	Cows (%)	Unk.	harvest
944	1986/87[a]								
Skilak	1987/88[a]								
Loop	1988/89[a]								
	1989/90	20	--	--	--	0	8		8
	1990/91	20	15	50	35	0	7		7
Totals for	1986/87[a]								
all permit	1987/88[a]								
hunts	1988/89	20	--	--	--	0	8		8
	1989/90	20	15	50	35	0	7		7
	1990/01	20	15	50	35	0	7		7

[a] Hunt began in fall 1989.

Table 4. Subunit 15A moose hunter[a] residency and success, 1986-91.

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
1986/87[c]									
1987/88	122	23	1	150	800	164	6	985	1,135
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

[a] Excludes hunters in permit hunts.
[b] Local = residents of Subunit 15A
[c] Data not available.

Table 5. Subunit 15A moose harvest[a] percent by transport method, 1986-1991.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1986/87[b]									
1987/88	9	4	26	4	0	7	81	19	150
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

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

Table 6. Subunit 15A moose harvest[a] chronology percent by time period, 1986-91.

Regulatory	Harvest periods						
year	8/25-8/29	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	n
1986/87[b]							
1987/88	11	53	21	20	28	17	150
1988/89	16	61	20	20	19	0	136
1989/90	18	65	28	20	39	11	181
1990/91	5	37	13	16	20	6	97

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

LOCATION

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

Geographical Description: Kenai Peninsula

BACKGROUND

Moose in Subunit 15B have been relatively abundant throughout this century with the most recent peak in occurring 1971. The near absence of wolves from 1913 to 1968 is believed to be the primary reason for the expansion of this moose population. A wildfire that burned approximately 500 mi^2 in adjacent Subunit 15A in 1947 also benefitted moose by improving winter forage. A series of harsh winters from 1971 to 1974 reduced the moose population in Subunit 15B. Population estimates suggested a decline from 1,975 moose in 1971 to 843 by 1975. A census in February 1990 indicated a slight increase since 1975, with the mid-winter 1990 moose population estimated at 1,042. Because habitat conditions have declined through plant succession, and predation impacts did not change, the slight increase may be attributed to a reduced harvest resulting from the selective harvest program initiated in 1987.

MANAGEMENT DIRECTION

Management Objectives

The moose management objectives in Subunit 15B West are to maintain a population of moose with a minimum bull:cow ratio of 15:100 and allow for maximum opportunity to participate in hunting. In Subunit 15B East, the objectives are to maintain a moose population with a minimum bull:cow ratio of 40:100 and provide for an opportunity to harvest a trophy-size bull under aesthetically pleasing conditions.

METHODS

We conducted aerial surveys each year during November and December in selected trend count areas to determine the sex and age composition of the moose population. During 1990 we conducted a winter census to estimate mid-winter moose density. The technique used was described in "Estimating Moose Population Parameters from Aerial Surveys" (Gasaway et al. 1986).

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: A 1990 census of suitable moose habitat in Subunit 15B revealed a mid-winter population estimate of 1,042 moose (90% C.I.= 779-1,305). The estimated mean density was 1.2 moose/mi^2 (range = 0.3-3.0). The census was conducted during mid-winter after most bulls had shed their antlers, so sex composition was not determined. Age composition was determined and calves comprised 9.5% of the population. This estimate indicates a slight increase in population size when compared to the 1975 estimate (843). Winters have been normal or mild since the mid-1970s with the exception of 1987-88 and 1989-90 when record snow depths were reported. No census data were available for 1989.

Population Composition: Insufficient population data were collected in 1989 and 1990 to determine sex and age composition other than percent calves during the 1990 census. Calves comprised 9.5% of the estimated population of 1,042 moose (Table 1).

Mortality

Harvest:

Season and Bag Limit. Moose hunting seasons in Subunit l5B, that portion bounded by a line running from the mouth of Shantatalik Creek on Tustumena Lake, north to the west fork of Funny River; then downstream along the west fork of Funny River to the Kenai National Moose Range boundary; then east along the refuge boundary to its junction with the Kenai River; then east along the south side of the Kenai River and Skilak Lake; then south along the west side of Skilak River, Skilak Glacier, and Harding Icefield; then west along the Subunit 15B boundary to the mouth of Shantatalik Creek were 1-20 September and between 26 September and 15 October. The bag limit is 1 bull with 50-inch antlers by drawing permit only with up to 100 permits issued. The hunting season in the remainder of Subunit 15B was 1-30 September. The bag limit was 1 bull with spike-fork or 50-inch antlers.

Board of Game Actions and Emergency Orders. No changes in seasons, bag limits or area boundaries occurred during this report period. The last board action was in 1987 when the selective harvest program was initiated.

Hunter Harvest. In Subunit 15B West, 54 bulls were reported harvested by 295 hunters during 1990. The 1990 moose harvest represents a 24% increase compared to 1989 (Table 2). Of the 54 moose reported by hunters in Subunit 15B West, 52 (96%) included antler spread data. Because the current bag limit focuses harvest on a portion of the yearlings and mature bulls, we assumed that antlers < 30 inches met the yearling (spike-fork) requirement and antlers ≥ 30 inches were from mature bulls. Sixty-two percent were spike-fork antlered and 38% were mature bulls. Twenty-nine percent (n=15 of 52) of the harvest were bulls with antler spreads ≥ 50 inches. In 1989, 66% of the harvest were spike/fork and 32% were mature bulls.

Permit Hunts. We managed Subunit 15B East as a trophy moose hunting area. Hunters were selected by a random drawing with 100 permits issued for two separate seasons. We received 2,868 applications for these permits during 1990. Bulls with antler spreads of at least 50 inches or with 3 brow tines were legal. Permittees reported harvesting 31 bull moose, and 71% of the permittees hunted. Hunter success was 44% (Table 3). Twenty-four (77%) of the successful hunters were unit residents, 5 (16%) were non-unit Alaska residents, and 2 (7%) were nonresidents. The mean antler spread of bulls harvested during 1990 was 55 inches (range = 39-62)and the mean age was 7 years (range = 3-10). The 1989 harvest data compares closely with that of 1990. Hunters harvested 25 bulls in 1989 with 62% hunter participation and 40% success.

Hunter Residency and Success: Fifty-three (98%) of the 54 successful hunters were Unit 15 residents and 1 hunter did not report residency. Unsuccessful hunters were comprised of 202 (84%) unit residents, 28 (12%) non-unit Alaska residents, 4 (2%) nonresidents, and 7 (3%) unspecified residency (Table 4). Hunter success was 18%. Successful hunters averaged 5.5 days afield compared to 6.3 days for all hunters.

Transport Methods. In Subunit 15B West, 74% of the successful hunters (34) and 69% of the unsuccessful hunters (135) reported highway vehicles as their primary means of transportation during 1990. Horses (17%) were the second most common transportation means for successful hunters (Table 5). In Subunit 15B East, 90% of the successful hunters used horses as the primary transport method to access the hunting area. During 1989, 76% of the successful hunters used highway vehicles. Transportation means remained constant for the past 4 years with highway vehicles the most commonly reported and horses second in Subunit 15B West.

Harvest Chronology: During 1990, 40% of the harvest occurred in the first 5 days of the season. The second highest harvest period was the last 5 days of the season. In 1989 the first and third 5-day periods accounted for 27% each, with the highest harvest (29%) occurring the last 5 days (Table 6).

Other Mortality: In addition to human harvest, 65 moose were reported killed in Subunit 15B West by vehicles from 1 July 1990 to 30 June 1991. No roads exist in Subunit 15B East. Road kills were 22% (14) cows, 74% (48) calves, and 5% (3) bulls. The 1990 kill by vehicles was 28% lower than 1989 when 90 moose were reported. The extent of weather-related mortality and predation by wolves and bears is unknown in Subunit 15B.

Habitat Assessment

No significant habitat enhancement has occurred in this subunit since a wildfire burned a large area around 1890. Approximately 2,000 acres of winter habitat on the refuge was enhanced using a variety of mechanical tree removal techniques during the early 1950s by the USFWS. Several small acreages (less than 50 acres) have also been designated as wood cutting areas for non-commercial 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 Subunit 15B is relatively poor and declining because of natural plant succession.

CONCLUSIONS AND RECOMMENDATIONS

The reported harvest of 54 bulls in Subunit 15B West during 1990 indicates a 24% increase compared to 41 moose killed in 1989. A mean of 72 bulls was harvested annually during the 5-year period (1982-86) before the selective harvest program began in 1987. The mean harvest has been 48 moose since 1987, with no apparent trend. A comparison of these mean harvests suggests a 33% mean reduction in harvest during the first 4 years. A similar comparison of hunting effort suggests a 27% decline, however, hunting increased slightly from 276 in 1987 to 295 in 1990.

Population modeling using estimated recruitment and mortality parameters, predicted the mean harvest would approach the 72 moose reported before 1991. The present harvest and trend suggest the harvest objective will be met. Moderate to severe winters in 1987-88 and 1989-90 may have caused high calf mortality. The model prediction was based on normal winter mortality. Winter mortality may also have reduced the number of bulls available for harvest in the fall 1990 season. The decline in hunting effort also contributed to reduced harvest. Because the selective harvest program was scheduled to continue through at least 1991, I recommend no changes for Subunit 15B West at this time.

The trophy bull moose hunt in Subunit 15B East continued to provide excellent hunting opportunities and was popular among resident hunters. The harvest of 31 bulls during 1990 was well within acceptable guidelines for maintaining a minimum bull:cow ratio of 40:100. Since the objective for this area was 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 15B continues to deteriorate because of wilderness land management policies which favor advanced forest succession. ADF&G and the USFWS should cooperate on selected habitat enhancement projects (mechanical manipulation and prescribed burning) 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, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1986/87[a]								
1987/88[a]								
1988/89[a]								
1989/90	17		30	20	204	230		1,000
1990/91[a]								

[a] No data available

Table 2. Subunit 15B moose harvest[a] and accidental death, 1986-91.

Regulatory year	Hunter Harvest							Accidental death			Grand total
	Reported				Estimated						
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	
1986/87	85	1	3	89			20	54	--	54	163
1987/88	40	2	7	49			20	51	--	51	120
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

[a] Excludes permit hunt harvest.

Table 3. Subunit 15B East moose harvest data by permit hunt, 1986-91.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
Totals for	1986/87	100	37	63	37	23 (100)	0 (--)	--	23
all permit	1987/88	100	31	57	43	33 (100)	0 (--)	--	33
hunts	1988/89	100	30	57	43	30 (100)	0 (--)	--	30
0930-0939	1989/90	100	38	60	40	25 (100)	0 (--)	--	31
	1990/91	100	29	56	44	31 (100)	0 (--)	--	31

Table 4. Subunit 15B West moose hunter[a] residency and success, 1987-91.

	Successful				Unsuccessful				
Regulatory year	Local[b] resident	Nonlocal resident	Nonresident	Total(%)[c]	Local[b] resident	Nonlocal resident	Nonresident	Total(%)[c]	Total hunters
1986/87									
1987/88	43	5	0	49	203	16	1	227	176
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

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

Table 5. Subunit 15B West moose harvest[a] percent by transport method, 1986-1991.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1986/87[b]									
1987/88	4	8	10	0	0	0	61	16	49
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

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

Table 6. Subunit 15B moose harvest[a] percent by time period, 1986-91.

Regulatory year	Harvest periods: 9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	n
1986/87[b]						
1987/88	43	12	12	20	12	49
1988/89	44	8	8	23	17	48
1989/90	27	17	27	29	0	41
1990/91	39	20	13	29	4	54

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

LOCATION

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

Geographical Description: Southern Kenai Peninsula

BACKGROUND

Moose are the main forest dwelling ungulate on the southern Kenai Peninsula and are important in the transfer of energy and nutrients in the terrestrial food chain. Moose are also 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.

Declining availability and quality of winter habitat are serious factors limiting moose on the lower Kenai Peninsula. During heavy snow accumulations in the uplands, 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 the Fox River and Sheep Creek, and the Homer Bench. Human development in these areas poses a serious loss of habitat for moose. Local public awareness of this resource conflict led to designation of the Anchor River/Fritz Creek Critical Habitat Area by the Alaska Legislature in 1985.

MANAGEMENT DIRECTION

Moose management objectives for Subunit 15C are to maintain a population of 3,000 moose and a posthunting sex ratio of not less than 15 bulls:100 cows.

METHODS

We assessed population trend and sex-age composition primarily by aerial surveys conducted in standardized count areas during October and November. Aerial surveys were made only during years when snowcover was extensive and moose sightability was high. Surveys were made at an intensity rate of 4.5-6.5 minutes/mi^2.

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 and 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

Moose were moderately abundant and probably near the ecological carrying-capacity of the coastal and boreal vegetation types in Subunit 15C. During the last decade, which was generally characterized by mild winters, moose populations appeared stable with an estimated minimum density of 2-3 moose/mi^2.

Population Size: We estimated 2,500-3,000 moose in Subunit 15C. Assuming there were 500 moose in the eastern mountainous region of Subunit 15C, we estimated that 2,000-2,500 moose inhabit 1,190 mi^2 of lowland habitat south of Tustemena Lake.

Population Composition: Count Area 24 was surveyed during 1989 resulting in the classification of 546 moose (89 bulls, 114 calves, 343 cows). The bull:cow ratios and calf:cow ratios were 26 bulls:100 cows and 33 calves:100 cows, respectively (Table 1).

Count Area 21 was surveyed during 1990 and 293 moose (68 bulls, 41 calves, and 184 cows) were classified. Bull:cow and calf:cow ratios were 37:100 and 22:100 cows, respectively. On 21 March 1991 we surveyed the Tier II moose hunt area near Nanwalek and Port Graham. Based on the observations of 8 moose (2 bulls, 1 calf, 5 cows) and tracks of 12-15 additional moose we estimated the moose population at 30 moose. We did not see moose on Elizabeth Island where 9 calves were transplanted in 1983.

Mortality

Harvest:

Season and Bag Limit. The moose season for resident and nonresident hunters in Subunit 15C was 1-20 September. The bag limit was 1 bull with a spike or fork antler on at least 1 side or with at least a 50-inch spread between antlers or at least 3 brow tines on 1 side.

A subsistence season took place in a portion of Subunit 15C, southwest of a line from Point Pogibshi to the point of land between Rocky Bay and Windy Bay. In 1989, the moose season for subsistence hunters in Subunit 15C was 1-30 September in 1989, and 26 September to 25 October in 1990 with a 1 bull bag limit. In 1990, 8 Tier II permitees were authorized to harvest a quota of 2 bulls.

Board of Game Actions and Emergency Orders. The Board of Game created the Lower Kenai Controlled Use Area in 1985 to reduce hunting pressure and increase the proportion of bulls in the population. As recently as 1990 there have been several unsuccessful attempts to modify or eliminate the Lower Kenai Controlled Use Area which limits the use of outdoor recreational vehicles during the last 10 days of the moose season. The most recent action by the board was to establish spike-fork/50 inch antler hunting regulations beginning in 1987.

Hunter Harvest. During 1989, 737 hunters reported harvesting 156 moose while the following year, 933 hunters harvested 200 bulls (Table 2). During 1989, 52% of the bulls harvested (153) were in the spike/fork category and 48% had antler spreads of at least 50 inches or had at least 3 brow tines on at least 1 side. One bull had an antler spread that exceeded 65 inches. In 1990, moose were split evenly between both size classes with 3 moose having over 65-inch antler spreads.

Beginning in 1987, regulations required hunters on the Kenai Peninsula to harvest only bulls with a spike/fork or 50 inch antlers. The response to the regulatory change was a 33% decline in the number of hunters and a 48% decrease in the number of moose harvested over the previous year, 1986 (Table 3). Between 1987 and 1989 the number of hunters appeared to stabilize (3-year mean = 759, range = 737-773), while moose harvests ranged between 127-170 (3-year mean = 151). However, in 1990, the number of hunters increased 27% and there was a commensurate increase (28%) in the number of moose harvested. This was the result of reductions in length or closing of moose seasons in Units 13, 14, and 16 during 1990, the season immediately following heavy winter mortality.

Hunter Residency and Success. Most (82-87%) moose hunters were local residents; hunters living in Unit 15 harvested 82% and 84% of the moose taken in 1989 and 1990, respectively (Table 3). Hunter success rate was 21% for both years. Successful hunters spent an average of 5.3 days afield compared to 6.4 days by all hunters.

Transport Methods. Hunters using highway vehicles took 31% of the harvest in 1989, followed by users of ORVs (21%), 3- or 4-wheelers (19%), horses (10%), and others (Table 4). In 1990, hunters using highway vehicles and 3- or 4-wheelers each harvested 29% of the total (Table 4). Highway vehicles have been the most popular means of transportation, however, hunters using automobiles have experienced low success rates (Table 5). Between 1987-91, hunters using highway vehicles had an average success rate of 19% (range = 15-25). The use of 3- or 4-wheelers and ORVs has steadily increased and hunter success among this group has averaged 28% (range = 16-34) between 1987-91.

Other Mortality: The number of moose killed by highway vehicles increased over the past 5 years (mean = 56) and peaked at 83 moose in 1990/91 (Table 2). A committee of concerned citizens and agencies created a public awareness program to remind motorists of the hazards of moose on highways. The slogan "Give Moose a Brake" was adopted as the theme and was presented to motorists in public service announcements, bumper stickers, window signs, road signs, and coloring posters (Del Frate and Spraker, 1991).

The 1989-90 winter was severe. No winter kills were documented but numbers of moose dying were believed to be higher than the 32 reported for 1988. The 1990-91 winter was generally mild with bare ground exposed most of the winter. Starvation cases in the Homer area were minimal because of available browse.

Habitat

Assessment: In the early 1980s concern was raised about establishing a red meat industry in Subunit 15C with the potential to impact moose negatively. Technologically improved ORVs made these vehicles more reliable and increased recreational opportunities. These factors combined with a growing human population added pressure on moose in Subunit 15C. ADF&G began a moose population identity study in Subunit 15C. The objectives of this project were to: 1) determine seasonal movements and habitat use of moose by sex and age class; 2) identify critical moose habitats; and, 3) determine the moose population size and rate of increase.

Thirty-eight moose were fitted with individually numbered visual collars equipped with radio telemetry equipment. Moose were relocated monthly by aerial tracking and occasionally from the ground by staff and public. Data were recorded on field forms and later filed on a computer. Several winter reconnaissance flights were conducted to determine distribution of rutting and postrutting concentrations of moose and to delineate wintering areas. From this information we will address geographic distribution, movement patterns, and seasonal habitat requirements as well as adult mortality and calf survival and recruitment. All locations will be digitized using computer mapping software to assist with distribution analysis. Upon completion of the mapping portion, data will be analyzed and a final report will be published in the 1993 Management Report series.

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 would be significantly affected by project construction and operation. Mitigation focused on compensation for habitat lost from rising water levels in the lake. Four options were considered, three of which have been implemented. A total of 456 acres of land in the Fritz Creek drainage near Homer was purchased for $345,279. The AEA also secured two Interagency Land Management Agreements with the Department of Natural Resources. A $50,000 trust fund was established to provide money for moose management. This fund will be administered by trustees selected by AEA.

CONCLUSIONS AND RECOMMENDATIONS

The Homer Bench winter range is the most depleted moose winter habitat on the lower Kenai Peninsula (Holdermann, 1990). Habitat availability and quality have steadily declined over the past 30 years because of human settlement and urbanization, advancing plant succession, and overuse of foraging areas by moose. The decadent condition of winter browse plants and the high rate of starvation among calves during winters of 1988-89 and 1989-90 indicated that this moose population exceeded range carrying capacity.

Holdermann (1990) recognized three components to address winter mortality on the Homer Bench area: moose population control, management of habitat on private lands, and maintenance and enhancement of winter forage. The wintering moose population in the Homer area should be reduced to allow browse to regenerate. I recommend a winter harvest of 50 cows and calves combined in the Homer area. Other drainages (Anchor River, Deep Creek, Ninilchik River, and Fox River) should be evaluated for habitat damage and considered for reductions in moose numbers.

In conjunction with population reduction, habitat enhancement programs should be encouraged on private land. ADF&G will cooperate with a local citizens group to develop a curriculum for students in grades K-12 focused on moose and habitat requirements. Two tentative sites were proposed for demonstration projects: Beluga Wetlands and the Homer Demonstration Forest. Exclosures will be constructed in both areas to demonstrate the effect of moose on forage plants.

Bradley Lake Moose Mitigation

Approximately $50,000 remains in a moose mitigation trust fund from the purchase of lands in the Fritz Creek drainage. Trustees of this fund are being selected. I recommend that this money be allocated to habitat enhancement as soon as possible. Rehabilitation of winter range near Homer and Fritz Creek is necessary. We will determine the feasibility of a controlled burn in the 593 acres of land in the Fritz Creek drainage.

As previously stated, moose winter foraging areas on the Homer Bench have become severely depleted over the past 30 years for various reasons. Intensive management of the moose population and winter habitat is needed to balance moose numbers and habitat.

Hunting effort and the number of moose harvested in Subunit 15C declined in 1987, following the adoption of the spike/fork or 50-inch antler regulation. The number of moose hunters remained well below the pre-1987 level until autumn 1990, when moose seasons were shortened or closed in Units 13, 14, and 16. During 1990 the number of local residents hunting increased significantly in Subunit 15C and the number of moose harvested increased correspondingly. Apparently in 1987, some local residents that usually hunted in Subunit 15C may have either stopped hunting or began hunting moose in other units of southcentral Alaska. Local residents returned to hunt in Subunit 15C in 1990 when moose seasons were curtailed in adjacent units in anticipation of larger moose because of harvest restrictions in previous years.

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Table 1. Subunit 15C fall aerial moose composition counts and estimated population size, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1986/87[a]								2500
1987/88[a]								2500
1988/89								
CA 24[b]	14	3	40	26	176	238	--	2500
CA 26[b]	10	3	47	30	242	346	--	2500
1989/90								
CA 24	26	8	33	21	422	546	--	2500
1990/91								
CA 21	37	16	22	14	253	293	--	2500

[a] No surveys
[b] CA = Count area

Table 2. Subunit 15C moose harvest[a] and accidental death, 1986-91.

	Hunter Harvest										
Regulatory	Reported				Estimated			Accidental death			Grand
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	total[b]
1986/87	244			244	--	--	30	51	--	51	325
1987/88	127			127	--	--	30	42	--	42	199
1988/89	170			170	--	--	30	43	--	43	243
1989/90	156			156	--	--	30	60	--	60	246
1990/91	200			200	--	--	30	83	--	83	313

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

Table 3. Subunit 15C moose hunter residency and success, 1987-91.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total	Local[a] resident	Nonlocal resident	Nonresident	Total	
1987/88	106	16	4	127	552	77	3	641	768
1988/89	148	10	7	170	523	66	8	603	773
1989/90	125	25	4	156	480	72	11	581	737
1990/91	162	27	3	200	608	90	12	733	933

[a] Local = Residents from Unit 15.

Table 4. Subunit 15C moose harvest percent by transport method, 1987-1991.

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1987/88	6	14	5	7	--	16	35	18	127
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

Table 5. Subunit 15C, hunter success by transportation type, 1987-1991.

	Hunters Using Highway Vehicles					Hunters using 3- or 4-wheelers or ORVs			
Year	Total 15C Harvest	No. Hunters	No. Successful	Proportion of Total Harvest[a] %	Success rate[b] %	No. Hunters	No. Successful	Proportion of Total Harvest %	Success rate %
1987	127	175	44	35%	25%	178	29	23%	16%
1988	170	318	56	33%	18%	182	46	27%	25%
1989	156	310	49	31%	16%	207	62	40%	30%
1990	200	389	58	29%	15%	304	86	43%	28%
1991	286	428	100	35%	23%	310	104	36%	34%

	Hunters Using Horses					Hunters using Aircraft			
Year	Total 15C Harvest	No. Hunters	No. Successful	Proportion of Total Harvest %	Success rate %	No. Hunters	No. Successful	Proportion of Total Harvest %	Success rate %
1987[2]	127	66	18	14%	27%	20	7	6%	35%
1988	170	60	31	18%	52%	30	11	6%	37%
1989	156	63	15	10%	24%	30	8	5%	27%
1990	200	74	32	16%	43%	17	7	4%	42%
1991	286	89	44	15%	49%	37	13	5%	35%

	Hunters Using Boats					Hunters using Unknown Types			
Year	Total 15C Harvest	No. Hunters	No. Successful	Proportion of Total Harvest %	Success rate %	No. Hunters	No. Successful	Proportion of Total Harvest %	Success rate %
1987	127	61	6	5%	10%	164	22	17%	13%
1988	170	53	5	3%	9%	129	21	12%	16%
1989	156	43	7	5%	16%	83	14	9%	17%
1990	200	45	5	3%	11%	103	11	6%	11%
1991	286	48	7	2%	15%	87	18	6%	21%

[a] Proportions of total harvest is the number of successful hunters in this transportation category divided by the total Subunit 15C harvest.

[b] Success is the number of successful hunters divided by the total number of hunters in the transportation category.

LOCATION

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

Geographical Description: Westside Susitna River (Yentna River to Chulitna River)

BACKGROUND

Before 1940 moose were at low densities in Subunit 16A. Since then habitat changes and reduced predator populations have allowed higher densities to develop. Winter die-offs occurred in response to deep snow, but the population rebounded during mild winters. Moose numbers peaked in the 1950s and late 1960s. Since the deep snow winters of 1971/72 and 1972/73 the population increased through 1984. Deep snow in 1984/85 caused another decline, but the absence of cow hunts allowed numbers to increase again.

Hunter harvest in Subunit 16A has increased steadily since the subunit was established in 1973. During the 1970s hunter harvest increased from 83 to 167 moose; about 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 102 bulls the following fall. Bull-only seasons and increased use of 3- or 4-wheelers allowed the bull harvest to increase rapidly. Hunter effort remained high for both decades. Except for 1975/76 (182 hunters), numbers of hunters ranged from 405 to 1,200 hunters. Less than 10% of hunters in any year were residents of Unit 16 while fewer than 5% were nonresidents.

MANAGEMENT DIRECTION

Management Goals

The moose management goals for Subunit 16A are to provide for optimum harvest of moose; and to provide for the greatest opportunity to participate in hunting moose.

Management Objective

The moose management objective for Subunit 16A is to maintain a moose population of 3,000-4,000 with a posthunting sex ratio of no less than 20 bulls:100 cows.

METHODS

We conducted a stratified random census (Gasaway, et al. 1986) from November to December 1990. The subunit was divided into north (55 survey units) and south (64 survey units). We surveyed the north from 20-27 November and the south from 28 November to 3 December. Sightability correction factors were calculated by strata to produce estimates. During April 1990 we conducted an aerial survey along the border between Subunits 16A and 14B to estimate moose population composition and evaluate winter mortality. Carcasses were checked for sex and age. During late February 1991 we conducted a complete census in the transportation corridor straddling the Subunit 16A and Subunit 14B border (west bank of Susitna River to the Alaska Railroad Corporation tracks from Willow to Talkeetna). Harvest data were obtained from harvest reports. The Department of Public Safety reported highway kills, DLP kills, and illegally killed moose.

RESULTS AND DISCUSSION

Population Status and Trend

The Subunit 16A moose population apparently peaked during 1988 and 1989, however, high winter mortality during 1989/90 caused a population decline. The deep snow winter of 1989/90 caused an estimated 30-40% decline. The population was expected to increase without additional deep snow winters.

Population Size: The first fall census of Subunit 16A was conducted in 1990 and resulted in an estimate of 2,961 ± 256 (80% C.I.) moose (Table 1). Estimated fall density for the subunit was 1.8 moose/mi^2. The population estimate before the estimated 30-40% decline was 2,500 (Faro 1990). Using estimated mortality and recent population estimates, the 1989 fall population was 3,800-5,200 moose. The previous estimate was based on stratification flights and a partial census during winters of 1982/83 and 1983/84. Radiotelemetry studies have shown that substantial moose redistribution occurs between fall and winter, which may partially explain the differences (Modafferi 1990). We adjusted past population estimates to reflect new information presented in Table 1.

Population Composition: Fall 1990 sex and age composition was 27 bulls:100 cows and 20% calves (31 calves:100 cows) (Table 1). Composition was derived from data collected during the fall census. The decline in bulls:cows and yearling bulls:cows, despite significant harvest reductions, reflected a large die-off of bulls and calves during 1989/90.

Mortality

Harvest:

Season and Bag Limit. During 1989/90 the open season for resident and nonresident hunters in Subunit 16A was 1-30 September; the bag limit was 1 bull. During 1990/91 the open season for subsistence, resident, and nonresident hunters was 1-10 September; the bag limit was 1 bull.

Board of Game Actions and Emergency Orders. During an emergency session the Board of Game reduced the 1990/91 open season for bull moose from 30 days to 10 days. High winter mortality prompted the reduction. For 1991/92, ADF&G recommended a 1-20 September season based on composition and population estimates generated from the fall 1990 census. The board chose a more conservative approach and adopted a 1-15 September season, with a 1 bull bag limit.

Hunter Harvest. Annual harvest during 1986-1989 increased from 163 to 286, but declined to 37 during 1990/91 (Table 2). The abbreviated season combined with reduced availability of bull moose resulted in low hunter effort and reduced harvest in fall 1990.

Moose killed illegally, in DLP incidents, and by highway vehicles peaked during 1989/90 (Table 2). While 15 moose were reported killed on roads and highways in the subunit, many more moose were believed killed. As much as 60% of moose killed by trains and highway vehicles in Subunit 14B are also believed to be moose from Subunit 16A. During 1989/90, 247 of 411 moose killed in Subunit 14B were estimated to be from Subunit 16A. The total estimate for Subunit 16A moose killed by these means is 260-280. In 1990/91, this estimate dropped to 25-30.

Estimates of moose killed in DLP incidents or illegally, peaked at 46 during 1989/90 when conflicts with residents and their pets were numerous (Table 2). That estimate dropped to 24 during 1990/91.

Hunter Residency and Success. The residency composition of successful moose hunters changed little from 1986 to 1990 (Table 3). Unit 16 residents accounted for a mean of 8% of the annual harvest. Other Alaska residents accounted for 85%. The scarcity of bull moose during 1990/91 produced only 7% hunter success. The mean success rate for the previous 4 years (1986-1989) was 23%.

Harvest Chronology. The number of moose killed by week during 1989/90 was consistent with previous years (Table 4). However, the brief season and reduced availability of moose during 1990/91 reduced the first week's harvest by 60%.

Transport Methods. Successful hunters used boats, highway vehicles and 3- or 4-wheelers in order of preference (Table 5). A slight increase in the preference for 3- or 4-wheelers was indicated during the 1986-1990 period. Increasing trail development into the southern portion of the subunit will probably cause that trend to continue.

Other Mortality: During winter 1989/90 snow accumulations reached near record levels, causing high natural mortality. Evidence from radio-marked moose wintering in or near Subunit 16A suggested that mortality of cows was 25-35% and calf mortality was 95-99% (R. Modafferi pers. comm.). Carcasses of winter-killed moose along the Susitna River suggested that bulls had higher mortality rates. Half the adult carcasses in the sample (80) were bulls, which would suggest 70-80% mortality in bulls. However, fall composition data suggested that bulls experienced only 45-55% winter mortality. Also, mortality of calves, as suggested by yearling bulls in the fall 1990 composition, may have been only 80-90%. An April 1990 aerial survey sampled 113 moose near the Susitna River between Willow and Talkeetna. In this portion of the winter range, calf mortality was 100%.

The high winter mortality of moose during 1989/90 prompted significant public and media reaction which in turn prompted release of emergency funds by the governor and private donations for a "Save the Moose" effort. Many citizens, private organizations, and state and federal agencies contributed labor and resources.

CONCLUSIONS AND RECOMMENDATIONS

Fall census results for Subunit 16A indicated population numbers below objectives during 1990/91, however, population levels were estimated to exceed objectives the previous year, 1989/90. In spite of population levels being below objectives in 1990/91, bull:cow ratios did exceed objective levels both years.

I recommend upgrading and expanding the population monitoring program in Subunit 16A. The Becker survey technique, currently employed in Subunit 14B, should be evaluated in Subunit 16A. If the Becker technique appears appropriate, it should be employed on a biennial basis. Full censuses should be conducted every 5 to 8 years.

I recommend collecting data in the lower Susitna Valley that would allow evaluation of yearling and 2-year-old bull antler size. Observers during surveys and censuses have difficulty differentiating yearling bulls from older bulls. I recommend collecting jaws and antler measurements and/or collaring fall calves. Collaring male calves would allow tracking of antler development between years. While capturing calves, fall sex composition of calves also could be verified. Antler growth in physiologically and nutritionally stressed bulls should be tested at the Moose Research Center. I recommend no changes in season or bag limits at this time.

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Table 1. Subunit 16A fall aerial moose composition counts and estimated population size, 1986-1991.

Regulatory year	Yearling Bulls: 100 cows	Bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	Total moose observed	Moose /hour	Population estimate
1986/87	40	11	34	20	416	517	76.4	3,500-5,000
1987/88	41	11	43	24	52	68	42.1	4,000-5,500
1988/89	36	12	35	19	392	484	45.7	4,000-5,500
1989/90[a]	--	--	--	--	---	---	---	3,800-5,300
1990/91[b]	27	7	31	29	1,105	1,366	---	2,961+256[c]

[a] No surveys conducted.
[b] These data were derived from a population census conducted in December 1990. SCF calculated by strata.
[c] 80% C.I.

Table 2. Subunit 16A annual moose harvest and accidental death, 1986-90.

Regulatory year	Reported				Estimated			Accidental			Grand Total
	M	F	Unk	Total[a]	Unreported[b]	Illegal[c]	Total	Road[d]	Train[e]	Total	
1986/87	161	1	0	162	8	10	18	8	0	8	188
1987/88	223	0	1	224	11	15	26	3	0	3	253
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

[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. Road and train are minimum numbers; in most years actual kill was probably higher.
[e] While the 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 1986-90.

Regulatory year	Successful: Local[a] resident(%)	Successful: Nonlocal resident(%)	Successful: Nonres	Successful: Unk	Successful: Total	Unsuccessful: Localb resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonres	Unsuccessful: Unk	Unsuccessful: Total	Total hunters
1986/87	15 (9)	154 (85)	3	6	163	23	543	5	7	555	718
1987/88	18 (8)	210 (86)	5	9	224	39	715	13	43	771	995
1988/89	19 (7)	261 (84)	17	10	288	41	754	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

[a] Unit 16 residents.

Table 4. Subunit 16A moose harvest chronology, 1986-1990.

Regulatory year	Before season opened	Weeks of season: 1st	(%)	2nd	3rd	4th	After season closed	Unk	Total
1986/87[a]	5	57	(35)	43	54	4	0	0	163
1987/88[b]	0	60	(27)	31	42	84	3	4	224
1988/89[b]	4	57	(20)	37	60	119	2	9	288
1989/90[b]	1	60	(21)	31	65	118	1	10	286
1990/91[c]	1	21	(57)	11	---	---	2	2	37

[a] 1-20 September season
[b] 1-30 September season
[c] 1-10 September season

Table 5. Successful moose hunter transport methods in Subunit 16A, 1986-90.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk	Total all methods
1986/87	21	1	39	28	1	25	38	10	163
1987/88	34	0	48	44	0	23	59	16	224
1988/89	37	0	74	52	2	43	67	13	288
1989/90	39	2	78	63	2	34	62	6	286
1990/91	8	1	9	5	0	9	5	0	37

LOCATION

Game Management Subunit: 16B (10,404 mi^2)

Geographical Description: West side of Cook Inlet

BACKGROUND

Moose were uncommon in Subunit 16B before World War II. Habitat changes and reduced numbers of predators allowed a large moose population to develop in the late 1950s and 1960s. Since then the population has slowly declined. Two consecutive severe winters in the early 1970s significantly reduced moose numbers. Several moderate winters in the 1970s and 1980s caused small declines and the severe winter of 1989-90 resulted in 15-20% mortality. Local, nonlocal, and nonresident hunters harvested a substantial number of moose for many years before 1990. After winter 1989, seasons were reduced by 20 days in the north and 5 days in the south. Cow hunts were cancelled. These changes greatly reduced hunting opportunity and reduced the harvest by 70-80%.

MANAGEMENT DIRECTION

Management Objectives

Moose management objectives for Subunit 16B are to: 1) maintain a moose population of 7,000 with a posthunting sex ratio of no less than 20 bulls:100 cows, excluding Kalgin Island; and 2) maintain an overwinter density of 1 moose/mi^2 (23 total mi^2) until the browse shows increased vigor and can support a higher population on Kalgin Island.

METHODS

We conducted fall sex and age trend area surveys throughout the subunit in 1989. We conducted an aerial census during 1990 in that portion of the subunit north of the Beluga River. We also flew a Kalgin Island composition survey. We obtained harvest data from harvest and permit reports.

RESULTS AND DISCUSSION

Population Status and Trend

Moose numbers have been declining slowly since the early 1970s because of poor calf recruitment and survival. The population on Kalgin Island is near 1 moose/mi^2.

Population Size: Population estimates before 1990 were probably low. Following the 15-20% die-off during winter 1989-90, numbers of moose calculated from a fall 1990 census approximated estimates made in the mid-1980s. The current subunit population was estimated at 7,300-7,500. The overwinter population on Kalgin Island was estimated at 20-35 in 1990-91.

Population Composition: Fall sex and age survey data are presented in Tables 1 and 2. We observed 1,536 moose in fall 1989 during nearly 27 hours of survey time. The bull:cow ratio was 38:100 and the calf:cow ratio was 26:100. During the fall 1990 stratified census 1,534 moose were observed north of the Beluga River with estimated ratios of 34 bulls and 24 calves:100 cows.

Distribution and Movements: Moose inhabited most of the subunit below 3,500 ft. elevation during summer. They were far less widespread during winter particularly above 1,500 ft. and in extensive black spruce-labrador tea bogs which provide little food and cover. They were most abundant near riparian zones and on south facing, open birch-cottonwood forests. Movements and home ranges recorded as a result of radio collaring studies near Alexander Creek, Lake Creek, and the lower Skwentna River were detailed in the most recent management report (1988).

Mortality

Harvest:

Season and Bag Limit. The 1989 open season for subsistence, resident, and nonresident hunters in that portion of Subunit 16B encompassing the Redoubt Bay drainage south and west of, and including, the Kustatan River drainage was 1-15 September; the bag limit was 1 bull. In 1990 all aspects of the above description remained the same except that the season was reduced to 1-10 September.

The 1989 open season for subsistence, resident, and nonresident hunters on Kalgin Island in Subunit 16B was 25 August to 30 September. The bag limit was 1 moose. In 1990 the season was reduced to 25 August to 10 September.

The 1989 open seasons for subsistence hunters in the remainder of Subunit 16B were 1-30 September and 1 December to 28 February. The bag limit was 1 moose; however, antlerless moose could be taken only from 25-30 September and 1 December to 28 February. A 2-week registration permit season within the latter period was announced by emergency order. During 1990 the open subsistence seasons in the rest of Subunit 16B were 1-10 September and 1 December to 28 February. The bag limit was 1 bull; however, from 1 December to 28 February, bulls could be taken by Tier II permit in a 2-week season announced by emergency order.

The 1989 open season for resident and nonresident hunters in the remainder of Subunit 16B was 1-30 September. The bag limit was 1 bull. During 1990 the resident season was reduced to 1-10 September and the nonresident season was eliminated.

Board of Game Actions and Emergency Orders. Emergency orders were used to set the season dates for hunts 981 and 982 in 1989 and for hunt 979T in 1990.

Hunter Harvest. Annual harvest and accidental mortality are presented in Table 3. The reported harvest of bull moose declined from 405 in 1986, to 308 in 1989, and to 93 in 1990 with abbreviated seasons. At the same time hunting pressure declined at a similar rate. General season cow hunting was discontinued in 1987 except for Kalgin Island. Accidental mortality was minimal given the limited road system and absence of train-killed moose. As part of the general harvest, 10 moose (8 bulls, 2 cows) were harvested on Kalgin Island in 1989 compared with 8 (3 bulls, 5 cows) in 1990.

Hunter Residency and Success. Although Subunit 16B is hunted primarily by Alaska residents in September (86% of all hunters in 1989), only 2% are subunit residents subunit (Table 4). Harvest by nonresidents increased from 9% in 1986 to nearly 20% in 1989. After the severe 1989-90 winter, nonresidents were excluded from hunting and a Tier II subsistence hunt system began in 1990. The Tier II winter hunt replaced the registration subsistence hunt and was open to Alaska residents provided they met several criteria including: customary and direct dependence upon the game populations as the mainstay of one's livelihood; local residency; and availability of alternative resources.

Permits Hunts. The harvest in the Subunit 16B winter subsistence hunt declined from 62 in 1989 to 30 in 1990. Although participants were selected statewide, and many were not residents of the subunit, the decline was apparently not related to a lack of knowledge regarding the unit but rather to the elimination of cow hunting. In earlier hunts, cows accounted for over one-half the harvest.

Transport Methods. Transportation means of successful hunters are presented in Table 6. During the September season aircraft were the most popular and efficient method of transportation for the 1989 and 1990 seasons combined (16% of all hunters and 56% of successful hunters). In 1989 and 1990 combined, both boats and snowmachines were used by 15% of successful hunters, while 7% of successful hunters used highway vehicles. Snowmachines were heavily used during the winter subsistence hunt.

Other Mortality. During winter 1989-90 snowfall in excess of 250 inches and accumulation of from 7-9 ft. for short periods resulted in the largest die-off in the subunit in two decades. All sex and age classes were affected, however, mortality was greatest among calves (70-90%), bulls of all ages, particularly 1- and 2-year-olds and those 8-years and above, and cows 10-years and older. Estimates placed mortality at 15-20%, however, later surveys indicated it was one-half that.

CONCLUSIONS AND RECOMMENDATIONS

An evaluation of habitat quality and/or quantity has never been attempted in Subunit 16B. Habitat apparently figures significantly in the productivity and abundance of moose in Subunit 16B. Although predation by bears is probably a significant mortality factor for calves during their first 1-2 months of life, winter range availability is perhaps equally significant. Bear predation has possibly been over-emphasized since fall ratios of calves:100 cows, tallied to a large part in expansive subalpine habitat frequented by numerous moose, are usually underestimated. As an example, Sunflower Basin composition counts in 1989 accounted for 23% of all moose tallied, yet just 12% of all calves. In 1987 the numbers were 30% and 17%, respectively. Most major Subunit 16B count areas are associated with the higher elevation portions of the subunit while most of the heavily timbered lowland areas, that have been shown to support higher calf:cow ratios, are not counted.

A small sample of radio-collared cows with calves monitored in Subunit 16B during 1990 indicated that calf:100 cows ratios were well above what composition counts often show. Harvests and hunting pressure in the subunit continued to decline. The large decrease (48%) from 1989 to 1990 in hunter numbers is mainly attributed to shortened seasons and the elimination of nonresident hunting. Aircraft are the most popular and most efficient method of access for successful hunters. Air taxi and private operators contribute significantly to level and distribution of harvest.

Cow moose seasons should remain closed for the next two years and then limited to subsistence hunters only during winter. Season length should remain conservative until several adjacent subunits (14B, 16A) have sufficient numbers of moose to allow seasons to remain open until 25 September or later. Although Subunit 16B could currently provide a larger harvest of bull moose, without adjacent units in which to hunt, hunting effort and harvest would be excessive.

The low count (10 moose + tracks) and the harvest of 5 cows in 1990 on Kalgin Island makes it advisable to eliminate the early season and cease cow hunting for the foreseeable future. The expense required to survey the island annually is excessive given that it currently supports only 0.3% of the subunit's moose. In the future surveys should be flown once every 3-4 years and if moose numbers warrant it then the season length and bag limit can be adjusted as necessary. I recommend no other changes in seasons or bag limits at this time.

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Table 1. Subunit 16B fall aerial moose composition counts and estimated population size, 1986-1991.

Regulatory Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Adults	Total moose observed	Moose/ hour.	Moose/ mi^2	Estimated population size
1986/87	35.6	7.7	22.8	14.4	1,017	1,188	59.1	1.7	8,600
1987/88	31.9	8.9	18.4	11.3	1,475	1,629	83.1	2.6	8,600
1988/89	34.7	11.2	22.4	12.4	1,190	1,359	54.8	1.8	8,600
1989/90	38.0	12.0	26.0	15.8	1,294	1,536	57.5	1.6	8,600
1990/91[a]	33.5	--	24.3	18.5	1,250	1,534	--	--	7,300-7,500

[a] Census data

Table 2. Subunit 16B moose composition counts, 1989.

Area	Date	Males 100 Females	Yearling bulls/ 100 Females	Calves/ 100 Females	Calves %	Moose/ hour	Moose/mi^2	N
Alexander Creek	11/10/89	36	8	29	17.5	214	7	200
Lone Ridge L1	11/10/89	400	0	0	0.0	3	0	5
Lone Ridge N3	11/24/89	28	10	30	18.9	41	2	106
Lone Ridge N3	11/26/89	30	11	8	6.0	29	1	84
Lone Ridge 4	11/10/89	29	13	18	12.5	27	1	56
McArthur River	11/26/89	27	17	31	19.6	92	2	112
Mt. Susitna A	10/26/89	23	4	47	27.9	63	2	201
N Beluga Mt. B	11/20/89	45	17	31	17.5	87	5	303
Sunflower G	11/10/89	24	9	21	14.6	61	2	96
Sunflower H	11/10/89	83	0	0	0.0	18	0	11
Sunflower J	11/10/89	44	11	10	6.6	108	7	243
Wolf Lakes	11/20/89	88	0	0	0.0	10	0	15
Yenlo East	11/11/89	76	24	27	13.5	36	2	104
Total		38	12	26	15.8	57	2	1,536

Table 3. Subunit 16B moose harvest and accidental death, 1986-1991.

Regulatory	Reported				Estimated			Accidental Mortality		Grand
year	M	F	Unk	Total	Unreported	Illegal	Total	Road	Train	Total
1986/87	405	114	8	527	25	25	577	2	0	579
1987/88	374	47	7	428	25	25	478	2	0	480
1988/89	338	35	7	380	25	25	430	2	0	432
1989/90	308	32	4	344	25	25	394	10	0	404
1990/91	93	5	1	99	25	25	149	2	0	151

Table 4. Subunit 16B moose hunter residency and success, 1986-91.

	Successful				Unsuccessful				
Regulatory year	Local[a] resident(%)	Nonlocal resident(%)	Nonres	Total[b](%)	Local[a] resident	Nonlocal resident	Nonres	Total[b](%)	Total hunters
1986	9	399	43	465 (36)	36	762	30	839 (64)	1304
1987	4	290	44	349 (32)	23	650	36	734 (68)	1083
1988	13	236	58	328 (30)	27	640	66	756 (70)	1084
1989	8	217	54	282 (29)	31	566	64	678 (71)	960
1990	3	64	2	69 (16)	24	322	1	351 (84)	

[a] Local resident = residents of Unit 16
[b] Total includes unreported residence

Table 5. Subunit 16B moose harvest[a] data by permit hunt, 1986-91.

Hunt No.	Regulatory Year	Permits[a] issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	Cows	Total harvest
981	1986/87	54	41	13	46	13	12	25
	1987/88	58	31	12	57	10	23	33
	1988/89	60	30	22	48	12	17	29
	1989/90	70	20	13	61	22	21	43
982	1986/87	73	26	25	40	17	12	29
	1987/88	68	21	19	57	21	18	39
	1988/89	65	35	28	37	12	12	24
	1989/90	51	22	27	37	11	7	19
879T	1990	141	45	34	21	30	0	30
Totals for all permit hunts	1986/87	127	32	20	43	30	24	54
	1987/88	126	25	16	57	31	41	72
	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

[a] Includes permittees who did not report

Table 6. Subunit 16B moose harvest percent by transport method, 1986-91.

Regulatory Year	Percent of Harvest							
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	n
1986/87	61	1	21	3	7	1	5	508
1987/88	59	3	16	2	9	2	10	398
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

LOCATION

Game Management Unit: 17 (18,800 mi^2)

Geographical Description: Northern Bristol Bay

BACKGROUND

Moose are new inhabitants in the Bristol Bay area, possibly having immigrated to the area from the Kuskokwim River drainages during the last century. Until recently, numbers 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 meat. ADF&G began to collect data on the Unit 17 moose population in 1971. At that time, Faro (1973) reported that moose were not abundant and that moose close to villages were subject to heavy hunting pressure.

Hunting seasons have varied over the years, but the bag limit has always been 1 bull. A disregard for seasons and bag limits by unit residents for most of the century was suspected as the main factor contributing to low moose densities (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 ADF&G education efforts, and in part to abundant alternative big game such as the Mulchatna caribou herd which 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 abundant suitable habitat, a viable population has not been 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

We used aerial surveys of trend count areas in Subunits 17B and 17C 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, snowcover, and survey aircraft were not available during the optimal period.

Aerial censuses of the population were conducted in two 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. We monitored moose movement into the subunit by tracking a sample of radio-collared moose each month since March 1989.

We collected harvest data from harvest ticket and registration permit reports. Non-reporting hunters were sent one 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 at less than 50 moose; well below the management goal of 100. Two surveys of the Togiak River drainage were conducted in the past 5 years. During January 1987, we observed 7 moose in 7.8 hours of flying. During April 1991, we observed 4 moose in 1.3 hours. We also observed moose in the Kulukak River drainage in limited numbers. Moose have occasionally been observed near Cape Peirce.

The moose population in Subunit 17B was estimated at 2,500 to 3,000 moose in 1987 (Taylor 1990). We based that estimate on extrapolations from a census in the upper Mulchatna River 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, the moose population size in the subunit appeared stable and remained below the management objective.

The moose population in Subunit 17C was estimated at 1,400 to 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 1,750 moose. Survey data suggested the 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 surveys. Calf production and survival have fluctuated between areas and years, but 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 tributaries 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 beaver trapping season (January and February) displaces moose from many wintering areas, particularly along the Nushagak River.

Preliminary data from the radiotelemetry study indicated that although most radio-collared moose remained in Subunit 17C, some moved into Subunit 17A. Two radio-collared moose moved from the Weary River in Subunit 17C to the Kulukak River drainage in Subunit 17A.

Mortality

Harvest:

Season and Bag Limit. Subunit 17A was closed to moose hunting.

Subunit 17B was divided into two sections: 1) the Mulchatna River drainage upstream and including the Chilchitna River; and, 2) the rest of the subunit. The upstream section was open for resident/subsistence and nonresident 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 Subunit 17B from 5-15 September. The bag limit in both areas was 1 bull.

Subunit 17C was also divided into two sections: 1) the Iowithla River drainage, Sunshine Valley, and all portions of the subunit west of the Wood River and south of Aleknagik Lake; and, 2) the remainder of the subunit. Open season for resident/subsistence hunters was from 1-15 September throughout the subunit. An additional season was open for subsistence hunters from 1-31 December in the remainder of the subunit. Nonresidents were permitted to hunt in the subunit from 5-15 September in 1989/90, but were prohibited from hunting in 1990/91. The bag limit in both areas was 1 bull.

An additional 1989/90 moose season was open for subsistence hunters from 20-31 August in Subunit 17C and the remainder of Subunit 17B. This season was curtailed in 1990/91 because of changes in subsistence regulations.

Board of Game Actions and Emergency Orders. The Upper Mulchatna Controlled Use Area became effective during the 1990/91 regulatory year. This area encompasses all of Subunit 17B. It is closed to the use of any motorized vehicle, except aircraft and boats and in legally permitted hunting camps, for hunting big game from 1 August to 1 November. Transportation of big game hunters and parts of big game is included in the prohibition. ADF&G proposed this Controlled Use Area because of concerns that all-terrain vehicle access was not biologically justified and their use was incompatible with other recreational uses of the area (Taylor 1988).

During summer 1990, court decisions granting subsistence hunting privileges to all Alaska residents prompted the Board of Game and ADF&G to reevaluate hunting seasons statewide. As a result, emergency regulations were written eliminating the 20-31 August subsistence seasons in Subunits 17B and 17C and the nonresident season in Subunit 17C during the 1990/91 regulatory year.

The board reviewed the emergency regulations during its spring 1991 meeting. The August hunt was reestablished as a registration hunt with permits available to any resident who applied in person at Dillingham. The nonresident season in Subunit 17C remained closed and the bag limit for nonresidents in Subunit 17B was changed to 1 bull with an antler spread of 50 inches or greater. These new regulations were to take effect in the 1991/92 regulatory year.

Hunter Harvest. Moose harvests in Unit 17 have increased 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. Despite this closure, from 10 to 15 moose of both sexes, were suspected to be killed annually (Table 4). The reported harvest in Subunit 17B has increased from 108 in 1986/87 to 178 in 1990/91, with a 5-year mean annual harvest of 140.4 moose (Table 5). The reported harvest in Subunit 17C has remained relatively constant with a 5-year mean annual harvest of 39.6 moose (Table 6).

Hunters continued to harvest large-antlered moose. During the last 5 seasons, half of the harvest consisted of moose with antler spreads of 50 inches or greater. The largest antlers reported for each of these seasons exceeded 70 inches (Table 7).

Permit Hunts. No permit hunts were conducted in Unit 17 during this report period. Before 1988/89, permits were issued for the subsistence hunt in Subunits 17B and 17C (Tables 8 and 9).

Hunter Residency and Success. The 5-year mean annual number of moose hunters participating in open moose hunting seasons in Unit 17 was 456. The number of hunters reporting increased during that period. Most of the increase was in the number of nonresident hunters (1986/87 = 137; 1990/91 = 226). Another reason for the increased harvest was improved hunter success. Hunter success increased from 34% in 1986/87 to 46% in 1990/91 (Table 10). The 5-year mean annual hunter success was 40%.

Residency of reporting hunters was relatively evenly distributed. Nonresidents accounted for 40%, residents of Unit 17 accounted for 30%, and other Alaska residents accounted for 30% of the number of hunters reporting from 1986 to 1991. These data did not include hunters that participated exclusively in permit hunts. The number of unit residents participating in the hunt was underreported because many individuals failed to submit harvest tickets.

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 during the August and December seasons. These seasons were originally established to provide local residents the opportunity to harvest non-rutting moose. The regulatory intent was to discourage the illegal killing of female moose and harvests during closed seasons.

Transport Methods. Aircraft were the primary transport means for moose hunters in Unit 17 (5-year mean = 57%, 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 report period there was no evidence of significant mortality caused by factors other than humans. Predation by wolves and bears occurred regularly but appeared inconsequential. Snow depths were above normal both winters (1989/90 - 1990/91), but moose were able to find adequate forage on winter ranges in riparian areas and winter mortality was light. No moose were reported killed by motor vehicles.

Illegal harvest continued to be a problem in Subunit 17A. Subunit residents pursued moose with aircraft and snowmachines during winter and spring. Both male and female moose were taken. Illegal harvests in Subunits 17B and 17C have decreased dramatically in the past 5 years. The number of female moose harvested also declined significantly.

Habitat

Assessment: No formal habitat monitoring programs were conducted in Unit 17. Winter range condition was 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 of those rivers, appeared in very good to excellent condition. Though 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 most of the unit's relative inaccessibility and natural habitat changes, habitat enhancement 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 of those rivers.

Nonregulatory Management Problems

A reevaluation of moose hunting seasons in Unit 17 is in order before the next Board of Game meeting when moose proposals are considered. Recent board decisions regarding subsistence seasons, nonresident bag limit restrictions, and motorized vehicles affect the way moose are harvested. The cumulative effects of these changes should be appraised given the current moose population and harvest data.

CONCLUSIONS AND RECOMMENDATIONS

Moose populations in Unit 17 were stable to increasing during this report period. The population in Subunit 17C appeared at, or approaching, the management objective. Bull:cow ratios and percent calves observed during annual composition counts of trend areas in Subunits 17B and 17C suggested the population was healthy and productive. Although objective habitat evaluations were lacking, browse quality and quantity appeared sufficient to support the population on most of the winter ranges.

Moose harvest has increased in Subunit 17B during the past decade. This was partially caused by increased numbers of hunters afield, as more nonresident 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 low despite abundant 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. A renewed effort involving ADF&G, Togiak National Wildlife Refuge, and the Togiak Traditional Council should be initiated to educate hunters on the long-term benefits of abiding by existing wildlife regulations. This education effort should be coupled with increased regulatory enforcement by the Division of Fish and Wildlife Protection, refuge personnel, and members of the traditional council.

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Table 1. Subunit 17C, Iowithla River moose trend count area, fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1986/87[b]	--	--	--	8 (11)	78	86	26	--
1987/88[c]	69	15	44	38 (21)	147	185	74	--
1988/89[d]	71	11	33	35 (16)	179	214	89	--
1989/90[e]	--	--	--	--	--	--	--	--
1990/91[f]	59	7	52	38 (25)	116	154	53	--

[a] No population estimates for this count area have been made.
[b] Survey flown on 30 Dec. 1986, determination of sex was not possible.
[c] Survey flown on 12 Nov. 1997.
[d] Survey flown on 21 Nov. 1988.
[e] No survey flown in 1989/90.
[f] Survey flown on 29 Oct. 1990.

Table 2. Subunit 17C, Sunshine Valley moose trend count area, fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size[a]
1986/87[b]	152	--	97	32 (26)	91	123	56	--
1987/88[c]	84	16	22	8 (11)	68	76	48	--
1988/89[d]	102	24	44	20 (18)	93	113	57	--
1989/90[e]	--	--	--	--	--	--	--	--
1990/91[f]	63	22	43	21 (21)	90	101	51	--

[a] No population estimates for this count area have been made.
[b] Survey flown on 27 Dec. 1986, determination of sex was not possible.
[c] Survey flown on 13 Nov. 1997.
[c] Survey flown on 5 Dec. 1988.
[e] No survey flown in 1989/90.
[f] Survey flown on 13 Dec. 1990.

Table 3. Subunit 17B, Mosquito River moose trend count area, fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size[a]
1986/87[b]	--	--	--	--	--	--	--	--
1987/88[c]	159	16	46	20 (14)	114	134	32	--
1988/89[b]	--	--	--	--	--	--	--	--
1989/90[b]	--	--	--	--	--	--	--	--
1990/91[d]	110	11	44	35 (17)	166	201	77	--

[a] No population estimates for this count area have been made.
[b] No survey flown in 1986/87, 1988/89 or 1989/90.
[c] Survey flown on 9 & 10 Dec 1987.
[d] Survey flown on 17 Dec 1990.

Table 4. Subunit 17A moose harvest[a] and accidental death, 1986-91.

Regulatory year	Hunter Harvest							Accidental death	Grand total
	Reported				Estimated				
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total		
1986/87	0	0	0	0	0	10[b]	10	0	10
1987/88	0	0	0	0	0	15	15	0	15
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

[a] Excludes permit hunt harvest.
[b] One male was reported from Subunit 17A, however there was no open season.

Table 5. Subunit 17B moose harvest[a] and accidental death, 1986-91.

Regulatory year	Hunter Harvest: Reported M (%)	F (%)	Unk.	Total	Estimated[b] Unreported	Illegal	Total	Accidental death	Grand total
1986/87	108(100)	0	0	108	0	0	0	0	108
1987/88	137(100)	0	0	137	0	0	0	0	137
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

[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, 1986-91.

Regulatory year	Hunter Harvest: Reported M (%)	F (%)	Unk.	Total	Estimated[b] Unreported	Illegal	Total	Accidental death	Grand total
1986/87	42 (100)	0	0	42	0	0	0	0	42
1987/88	36 (100)	0	0	36[c]	0	0	0	0	36
1988/89	28 (100)	0	0	28[d]	0	0	0	0	28
1989/90	48 (100)	0	0	48[e]	0	0	0	0	48
1990/91	44 (100)	0	0	44[f]	0	0	0	0	44

[a] Excludes permit hunt harvest.
[b] No estimates of unreported/illegal harvests have been made for this subunit.
[c] Does not include 4 bulls from an unspecified portion of Unit 17.
[d] Does not include 3 bulls from an unspecified portion of Unit 17.
[e] Does not include 5 bulls from an unspecified portion of Unit 17.
[f] Does not include 3 bulls from an unspecified portion of Unit 17.

Table 7. Unit 17 moose antler sizes (percent) in the reported harvest, 1986-91.

Regulatory year	Antler size <30"	30 - 50"	>50"	Largest antlers (inches)
1986/87	5	45	50	73
1987/88	5	37	58	71
1988/89	5	41	54	73
1989/90	10	40	50	76
1990/91	4	47	49	74

Table 8. Subunit 17B moose harvest data by permit hunt, 1986-91.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
983	1986/87	275[a]	22	40	19	14(100)	0	0	14
	1987/88	225[a]	19	61	13	15(100)	0	0	15
	1988/89	0[b]	--	--	--	0	0	0	0
	1989/90	0[b]	--	--	--	0	0	0	0
	1990/91	0[b]	--	--	--	0	0	0	0

[a] Registration permits were valid for both Subunits 17B and 17C. Permit data are for both areas combined, harvest data are specific to Subunit 17B.

[b] 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.

Table 9. Subunit 17C moose harvest data by permit hunt, 1986-91.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
983	1986/87	275[a]	22	40	19	31[b] (100)	0	0	31
	1987/88	225[a]	19	61	13	6[c] (100)	0	0	6
	1988/89	0[d]	--	--	--	0	0	0	0
	1989/90	0[d]	--	--	--	0	0	0	0
	1990/91	0[d]	--	--	--	0	0	0	0

[a] Registration permits were valid for both Subunits 17B and 17C. Permit data are for both areas combined, harvest data are specific to Subunit 17C.

[b] Not included are 6 bulls from an unspecified portion of Unit 17.

[c] Not included are 8 bulls from an unspecified portion of Unit 17.

[d] 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.

Table 10. Unit 17 moose hunter[a] residency and success, 1985-89.

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
1986/87	65	36	45	151 (35)	98	92	92	284 (65)	435[b]
1987/88	48	55	70	177 (38)	113	90	76	286 (62)	463[c]
1988/89	28	38	82	188 (41)	42	89	106	269 (59)	457[d]
1989/90	62	47	59	175 (40)	86	76	97	263 (60)	438[e]
1990/91	60	52	104	225 (46)	53	77	122	264 (54)	489[f]

[a] Excludes hunters in permit hunts.
[b] Includes 5 successful and 1 unsuccessful hunters of unknown residency.
[c] Includes 4 successful and 7 unsuccessful hunters of unknown residency.
[d] Includes 40 successful and 26 unsuccessful hunters of unknown residency.
[e] Includes 7 successful and 4 unsuccessful hunters of unknown residency.
[f] Includes 9 successful and 12 unsuccessful hunters of unknown residency.

Table 11. Unit 17 moose harvest[a] chronology percent by time period, 1986-91.

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
1986/87	1	5	45	27	2	1	0	7	11	151
1987/88	0	2	40	41	4	1	1	7	5	177
1988/89	0	9	26	55	1	1	2	2	5	188
1989/90	1	5	33	49	2	1	3	3	5	175
1990/91	0	0	36	45	1	2	3	4	9	225

[a] Excludes permit hunt harvest.
[b] Data for all regulatory years before 1990/91 are approximate because of data storage by week number rather than by day.

Table 12. Unit 17 moose harvest[a] percent by transport method, 1986-1991.

Regulatory year	Percent of harvest Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1986/87	54	0	31	1	4	0	1	8	435
1987/88	56	0	27	1	5	0	1	11	463
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

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit: 18 (42,000 mi^2)

Geographical Description: Yukon-Kuskokwim River Delta

BACKGROUND

Moose were thought to have begun immigrating to the lower Yukon-Kuskokwim Delta during the mid to late 1940s, and have since colonized riparian corridors of the Yukon and Kuskokwim rivers in low to moderate numbers (Helmericks 1944, ADF&G 1976). Further expansion of range and population size is limited by spring flooding, availability of winter habitat, and heavy hunting pressure. The Yukon-Kuskokwim Delta is mostly lowland treeless tundra, which is unsuitable as moose winter habitat. During winter moose are confined to forested and willow riparian habitats along major river systems.

Moose densities in Unit 18 appear to be moderate and growing in the Yukon River drainage upriver from Pilot Station, but are very low in the remainder of that drainage, and in the entire lower Kuskokwim River drainage. Though moose are now more common than in the past, densities are extremely low considering habitat availability.

Heavy hunting pressure has limited moose population growth in many areas of Unit 18. Extensive habitat is available for further colonization, and moose densities in adjacent Subunits 19A and 21E are much higher than in Unit 18. Human populations, however, are concentrated in many communities along the lower Yukon and Kuskokwim rivers.

In 1988, the Board of Game adopted a regulatory proposal that completely closed the moose hunting season in the lower Yukon Delta downriver of Mountain Village to allow a moose population to establish itself there. That population is being monitored to assess the impact of the season closure.

MANAGEMENT DIRECTION

Population management goals and objectives established for Unit 18 moose are to: 1) allow the moose population in Unit 18 to increase to a minimum of 3,000 moose; 2) maintain a bull:cow ratio of 30:100 or greater; 3) improve harvest reporting and compliance with hunting regulations; and 4) minimize conflicts between user groups harvesting moose.

METHODS

We monitored moose hunting activity by operating a hunter check station from late August through September 1989 and 1990 at Paimiut Slough along the Yukon River. We also collected harvest data through the statewide harvest ticket system. We conducted aerial composition surveys along the Yukon River corridor of Unit 18 during mid-winter, and along select drainages of the Kuskokwim River during late fall.

A cooperative telemetry study documenting seasonal movements of moose along the Yukon and Kuskokwim rivers was continued by the USFWS, ADF&G, the Association of Village Council Presidents (AVCP), the Lower Yukon School District, the Yupiit School District, and the Kuspuk School District. Fourteen cows and 1 bull were outfitted with radio collars between the Aniak and Kwethluk rivers on the Kuskokwim portion of the study area, and 4 cows and 5 bulls were collared on the Yukon portion of the area.

RESULTS AND DISCUSSION

Population Status and Trend

Available aerial survey data indicate that the Yukon River population in Unit 18 is increasing. The number of moose observed during late winter surveys along the riparian corridor of the Yukon River, especially on islands located upriver of Marshall, has increased significantly in recent years. We surveyed sections of the Yukon River from the eastern Unit 18 boundary at Paimiut to Pilot Station during March 1990 and 1991. The total number of adult moose and short yearlings observed during both surveys increased (Table 3). Until a statistically valid census of the area is completed, it is difficult to estimate density with any degree of confidence. We plan to census the Yukon River portion of Unit 18 during February 1992.

Moose populations remained very low but stable in number along the Kuskokwim River and its tributaries in Unit 18 (Tables 1 and 2). Only residual numbers of moose were present in most tributary drainages. However, an exception is the upper Tuluksak and Bear creek drainage which appears to have a moderate density moose population. The upper Tuluksak River drainage is difficult to access during hunting season and sees very little, if any, hunting pressure. The southern portion of Unit 18 that drains into Kuskokwim Bay was surveyed by the USFWS staff during the winters of 1990 and 1991. We observed no moose during surveys conducted in the Kanektok, Goodnews, and the Arolik rivers. Occasionally, moose are observed on these drainages during summer and early fall. Very few moose were harvested in these 3 drainages, and moose were rarely seen in the area by residents of Quinhagak, Goodnews Bay, and Platinum.

Population Size: We completed four moose surveys of the Yukon and Kuskokwim river drainages in Unit 18 between November 1989 and March 1991 (Tables 1, 2, and 3). We believe moose numbers have increased in the Yukon River drainage to approximately 700-900 moose. In the Kuskokwim River drainage, we estimate 300-400 moose. Until we complete a statistically valid census, these estimates should be viewed as tentative.

Population Composition: The only fall composition survey completed during this report period was for select drainages of the Kuskokwim River (Table 1). Composition surveys within Unit 18 are often not completed because of the lack of snow and marginal weather conditions that often occur during late fall. Of the 219 moose observed in the Kuskokwim survey, 23% were calves, and the bull:cow ratio was 58 bulls:100 cows. Most bulls were young, and large antlered bulls were rare, except in the inaccessible area along the upper Tuluksak and Bear creek drainage.

Short yearling surveys along the Yukon River corridor were conducted between Paimiut and Pilot Station during mid-winter of 1989 and 1990 (Table 3). The March 1990 short yearling surveys counted 473 moose of which 16% were calves. The February 1991 survey conducted in the same area counted 651 moose of which 27% were calves.

Distribution and Movements: Small numbers of moose migrate in late summer to coastal regions from the mouth of the Kuskokwim River to Scammon Bay, Nelson Island, and the lower Yukon Delta. Local USFWS staff sporadically monitored locations of radio-collared moose in Unit 18, and portions of Subunit 19A. Information received to date indicates that most collared moose migrated 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 collared moose along the lower Yukon River showed any signs of moving long distances. This particular bull was collared near Pilot Station in March 1990, and recently was seen near Mountain Village during spring 1991.

With the advent of winter and fall hunting pressure, moose retreated to forested regions along the Yukon River. Moose were also found in alpine and subalpine regions of the Kilbuck and Andreafsky mountains during summer, but descended to yards along the Aniak River, in forested tributaries of the Kuskokwim River, and along the lowlands and island of the Yukon and Kuskokwim rivers during late winter. The Yukon River lowlands between Holy Cross and Paimiut support large numbers of moose, particularly in winter. A 6-hour survey of the Paimiut-Holy Cross portion of the Yukon River in Subunit 21E corridor counted 1,034 moose during April 1990.

The densities of moose along both the Yukon and Kuskokwim rivers are much higher upriver from their mouths. The further you go upriver on both drainages, the greater the number of moose observed. This is evident from aerial survey and harvest data. The number of moose observed during aerial surveys, and the number of moose killed by hunters increases the further upriver you travel from the coast.

Mortality

Season and Bag Limits: No open season occurred in that portion of Unit 18 north and west of a line from Cape Romanzof to Kuzilvak Mountain and then to Mountain Village, and west of (but not including) the drainage of the Andreafsky River. The open seasons for subsistence and resident hunters in the remainder of Unit 18 were 1-30 September and 20-30 December, and the bag limit was 1 bull. The open season for nonresident hunters in the remainder of Unit 18 was 1-30 September, and the bag limit was 1 bull.

Harvest:

Human-Induced Mortality. Hunting remains the most significant source of moose mortality in Unit 18. Although reported harvests declined between 1981 and 1987, harvests increased substantially during the 1988-89 season. The 1988-89 season had the third highest reported harvest since the 1978-79 season. During the 1989-90 season, however, reported harvest declined with 130 hunters reporting a harvest of only 33 moose. Reported harvest for the 1990-91 season rebounded back to normal levels with 171 hunters reporting a harvest of 61 moose (Table 1).

The moose population in Unit 18 is heavily used by local residents, and the combined reported and unreported annual harvest is estimated to equal or exceed 10% of the population size on the Yukon River, and may exceed the annual recruitment rate on the Kuskokwim River. The estimated unreported harvest in the Kuskokwim drainage may equal or exceed the reported harvest. On the Yukon River, we believe that harvest reporting has improved dramatically in the past 5 years because of the moose hunter check station, the acceptance among local hunters of using harvest tickets, and the willingness of hunters to harvest only bulls.

The estimated 1989-90 Unit 18 harvest, including the unreported harvest, is 100-200 moose annually. The overall moose harvest in the unit is believed to be increasing slightly in response to improving economic conditions, increasing human populations, and increased demand for moose.

Many local residents are aware that hunting opportunities are significantly better in Subunits 19A and 21E than in Unit 18. Approximately 50% of the successful hunters who harvested moose in Subunit 19A were residents of Unit 18. These percentages are based on reported harvest, and probably are below what the actual percentages should be. Approximately 70% of all successful and unsuccessful hunters who hunted the fall season in Subunit 19A were residents of Unit 18 traveling to the Holitna-Hoholitna River, and between 85-95% of the hunters checking in at the Paimiut check station who hunted in Subunit 21E were residents of Unit 18. Consequently, fall moose hunting activity in the central Kuskokwim region of Subunit 19A, and in the Innoko-Iditarod region of Subunits 21E-21A has occasionally become a controversial allocation issue among residents of Unit 18 and Subunits 19A and 21E. The concern is that heavy harvests attributable to non-local hunters may result in reduced seasons and bag limits. In spring 1989, at the request of residents of Subunit 21E, the board decided to eliminate the February moose season because the combined take of moose for both fall and winter seasons was thought to be approaching the annual recruitment rate. That particular season was recently reinstated for the 1991-92 regulatory year.

The reported harvest of moose in Unit 18 reflects only hunters who comply with the regulatory system. The percentage of local residents hunting in season with licenses and harvest tickets appears to be increasing, particularly during fall. The out-of-season harvest probably has declined with the advent of the December season.

During the 1989-90 season, approximately 55% of the reported moose harvest occurred in the Yukon River drainage, and the remainder occurred in the Johnson and Kuskokwim river drainages. During the 1990-91 season, approximately 80% of the harvest (49 moose) were reportedly taken in the Yukon River drainage upstream of Mountain Village. Of those taken in the Yukon drainage, 54% were from along the Yukon River between Marshall and Paimiut villages. Fifteen percent of the harvest (9 moose) were taken from the Kuskokwim drainage, and 5% (4 moose) were taken from the Johnson River drainage. Of those taken from the Kuskokwim drainage, 46% were from the Kwethuk-Kisaralik River systems, 38% were from the upper Johnson River, and the remainder were from other portions of the Kuskokwim drainage. A few moose were reported taken from the remainder of the unit.

During September 1989 and 1990, ADF&G staff operated a check station for the 5th and 6th consecutive years at the junction of Twelve-Mile Slough and Paimiut Slough on the Yukon River near the border of Unit 18 and Subunit 21E. Voluntary participation at the check station has increased from previous years. During the fall seasons of 1989 and 1990, 165 and 209 hunters, respectively, stopped at the check station. Nearly all hunters going through the check station were residents of Unit 18. Hunters were from the 17 towns and villages, located primarily along the lower Yukon River. Between 80-100 moose were reported harvested from an area extending from the upper Innoko River and Iditarod River in Subunits 21E and 21A to Russian Mission in Unit 18. Most of these moose were brought through or processed near the check station. The moose sampled at the check station were primarily young bulls in good condition.

In 1989, a sample of 32 bull moose reportedly taken in Unit 18 yielded an average antler width of 38.9 inches. In 1990, a sample of 44 bulls yielded an average antler width of 33.0 inches. Approximately 77% of the moose sampled were between 1-3 years of age in 1989, and 75% were between 1-3 years of age during the 1990 season.

We were aware of approximately 72 moose killed in 1989 and 105 moose in 1990 within the northeastern portion of Unit 18 and Subunit 21E along the Yukon-Innoko rivers. Some of these moose were not sampled, having been harvested well away from the check station. Most of these moose were taken in Subunit 21E.

Hunter Residency and Success. As reported in previous years, Alaska residents accounted for most hunting activity in Unit 18. Only 2% of the hunters were nonresidents in 1990, and no nonresidents reported hunting in 1989. Hunter success rate based on those contacted at the check station was approximately 33% (1989-1990), and overall for Unit

18 the success rate was approximately 25%. Hunters needed an average of 6.3 days to harvest a moose.

Transport Methods. During the 1989 season, boats were the most frequently used transportation by successful hunters in Unit 18 (80%). Other successful hunters used snowmachines (2%), aircraft (8%), and (10%) were unspecified. In 1990, 85% of the successful hunters used boats, 4% used snowmachines, 1% used aircraft, and 10% were unspecified. Because compliance with harvest reporting requirements is poorer in winter than in fall, we believe that snowmachines were used more often than reported.

Harvest Chronology. Thirty-two bull moose were reportedly taken in Unit 18 during the September 1989 season, and 1 during the December 1989 season. Hunters reported taking 55 bull moose in Unit 18 during the September 1990 season, and 6 during the December 1990 season. We believe that the December figures for 1989 were substantially less than the actual harvest.

Weather conditions during the falls of 1989 and 1990 were generally milder and wetter than in previous years, and no snowfall was recorded either season. Moose rutting activity near the check station began about 20 September. Most hunters were afield during the first 2 weeks of September (66%), and the remainder hunted until 30 September.

Natural Mortality. Little information is available indicating whether predation by either bears or wolves was a significant source of moose mortality in Unit 18 during 1989 and 1990. At least 2 packs of wolves were in the Kilbuck Mountains, and several packs were near Russian Mission and Paimiut Slough. We estimate that 50-75 wolves inhabited Unit 18. The distribution of wolves appears to reflect the distribution of moose, especially on the Yukon River. In the Kilbuck Mountains, caribou are an alternative prey species. Wolf numbers may be increasing slightly in the unit as ungulate numbers increase, but the overall density of wolves remains very low. Many bears and wolves found in Unit 18 also reside in Units 17, 19, 21, and 22.

Grizzly bears probably outnumber moose in the Andreafsky and Kilbuck mountains. Black bears are abundant in the Kuskokwim and Yukon river drainages. Predation by bears, particularly on calves, may significantly impact moose population growth, although quantitative information is lacking.

Spring flooding of lowlands along the Yukon and Kuskokwim rivers may follow winters characterized by heavy snowfall and severe temperatures as seen in January 1989. Loss of calves to flooding probably occurred during May and June 1989. Many local people believe that the 1989 flood was worse than in 1985, although recruitment was higher in the springs of 1990 and 1991 than in previous years. Sufficient quantitative data indicating an under representation of the 1985 cohort are not available, but age data from hunter-harvested moose in Subunits 19A and 21E show a low percentage of moose in these age classes.

Board of Game Actions and Emergency Orders. Local advisory committees voted in 1990 and 1991 to split the moose season, and lengthen the winter season into January and February. ADF&G staff and USFWS biologists suggested that any moose season liberalization may increase the probability of overharvest, and recommended that the winter season remain in December when the chances of harvesting cow moose are less. The Board of Game did not adopt the advisory committee's proposal.

Habitat Assessment

The islands and adjacent sloughs along the Yukon River from Paimiut to Mountain Village appear to be productive moose habitat. No overbrowsing is evident. However, upstream of Paimiut on the Innoko River, some overbrowsing is evident in the better winter yarding areas, resulting in moose migrating downriver into better browsing areas. The narrow bands of willow stands downriver from Mountain Village along the Yukon River are overgrown and senescent, except for the expanse of willow near Kusilvak Mountain and the Kashunak River. The willow stands along the Yukon River downstream of the Anuk River are so narrow that cover may be inadequate for moose during winter.

The riparian habitat along the Kuskokwim River in Unit 18 downstream of Kalskag appears to represent good moose habitat. Between lower Kalskag and Akiachak, the forest and brush along the Kuskokwim River may provide sufficient escape cover for moose. Moose are occasionally seen in this area standing in meadows surrounded by thick willow, spruce and cottonwood mixed forest. Downstream of Akiachak towards the mouth of the Kuskokwim River, the riparian corridor narrows, and lacks escape cover. Along the Kanektok, Goodnews, and Arolik rivers, moose are rarely found in the forest fringes of these drainages, as cover and browse are very sparse.

Tributaries of the Kuskokwim River bordered by spruce and cottonwood, and interspersed with willow and alder, extend into 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, resident moose population.

CONCLUSIONS AND RECOMMENDATIONS

Moose have colonized the Yukon-Kuskokwim Delta during the last 40 years, and are found in moderate densities along the Yukon River from Paimiut to Ohagamiut, but remain at very low densities in the rest of the unit. Though much of Unit 18 is lowland tundra that is unsuitable winter habitat for moose, moose should be present in higher numbers because of the extensive habitat still unoccupied. Though calf production and yearling recruitment are high in years without major flooding, hunting pressure from the unit's relatively dense human population has effectively limited moose population growth.

Illegal harvest, particularly of cows and calves, is the most serious moose management problem. Though compliance with regulations is improving, a lack of alternative ungulate resources, a poorly developed cash economy, and a high density of people and villages along the major rivers complicates the situation considerably. Recent actions by user groups within the unit, especially along the lower Yukon River, to shoulder more responsibility for improving the status of local moose populations are welcome signs of increasing participation in the management system.

The concurrent growth of muskox and caribou populations in Unit 18 may also eventually lessen pressure upon the moose population, although demand for moose will always exceed the supply.

We recommend that further monitoring of the moose population remain a primary management goal; especially continuing mid-winter counts along the Yukon River and fall aerial surveys/composition counts along the Kuskokwim River and its major tributaries. Fall composition counts should also be conducted in the Yukon River drainage. Poor weather conditions often hamper attempts at composition counts before bulls drop their antlers. We need this information to determine numbers, composition, and recruitment levels of Unit 18 moose. We also need to complete a moose census in the Yukon and Kuskokwim River drainages. These censuses should provide ADF&G with baseline density information needed to manage the moose population properly.

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Table 1. Fall composition survey in the Kuskokwim drainage, Unit 18, November 1989.

Survey area	Bulls	Cows	Calves	Yearling	Total
Lower Kwethluk	0	1	0	0	1
Upper Kwethluk	1	5	2	0	8
Lower Kiseralik	0	1	1	0	2
Upper Kiseralik	0	5	0	0	5
Upper Eek	0	0	0	0	0
Lower Eek	0	0	0	0	0
Kanektok	0	0	0	0	0
Arolik	0	0	0	0	0
Lower Bogus	0	0	0	0	0
Upper Bogus	1	3	1	1	6
Lower Tuluksak	0	0	0	0	0
Upper Tuluksak	9	14	7	12	42
Lower Fog	0	0	0	0	0
Upper Fog	8	11	9	5	33
Akulikutak	0	0	0	0	0
Kasigluk	0	0	0	0	0
Quartz	2	5	2	1	10
Quicksilver	1	0	0		1
Greenstone	5	6	3	1	15
Spein	0	0	0	0	0
Slate	0	4	3	0	7
Bear	20	28	17	8	73
Kuskokwim (Kalskag-Tuluksak)	5	6	5	0	16
Kuskokwim (Tuluksak-Bethel)	0	0	0	0	0
Totals	52	89	50	28	219
Percent Composition	23.7	40.6	22.8	12.9	

Total Bulls:100 cows = 58
Total Calves:100 cows = 56
Total Yearlings:100 cows = 31

Table 2. Winter recruitment survey in the Kuskokwim drainage, Unit 18, February 1991

Survey area	Number of Adults	Number of Calves	Total
Lower Kwethluk	1	0	1
Upper Kwethluk	2	3	5
Lower Kiseralik	2	0	2
Upper Kiseralik	2	1	3
Both forks of Eek	1	1	2
Kuskokwim (Kalskag-Tuluksak)	26	4	30
Total	34 (79%)	9 (21%)	43 (100%)

Table 3. Winter recruitment surveys along the lower Yukon River, Unit 18, 1980-1991.

	No. moose (No. short yearlings)		
Year	Pilot to Ohagamiut	Ohagamiut to Russian Mission	Russian Mission to Paimiut
1980	---	11 (5)	49 (11)
1981	15 (4)	47 (27)	39 (12)
1982	17 (9)	27 (16)	37 (15)
1983	---	7 (1)	45 (15)
1984	---	22 (1)	63 (10)
1985	10 (1)	54 (21)	107 (32)
1986	---	11 (5)	---
1987	---	45 (15)	106 (5)
1988	30 (8)	106 (21)	209 (54)
1989	---	---	---
1990	63 (9)	73 (9)	337 (72)
1991	139 (41)	99 (21)	413 (119)

Table 4. Reported moose harvest for Unit 18 by regulatory year and season, 1978-91.

Regulatory year	Fall[a]	Winter[b]	Unknown	Total
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 (88%)	7 (24%)	2 (3%)	72
1985-86	43 (83%)	8 (17%)	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

[a] Between 1977-82, the moose season was 1 Sept.-31 Dec. in all of Unit 18, except the Yukon River Delta; the Delta season was 1-20 Sept. beginning in 1982 until 1988, when a moose harvest moratorium was established on the Delta. In 1985, the fall season was 1-30 Sept. in the remainder of Unit 18. The bag limit in Unit 18 has been 1 bull throughout this time period.

[b] In 1982-85, the winter season was 15 Nov.-31 Dec. in Unit 18, excluding the Yukon River Delta. No winter season was held in the Delta. During 1977-1985, only bulls were reported caught in the winter seasons. During 1985-88, the winter season was 1-10 Feb. 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% of the annual harvest, depending on the sex of unknown animals. During the 1988-89 regulatory year, the winter season was 20-30 Dec. and continued to be 20-30 Dec. through 1989, 1990 and 1991.

LOCATION

Game Management Units:	Unit 19 (36,486 mi^2) and Subunits 21A and 21E (23,270 mi^2)
Geographical Description:	Drainages into the Kuskokwim River upstream from Lower Kalskag; Yukon River drainage from Paimiut upstream to the Blackburn Creek drainage; Innoko River drainage; and the Nowitna River drainage upstream from the Little Mud and Nowitna rivers

BACKGROUND

Moose are a relatively recent addition to western interior Alaska. Their first occurrence was after the turn of the century. Present populations are probably as high as they have ever been. Moose are found throughout the area, with the exception of rugged peaks of the Alaska Range. Major factors influencing moose abundance in the unit include predation, hunting, and weather. Hunting pressure is thought to be moderate except in a few easily accessible areas. Failure to report harvests is a chronic problem.

Unit 19, as well as Subunits 21A and 21E, can be divided into two regions that have distinctive differences in moose habitat, user access, and hunting practices. Subunits 19A, 19D, and 21E are lower elevation areas accessible by boat. Most hunters are local residents, living in either Unit 19, Unit 21, or adjacent Unit 18. Most hunters harvest moose for food. Subunits 19B, 19C, and 21A are higher elevation areas where access is largely by aircraft. Few people live in these areas, and those hunting there mainly seek large trophy quality bulls, though acquiring 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. Surveys date back several decades, but the data are of limited value because of inconsistencies in survey areas and methods which compounded the usual problems caused by annual variations in snow and weather conditions.

MANAGEMENT DIRECTION

Subunit boundaries were designed to provide for two major uses of moose. The lowland areas along the Kuskokwim River (Subunits 19A and 19D) and along the Yukon and lower Innoko rivers (Subunit 21E) have been managed to provide a sustained, relatively high moose harvest. The higher elevation areas (Subunits 19B, 19C, and 21A) are managed to produce trophy quality animals. Because topography directly affects access, area management will continue to be based on these premises.

Management Goals and Objectives

Management goals and objectives for the area are to: 1) develop statistically sound population estimates for select portions of the area by spring 1993; 2) annually assess population status and trend in portions of the area where harvest levels make significant impacts on moose populations; 3) maintain a Unit 19 reported harvest of at least 500 moose; 4) maintain an areawide reported hunter success rate of at least 45%; 5) maintain an annual average antler spread measurement of at least 48 inches in Subunits 19B, 19C, and 21A; 5) assess accuracy of harvest reporting in select portions of the area; and 6) 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 areas using standard aerial survey techniques. We greatly reduced these efforts during fall 1991 because of poor survey conditions. We also postponed a census planned for the Lime Village Management Area because of poor conditions. We used information from harvest tickets to monitor hunter demographics and harvest parameters.

We conducted browse utilization surveys on foot using standardized ADF&G transect methods. 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.

We conducted late winter/spring aerial surveys in 1991 to assess the effects of severe winter weather conditions on moose in Subunit 19D. Mortality rates and causes were assessed. During summer 1990 and 1991, we aerially monitored calving rates and timing in a select area of Subunit 19D. In cooperation with the USFWS and Innoko Refuge staff, an experimental moose census was conducted in a portion of Subunit 21E using a helicopter and strip transect method. The effort yielded no statistically sound data.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: No population estimation surveys have been conducted in the area. Historical data from composition/trend surveys suggest that moderate moose numbers exist and populations are stable. We did not conduct a moose census in the Lime Village area in Subunits 19A and 19D in fall 1991 because of poor survey conditions.

Population Trend: Long-term historical data, which can be used to depict population trends, are available from two areas in Unit 19. 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 were entirely different than conditions during early winter surveys. The only other survey area subject to repeated surveys over a long period was in the Farewell (Bear Creek) Burn/Alaska Range Foothills area (Table 2). Fifteen surveys were completed in that portion of Subunit 19C between 1976 and 1991.

In early winters of 1987 and 1988, six additional composition/trend count areas were established in Unit 19, as well as three trend 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, during early winter 1991, snow conditions were poor and we completed few surveys.

In Subunit 19A, trend information is available only from the Holitna and Hoholitna river trend count 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/hour figures from the Holitna/Hoholitna river count areas (Table 1) have increased dramatically since 1976 when the first fall surveys were done. Four surveys done between 1976 and 1984 had a mean of 39 moose/hour. Surveys done during the 4-year period 1987-90 had a mean of 126 moose/hour. Counts were standardized in 1987 and conducted in early winter concentration areas; this partially explains the threefold increase. Because of standardization, future data should better reflect actual trends in the population.

Bull:cow ratios from eight fall surveys between 1976 and 1990 in the Holitna River drainage reveal a decline (49 to 26 in 1976 and 1990, respectively) and we assume are an accurate reflection of actual population trends. September hunting pressure has been intense in the area and has contributed to the documented declines. From 1987 to 1990, following standardization of survey procedures, no statistically significant declines in bull:cow ratios have been noted. Calf:cow ratios have increased since 1976, with the last 3-year surveys average at 54 calves:100 cows.

From these data, moose populations along the lower reaches of the Holitna and Hoholitna rivers in Subunit 19A appear in relatively good shape. Hunting pressure is intense, so the declines in bull:cow ratios are not surprising. Moose per hour figures indicate very strong recruitment; while bull:cow ratios have declined, total number of bulls available has increased dramatically. The area contains excellent moose habitat, which leads 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 area was surveyed five times between 1982 and 1990. Moose/hour figures increased from 16 to 41 during that period. Calves:100 cows increased from 28 to 41. Observed bull:cow ratios declined, but remained 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 ($\bar{x}$ = 69), calves:100 cows ($\bar{x}$ = 24:100), and bulls:100 cows ($\bar{x}$ = 45:100) are all highly variable and show no distinct trends.

The Farewell Burn and Windy/Pingston count areas were used to document moose population trends in Subunit 19C. The Farewell Burn count area (Table 2) was surveyed 15 times from 1973 to 1991. Moose/hour figures dropped from 94 to 31 between the 1974 and 1979 surveys. This drop was due in large part to the 1977 Bear Creek Burn. However, from 1983 to 1989, moose/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 because of that same wildfire. As spruce reinvades the burn, willow growth will continue to decline. Habitat deterioration has probably influenced the 1990 and 1991 declines in moose/hour data from the count area.

Bull:cow ratios have steadily declined on the count area, while calf:cow ratios have increased. Heavy hunting pressure has probably affected the bull:cow ratios. Classic evolutionary changes following wildfire are evident. Immediately following the burn, moose densities declined severely. However, initial revegetation had high amounts of willow which 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.

The Windy Fork/Pingston Creek count area was surveyed five times between 1984 and 1990. Moose/hour figures fluctuated widely at relatively high levels, as have calf:cow and bull:cow ratios. The trend count area has not proved a good indicator of area moose population trends, 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 only have 3 years of composition data.

In addition to 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/hour comparisons among surveys are meaningless. Bull:cow ratios are not readily gathered, as most bulls have shed their antlers. Observed calf percentages in the subpopulation are particularly important. 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%.

Moose densities appear stable in Unit 19. Localized populations have recently declined in total numbers or in the bull segment. Severe weather conditions during 1989-90 and 1990-91 winters, with high starvation mortality and heavy wolf predation, led to local declines, especially along the upper mainstream Kuskokwim River of Subunit 19D. However, calf production and subsequent recruitment in those areas 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 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 we lack 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 counted during 3 hours of survey in November 1990 (253 moose/hour). Calf:cow ratios remained high ($\bar{x}$ = 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.

Mortality

Harvest: Reported moose harvest in Subunit 19A was 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 in mandatory harvest report tickets. Thus, the actual harvest in Subunit 19A probably exceeded 300 moose annually. Reported harvest in Subunits 19B and 19C are probably much closer to reality and have averaged 140 and 113 moose, respectively. Because of shortened seasons and warm, mild fall weather, 1990 and 1991 harvests declined somewhat compared with previous years. In Subunit 19D, compliance with reporting requirements was also poor, averaging 122 reported moose harvested during the 1986-90 seasons. Overall, reported moose harvests for Unit 19 (Table 4) began a 3-year decline in the 1989-90 season. This was probably because of shortened season lengths, heavy mortality because of winter starvation and wolf predation, and unseasonably warm autumn weather during 1991.

In Subunit 21A, reported moose harvests remained relatively constant from 1986 to 1990 with a mean reported annual harvest of 142. Reporting rates are assumed to be high, with estimated harvest 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 apparent 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 5.

Seasons and Bag Limits.

Subunit 19A (Lime Village residents):

1986-1988	10 Aug.-25 Sept., 20 Nov.-31 Mar.	= 179 days.
1989	Same season dates; no bag limit; either sex.	
1990-1991	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, Sept. only.

1986-1991	1-30 Sept., 1 Dec.-28 Feb.	= 120 days

Subunit 19D (Outside CUA Portion): Nonresidents, Sept. 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

Where season dates changed during the past 6-years they became more restrictive. In 1990 nonresident hunters also were restricted to harvesting bull moose having antlers at least 50 inches in spread or with a minimum of 3 brow tines on at least one side.

Permit Hunts. One moose permit hunt occurs in the area. Beginning in 1990-91, a Tier II drawing permit was required to hunt moose in the Lime Village Management Area. During 1990, we issued 10 permits with a harvest quota of 25 either-sex moose. Two moose were reported harvested, both by Lime Village residents.

Hunter Residency and Success. Local residents account for most moose harvests in Subunits 19A, 19D, and 21E, while most hunters in Subunits 19B, 19C, and 21A were nonlocal Alaska residents or nonresidents (Tables 6 and 7). This segregation by residence is caused by accessibility of respective areas. Most access (Table 8) is by boat in Subunits 19A, 19D, and 21E, while access in Subunits 19B, 19C, and 21A is by aircraft.

During the 1990-91 season in Subunit 19A, 122 (48%) reporting hunters came from 1 of 13 villages in Unit 18. Fifty-four hunters (21%) representing 7 villages were from Unit 19. Only 24 hunters (9%) were from other Alaska locations, 34 (13%) hunters were not Alaska residents (two nonresident aliens). Twenty-two hunters (9%) did not list residence.

Subunit 19B hunters were mostly nonlocal. Seven hunters (2%) were from Unit 19. Other Alaskan hunters numbered 144 (48%), and nonresidents numbered 144 (48%). Three hunters (1%) did not list residence.

Subunit 19C hunters were 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 came from Alaska outside Unit 19, and 120 (48%) were not residents of the state. Four hunters (2%) were from unknown locations.

Almost half of Subunit 19D hunters ($\underline{n}$ = 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 most hunters are not local residents. Nonresidents or aliens 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 consistent between subunits. In Subunit 19A, the reported success rate during 1990-91 was 54%. As noted above, reporting rates are poor, and successful hunters are more likely to report their hunt than unsuccessful hunters. The reported success rate of 54% in Subunit 19A is probably inflated. The other three subunits of Unit

19 had 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 are 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 Subunit 21E.

Harvest Chronology. Most of the Unit 19 reported moose harvest occurred 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 occurred mostly during September, with February seasons contributing < 5% annually to the overall reported moose harvest.

Other Mortality: Illegal harvests, DLP kills, wounding loss, and funeral potlatch harvests probably account for 100-150 more moose deaths annually in Unit 19, and probably 50-75 additional kills in Subunits 21A and 21E. Predation and high starvation mortality were of greater importance to the moose population, particularly during winters.

From 4 January through 5 May 1991, we conducted 7 aerial surveys along the Kuskokwim River near McGrath in Subunit 19D. Surveys were designed to count moose populations and determine extent, timing, and causes of mortality during this particularly severe winter. Because of deep and crusted snow, 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 was about 400 moose. We found 57 dead moose during surveys (14% of estimated moose population), but this probably represents a fraction of 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 for which age class was determined, 22 were calves and 19 were yearlings or adults. Mortality was extremely high during winter 1990-91 and will probably affect the harvest for several years.

Habitat Assessment and Enhancement

Ongoing assessment will document browse use on heavily used winter ranges along the Kuskokwim River. Standard browse transects monitored in 1988 and 1990 will be surveyed in summer 1992 and reported on in a later moose management report. Because winter 1991-92 has been mild to date, results of 1992 summer browse assessment work will be most interesting compared with previous years of relative winter severity.

Habitat enhancement efforts continued. Close cooperation with Alaska Department of Natural Resources fire management personnel resulted in relatively high-acreage burns during both 1990 and 1991. Education efforts in schools and on radio programs have also dispelled myths about wildfires and attempts to allow more areas to burn.

CONCLUSIONS AND RECOMMENDATIONS

Because of two successive severe winters (1989-90 and 1990-91) moose populations in many areas of Unit 19 declined slightly, and the harvest reflected the declines. Shortened moose seasons in portions of the unit also contributed to the declining harvest rates. Moose populations in Subunits 21A and 21E have not had to contend with winter conditions as severe as those in Unit 19, and populations (as well as harvests) have not declined. We should increase our efforts to educate hunters about needing 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 continue in established trend count areas. Census areas should be established in select areas and populations assessed on a 5-year rotating schedule. We must 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 wildfires maintain young, highly productive, and diverse habitats. A prescribed burn should be completed for a portion of the 1977 Bear Creek Burn and that area reburned when prescription parameters are met.

Future direction of moose population management in the area depends on the ability to keep harvesting predator populations. Particularly during severe winters when moose are stressed because of 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 sustain themselves above critically low population 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, 1987-91.

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

[a] Six unclassified moose.
[b] Seven unclassified moose.

Table 2. Farewell Burn Count Area (Subunit 19C) fall aerial moose composition counts, 1987-91.

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

[a] Three unclassified moose.

Table 3. Holy Cross (Subunit 21E) fall aerial moose composition counts, 1987-91.

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

[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. Unit 19 moose harvest, 1986-91.[a]

Regulatory year	Harvest by hunters: Reported				Harvest by hunters: Estimated			Total
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	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

[a] Excludes permit hunt harvest.

Table 5. Subunits 21A and 21E moose harvest, 1986-91.

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

Table 6. Unit 19 moose hunter[a] residency and success, 1986-91.

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	375 (46)	821
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

[a] Excludes hunters in permit hunts.

[b] Local resident means those living in Unit 19.

Table 7. Subunits 21A and 21E moose hunter residency and success, 1986-91.

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

[a] Local resident means those living in Subunits 21A or 21E.

Table 8. Unit 19 moose harvest[a] percent by transport method, 1986-91.

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	n
1986-87	44	<1	44	2	3	<1	1	5	821
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

[a] Excludes permit hunt harvest.

LOCATION

Game Management Subunit: Subunit 20A (6,751 mi^2)

Geographical Description: Tanana Flats, Central Alaska Range

BACKGROUND

Moose occur throughout the Alaska Range foothills and the Tanana Flats. Preferred moose habitat includes riparian willow, second growth forest, and subalpine shrub communities. Habitat may have limited moose population growth during the 1960s when densities were high, but browse availability has not recently limited moose population growth. During the 1960s when average moose densities may have exceeded 3 moose/mi^2, moose affected browse production (W. Gasaway, pers. commun.). A detailed history of the moose population through 1978 was published by Gasaway et al. (1983).

Moose numbers increased in Subunit 20A during the 1950s and reached high densities in the early 1960s. The moose population declined in the late 1960s, and reached its lowest point in the mid-1970s. After predator reduction, which began in 1976, the moose population again increased. Six population estimate surveys (Gasaway et al. 1986) were done in Subunit 20A since 1976. The whole subunit was censused in 1978 and 1988, the flats were censused in 1982, and the foothills in 1984. In 1991, we censused the central Tanana Flats and western foothills. Population estimates from those surveys were 3,511 moose (1978), 7,663 moose (combined 1982 and 1984), 9,296 moose (1988), and 11,072 moose (1991), respectively.

Harvests averaged 311 moose between 1963 and 1969. From 1969 to 1974, harvests averaged 617 moose per year. From 1963 to 1974, 34% of the annual harvest were cows. Beginning in 1975, seasons and harvests were reduced and cow harvests were prohibited. From 1975 to 1978, mean annual harvest was 64 bulls. From 1979 to 1982, harvests averaged 226 bulls/year. Since 1982, the annual harvest has averaged 370 bulls.

MANAGEMENT DIRECTION

Management Goals

Management goals fur Subunit 20A moose are to: 1) provide the maximum opportunity for hunting moose; 2) provide the maximum sustained harvest of moose; 3) provide for diverse interests in the use of motorized and nonmotorized access for moose hunting; 4) provide the opportunity to view and photograph moose; and 5) maintain a sufficiently large population of moose that will support healthy populations of large predators that depend on moose.

Management Objectives

Management objectives for Subunit 20A moose are to: 1) manage for a November population of 10,000 to 12,000 adult moose by 1995; 2) manage for a bull:cow ratio of at least 30 bulls:100 cows and at least 20 bulls:100 cows in the Tanana Flats and the western and eastern foothills census areas; 3) maintain an annual harvest of no more than 300 bulls $\geq$ 2 years of age and a total harvest of less than 400 bulls, until the population objective is reached; and 5) allow the harvest of cow moose when the population is above 10,000 adult moose.

METHODS

Biologists conducted population estimation surveys (Gasaway et al. 1986) in the western foothills and central Tanana Flats of Subunit 20A during November 1991. I calculated population growth rates by comparing the 1991 survey results with identical portions of the 1988 total subunit survey. Because the eastern foothills were not surveyed in 1991, I extrapolated a 1991 population estimate for the eastern foothills by applying the growth rates observed between 1988 and 1991 in the western foothills to the 1988 eastern foothills population estimate. I used a similar extrapolation to estimate numbers in the entire Tanana Flats from the 1991 central Tanana Flats survey.

During the report period I reviewed final data from the 1988 Subunit 20A population estimation survey and found several errors in the data files used in the preliminary estimate. I made corrections and calculated a final 1988 moose population estimate. We surveyed to assess overwinter survival of calves and neonatal twinning rates on 4 and 24 May 1990 and 20 and 22 May 1991 on the northeast Tanana Flats. Similar surveys were conducted in 1987, 1988, and 1989 were reported by McNay (1990a).

Between 7 and 21 September 1991, biologists operated a check station at the Chena Pump boat landing in Fairbanks. We recorded harvest ticket and license numbers of all interviewed Subunit 20A moose hunters. An estimate of the actual moose harvest in Subunit 20A can be calculated by comparing check station harvest tickets with harvest tickets received through the harvest reporting system (McNay 1990b). Data from those interviews have not been compiled, but will be reported in future reports.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: Between 19 November and 4 December 1991, we completed moose population estimation surveys in a 1,610-mi^2 area in the central Tanana Flats and a 1,418-mi^2 area in the western foothills of Subunit 20A. We estimated population sizes of

3,906 ± 15.2% moose (90% C.I.) in the central Tanana Flats and 3,927 ± 15.0% moose (90% C.I.) in the western foothills. Mean densities were 2.4 and 2.8 moose/mi^2 in the flats and foothill survey areas, respectively.

The adult moose population increased in the western foothills from an estimated 2,229 ± 9.6% in 1988 to 3,161 ± 14.5% in 1991 ($P < 0.01$). The difference in point estimates represented an annual finite growth rate of 12%, but growth rates based on upper and lower confidence limits ranged from 3% to 21%. In the central Tanana Flats no detectable change occurred in the adult population between 1988 (2,888 ± 13.8%) and 1991 (3,047 ± 16.4%) ($P = 0.68$).

High variability in production and mortality of different calf cohorts can bias interpretation of basic population performance, so I used estimates of adults only (moose older than 1 year) to test if the observed rates of increase were statistically significant. The extrapolated total population estimate for Subunit 20A in 1991 was 11,072 moose; 4,989 in the Tanana Flats and 6,083 in the foothills. The extrapolated 1991 adult population was 8,788; 3,893 in the Tanana Flats and 4,895 in the foothills. The total population estimate represents a density of 2.2 moose/mi^2 in Subunit 20A. The estimate of 8,788 adults in Subunit 20A is below the management objective of 10,000 adult moose, but the management objective will be met by 1995 if the population grows at the rate observed between 1988 and 1991. The 1988 Subunit 20A population estimates previously reported (McNay 1990a) were based on preliminary data and contained errors. The corrected estimates are in Table 1, which supersedes Table 1 found in McNay (1990a).

Population Composition: Despite the severe 1990-91 winter which could have affected 1991 calf productivity and neonate survival, November calf:cow ratios were moderate in the central flats (34:100) and western foothill (32:100) survey areas (Table 2). The severe winter was reflected by the low yearling bull:cow ratio observed on the Tanana Flats in 1991 (4:100), but not in the yearling bull:cow ratio from the western foothills (10:100). The foothills component of the 1990 calf crop probably benefited from lower snow depths in the foothills and from the presence of caribou which are alternate prey for wolves.

During 1991, bull:cow ratios were 21:100 and 32:100 in the central Tanana Flats and western foothill survey areas, respectively. The combined bull:cow ratio weighted by adult sample size in the flats and foothills was 28:100. That was below the overall objective of 30 bulls:100 cows, but the bull:cow ratios in the Tanana Flats and western foothills met the individual count area management objectives of 20 bulls:100 cows.

The low bull:cow ratio on the Tanana Flats was probably related to moderate harvest rates during 1989, 1990, and 1991 while yearling recruitment declined after severe winters. In the western foothills, where the moose population exhibited substantial growth, the 1991 bull:cow ratio of 32:100 was the same as in 1988.

On 4 May 1990, we conducted an aerial survey in the northeastern Tanana Flats to assess overwinter survival of calves (11 months old). During two hours of survey time, we classified 154 moose. Bull:cow ratios were 37:100 and calf:cow ratios were 16:100. On 20 and 22 May 1991, we classified 243 moose during 3.3 hours in the northeastern Tanana Flats. Bull:cow ratios were 34:100 and calf:cow ratios were 11:100. The only comparable survey conducted before 1990 was conducted on 12 May 1987; calf:cow ratios were 28:100. The lower calf:cow ratios observed in 1990 and 1991 compared with 1987 may have reflected higher overwinter mortality of calves during 1990 and 1991 because snow depths were significantly greater than average during those winters.

Twinning rates on the Tanana Flats have been lower than elsewhere in Alaska (McNay 1990a). On 24 May 1990 and on 20 and 22 May 1991, we flew aerial surveys over the northeastern Tanana Flats to assess twinning rates at the peak of calving. In 1990, 7 of 32 (22%) cows with neonates had twins. In 1991, 5 of 24 (21%) cows with neonates had twins. Those twinning rates are the highest seen since 1987 when twinning surveys began.

Beginning in 1988, moose hunters in southwestern Subunit 20A were required to take only bulls with ≥ 50-inch antlers. That regulation was imposed in response to declining bull:cow ratios in areas where numerous trail systems allow motorized access. Bull:cow ratios in the Walker Dome trend count area of southwestern Subunit 20A increased from 17:100 in 1988 to 26:100 in 1990 (Table 3). In other areas of Subunit 20A where any bull was legal, bull:cow ratios were unchanged during the same period (Tables 4, 5, 6, and 7).

Distribution and Movements: Gasaway et al. (1983) documented significant movement of moose from the surrounding hills to the Tanana Flats beginning in April. Moose numbers remained high on the flats throughout summer. Movement back to the hills began in August and was completed by late October. Resident populations of moose remained on the Tanana Flats and in the foothills.

After reviewing the results of the 1991 census, I questioned whether the significant population increase in the western foothills was the result of moose movement from the flats or an actual increase in population size. However, regularly occurring movements of moose from the foothills to the flats during fall have not been documented, and during 1988 and 1991, November snow depths were insufficient to inhibit moose movement or reduce availability of browse in the flats or foothills. For those reasons, I believe the increase in observed moose numbers between 1988 and 1991 in the western foothills reflected an actual increase in that segment of the population.

Mortality

Harvest:

Season and Bag Limit. Seasons and bag limits in Subunit 20A during regulatory years 1989 and 1990 were as follows:

Units and Bag Limits	Subsistence	Res./Nonres.
Unit 20A, that portion south of the Rex Trail and west of the Wood River Controlled Use Area and the Yanert Controlled Use Area One bull with a spike-fork or 50 inch antlers	Sept.1-Sept.20	Sept.1-Sept.20
Remainder of Unit 20A One bull	Sept.1-Sept.20	Sept.1-Sept.20

Board of Game Actions and Emergency Orders. The Board of Game changed the boundaries of the Healy-Lignite Closed Area in March 1990 and described the new boundaries as the Healy-Lignite Management Area. Hunting within the Healy-Lignite Management Area is restricted to bow and arrow use only. The boundaries of the Wood River Controlled Use Area were extended in March 1990 to include portions of Subunit 20A along the Parks Highway, and the board established the Ferry Trail Management Area. No emergency orders were issued for moose in Subunit 20A from 1986 to 1990.

Hunter Harvest. During 1989, 1,133 hunters reported taking 371 moose in Subunit 20A, and in 1990, 1,194 hunters reported taking 368 moose. In both years, 64% of the harvest was from the Tanana Flats. During 1990, 88 bulls taken by hunters had antler spreads of ≤ 30 inches. Assuming bulls with antler spreads of ≤ 30 inches are mostly yearlings, the adult harvest during 1990 was 280 bulls. During 1989, 110 bulls harvested had antler spreads of ≤ 30 inches, leaving an adult bull harvest of 261. In both years the harvest guideline of no more than 300 adult bulls was met.

Permit Hunts. No permit hunts occurred in Subunit 20A for moose from 1986 to 1990.

Hunter Residency and Success. Overall hunter success was 33% during 1989 and 31% during 1990. Hunter success rates, as in past years, continue to be higher for nonresident hunters (49% and 54% during 1989 and 1990, respectively). Hunter success for Alaskan residents was 31% in 1989 and 28% in 1990. During 1989 and 1990, 70% and 73%, respectively, of the harvest was taken by Unit 20 residents (Table 8). Nonresidents took 14% and 16% of the harvest during 1989 and 1990, respectively.

Harvest Chronology. Moose harvest in Subunit 20A has traditionally been well distributed throughout the 20-day September season (Table 9). In 1989, 33% of the harvest was reported from the first week of the season, 28% from the second week, and 39% from the final week. Similarly in 1990, 32% of the harvest occurred during the first week, 21% during the second week, and 47% during the final week. The increase in harvest during 14-20 September in both years is related to leaf drop which improves hunting visibility, and to increased activity of bulls as the breeding season approaches.

Transport Methods. During the past 5 years (1986-90), hunters using either aircraft or boats have taken 58-68% of the annual harvests (Table 10). During most years, aircraft hunters take slightly more moose than boat hunters. Hunters using overland mechanized access such as 3-wheelers or track vehicles have taken from 18% to 23% of the annual harvest during the past 5 years. In southwestern Subunit 20A hunting by horseback is popular in the Yanert Controlled Use Area and in the Montana Creek drainage. Hunters using horses for transport take 5-6% of the harvest each year.

Other Mortality: Because of unusually deep snow during winters 1989-90 and 1990-91, reports of road and train-killed moose increased (Table 11). Documented moose mortalities from vehicle or train collisions increased from zero reported in 1986-87 and 1987-88, to 69 moose killed by cars or trains during winter 1990-91.

Low spring calf:cow ratios indicated weather-related mortality among calves was higher than normal during winters 1989-90 and 1990-91. However, there were no reports of large numbers of adults succumbing to effects of deep snow either year. The assumption that adult moose were not significantly affected by winters 1989-90 and 1990-91 is supported by the increase in the western foothills moose population between 1988 and 1991 and by the stable moose population on the Tanana Flats during the same period.

Wolf predation appears to be the major contributor to adult moose natural mortality. From 1 June 1988 to 1 June 1989 wolves killed an estimated 9.9% of the Subunit 20A adult moose population. Wolf predation probably has a greater impact on moose on the Tanana Flats area of the subunit where moose are the only year-round big game prey. Using two independent methods of calculation, total natural mortality among adult moose was estimated at 11% annually between 1984 and 1988 (McNay 1990a).

CONCLUSIONS AND RECOMMENDATIONS

Moose numbers have increased in Subunit 20A since 1988. Despite severe winters in 1989-90 and 1990-91, the foothills adult portion of the population increased at an annual rate of 12% between 1988 and 1991. The increase in the foothills moose population coincided with a sharp decline in the Delta caribou herd that ranges in the Subunit 20A foothills. Possibly wolf predation pressure shifted to caribou, allowing continued growth of this moose population. On the Tanana Flats where moose are the only year-round big game prey for wolves, moose numbers were stable between 1988 and 1991.

Subunit 20A moose harvests were within the guidelines of less than 300 adult bulls/ year, but overall bull:cow ratios are now estimated at 28:100, slightly below the management objective of 30:100. Lowered recruitment of yearling bulls after winters 1989-90 and 1990-91 probably contributed to the decline in bull:cow ratios. If recruitment returns to the long-term average, we expect bull:cow ratios to increase if harvest guidelines are met.

Pending a continued increase in the foothills population, an increased harvest of bulls and limited harvest of antlerless moose by permit could be allowed in fall 1993. Harvests on the Tanana Flats should not be allowed to increase and should be reduced if bull:cow ratios on the Tanana Flats fall below 20 bulls:100 cows.

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Table 1. Moose population estimates in Subunit 20A since 1978, as determined by population estimation surveys.[a]

Area/year	Total adults + yearlings	Calves	Total population
Tanana Flats			
1978	979	327	1,306
1982	2,630	578	3,208
1984	2,872[b]	733	3,605[c]
1988	3,616	1,176	4,792
1991[d]	3,893	1,096	4,989
Foothills			
1978	1,786	419	2,205
1984	3,409	649	4,058
1988	3,455	1,049	4,504
1991[d]	4,895	1,188	6,083
Total 20A			
1978	2,765	746	3,511
1984	6,281[e]	1,382	7,663
1988	7,071	2,225	9,296
1991[d]	8,788	2,284	11,072

[a] Gasaway et al. (1986)

[b] A calculated value based on 4.5% annual growth from 1982 to 1984; 4.5% was the observed growth rate from 1982 to 1988.

[c] A calculated value based on a 6.0% annual growth rate from 1982 to 1984; 6.0% was the observed growth rate from 1982 to 1988.

[d] These values extrapolated from surveys in the central Tanana Flats and western foothills.

[e] Sum of 1984 foothills survey estimate and 1984 calculated flats estimate as described in footnotes a and b.

Table 2. 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)
<u>1988</u>										
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)	2,879.9
Foothills west	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)	1,417.6
Foothills east	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)	738.9
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)	1,610.4
<u>1991</u>										
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)	1,610.4
Foothills west	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)	1,417.7

[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.

Table 3. Subunit 20A, Walker Dome fall aerial moose composition counts, 1986-91, includes data from identical areas flown in 1988 and 1990.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2	Survey area size(mi^2)
1986-87	--	--	--	--	--	--	--	--	--
1987-88	--	--	--	--	--	--	--	--	--
1988-89	17	12	49	37	30	88	125	1.89	66.2
1989-90	--	--	--	--	--	--	--	--	--
1990-91	26	7	50	51	28	129	180	2.72	66.2

Table 4. Subunit 20A, Windy Creek Trend Area fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2	Survey area size(mi^2)
1986-87	--	--	--	--	--	--	--	--	--
1987-88	21	6	35	57	22	198	255	3.37	86.7
1988-89	--	--	--	--	--	--	--	--	--
1989-90	--	--	--	--	--	--	--	--	--
1990-91	23	7	51	86	29	206	292	3.86	86.7

Table 5. Subunit 20A, Japan Hills Trend Area fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2	Survey area size(mi^2)
1986-87	--	--	--	--	--	--	--	--	--
1987-88	29	6	40	48	24	155	203	2.35	61.5
1988-89	--	--	--	--	--	--	--	--	--
1989-90	--	--	--	--	--	--	--	--	--
1990-91	33	9	44	83	25	249	332	3.80	61.5

Table 6. Subunit 20A, 100 Mile and Ptarmigan Creek combined trend area fall aerial moose composition counts 1986-91, includes data from identical areas flown in 1986, 1987, and 1989.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2	Survey area size(mi^2)
1986-87	33	10	39	42	23	142	184	2.06	89.3
1987-88	62	19	32	15	16	76	91	1.02	89.3
1988-89	--	--	--	--	--	--	--	--	--
1989-90	33	9	42	54	24	172	226	2.53	89.3
1990-91	--	--	--	--	--	--	--	--	--

Table 7. Subunit 20A, Bear Creek Trend Area fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2	Survey area size(mi^2)
1986-87	25	10	22	30	15	169	199	2.17	84.8
1987-88	20	9	36	67	23	223	290	3.37	84.8
1988-89	--	--	--	--	--	--	--	--	--
1989-90	--	--	--	--	--	--	--	--	--
1990-91	--	--	--	--	--	--	--	--	--

Table 8. Subunit 20A moose hunter[a] residency and success, 1986-91.

	Successful				Unsuccessful				
Regulatory year	Local[b] resident	Nonlocal resident	Nonresident	Total[c]	Local[b] resident	Nonlocal resident	Nonresident	Total[c]	Total hunters
1986-87	303	53	51	420	727	83	54	892	1,312
1987-88	178	51	34	301	565	106	31	769	1,070
1988-89	193	50	48	351	428	101	43	684	1,035
1989-90	271	44	53	371	612	80	56	762	1,133
1990-91	256	43	60	368	641	118	52	826	1,194

[a] Excludes hunters in permit hunts.
[b] Resident of Unit 20.
[c] Difference in total and sum of residency categories equals number of hunters with unknown residency.

Table 9. Subunit 20A moose harvest[a] chronology by time period, 1986-91.

Regulatory year	Harvest periods 9/1-9/6	9/7-9/13	9/14-9/20	9/21-9/27	9/29-10/5	n[b]
1986-87	111	103	127	40	26	420
1987-88	80	88	119	0	0	301
1988-89	112	103	118	0	0	351
1989-90	120	100	139	0	0	371
1990-91	114	74	167	2	0	368

[a] Excludes permit hunt harvest.

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

Table 10. Subunit 20A moose harvest[a] percent by transport method, 1986-91.

	Percent of harvest								
Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	n
1986-87	39	6	27	7	0	11	5	5	420
1987-88	33	5	25	11	0	12	6	8	301
1988-89	38	5	25	9	0	12	5	6	351
1989-90	29	5	37	9	0	10	6	4	371
1990-91	37	6	31	10	0	9	4	3	368

[a] Excludes permit hunt harvest.

Table 11. Subunit 20A moose harvest[a] and accidental death, 1986-91.

Regulatory year	Harvest by Hunters: Reported				Harvest by Hunters: Estimated			Accidental death			
	M	F	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1986-87	415	0	5	420	--	--	--	0	0	0	420
1987-88	301	0	0	301	--	--	--	0	0	0	301
1988-89	348	1	2	351	--	--	--	0	13	13	364
1989-90	366	1	4	371	--	--	--	4	35	39	410
1990-91	364	0	4	368	--	--	--	12	57	69	437

[a] Excludes permit hunt harvest.

LOCATION

Game Management Subunits: Subunits 20B (9,088 mi^2) and 25C (5,252 mi^2)

Geographical Description: Fairbanks, central Tanana Valley, White Mountains

BACKGROUND

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 after 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.

After wolf reduction programs in Subunits 20A (1976-82) and 20B (1980-86), moose populations again increased. Hunting seasons were extended from 10 days in 1981 to 20 days from 1983 to 1987. Harvests increased to approximately 300 bulls per year between 1983 and 1986. During 1987 and 1988, harvests increased to 375 bulls each year, despite a 5-day reduction in the 1988 moose season. In 1989, the harvest increased to 417 bulls.

Wolf numbers were not reduced in Subunit 25C in the 1970s or 1980s. Moose densities stayed low. Annual harvests in Subunit 25C ranged from 25 to 44 bulls since 1983. Demand for moose hunting opportunities is high and increasing in Subunits 20B and 25C. Extensive road systems and numerous mining trails provide overland access in both subunits. Waterway access is available along the Tanana, Chena, Salcha, and Chatanika rivers in Subunit 20B; and along Beaver Creek and Birch Creek in Subunit 25C.

Game Management Unit boundaries changed in 1981, increasing the size of Subunit 20B and creating Subunit 25C. For management purposes Subunit 20B is divided into three geographic zones. The portion west of Fairbanks is managed as Subunit 20B West (3,955 mi^2), the portion east of Fairbanks and west of the Salcha River drainage is managed as Subunit 20B Central (2,741 mi^2), and the Salcha and Little Salcha drainages are managed as Subunit 20B East (2,392 mi^2). Before 1981, the eastern and western portions of present-day Subunit 20B and all of Subunit 25C were managed as Subunit 20C.

MANAGEMENT DIRECTION

Management Goals

Management goals for area moose are to: 1) provide the maximum opportunity to hunt moose; 2) provide the maximum sustained harvest of moose; 3) provide the opportunity to view and photograph moose; and 4) maintain a sufficiently large population of moose that will support healthy populations of large predators that are dependent on moose.

Management Objectives

Management objectives for area moose are to: 1) 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; 2) 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; 3) sustain an annual harvest of between 300 and 400 bulls in Subunit 20B until the population objective is reached; 4) establish an estimate of moose density in Subunit 25C by 1990; and 5) provide for an annual harvest of 30-50 bull moose and an overall bull:cow ratio of 30:100 in Subunit 25C.

METHODS

I reviewed, compiled, and reanalyzed the stratification and trend area data that ADF&G biologist Dale Haggstrom used to produce a 1985 population estimate (Crain and Haggstrom 1987). I then calculated moose population growth rates for Subunit 20B as $r = (\log_e T_2 - \log_e T_1)/t$, where T_1 and T_2 were population estimates in 1985 and 1990, respectively, and t was the time interval in years. The finite annual growth rate was calculated as $k = e^r$.

I estimated recruitment using a recruitment index, R = yearlings/(adults+yearlings) x 100%. Total yearlings were estimated by doubling the number of yearling bulls seen during surveys. Recruitment indices from the Salcha and Minto survey areas were believed to approximate actual recruitment because hunting pressure was light. In contrast, hunting pressure in the Chena survey area was high and the Chena recruitment index probably underestimated actual recruitment.

All of Subunit 20B and portions of adjacent Subunits 20C and 25C were stratified over a 2-week period in November 1985 by 3 observers and a pilot from Cessna 185 or Helio Courier 295 aircraft (Crain and Haggstrom 1987). Six hundred eighty-six 10- to 15-mi^2 sample units were classified into one of five density strata (very low, low, medium, high, and very high), based primarily on the number of moose seen and, secondarily, the presence of moose tracks. The purpose of the stratification was to determine distribution and relative abundance of moose. After the stratification survey, the sample units in existing and newly established trend count areas in Subunit 20B were intensively surveyed ($\geq$4 minutes/mi^2) to assess population status and trend. Ten percent of the sample units in Subunit 20B were intensively surveyed.

Haggstrom had pooled the trend area data to calculate mean moose densities for each stratum observed during the stratification survey. I separated the data by strata and calculated mean densities for each stratum in Subunits 20B West, 20B Central, and 20B East. I then applied those densities to the unsurveyed but stratified sample units to produce a revised 1985 moose population estimate for the subunit's three subdivisions.

In the 1985 stratification, the very low stratum was subjectively assigned a value of 0.04 moose/mi^2 to reflect a density near zero (Crain and Haggstrom 1987), but none of the very low sample units were surveyed intensively. Flight lines on the original stratification map showed that the very low stratum was flown less intensively than higher density strata, and I believe the 0.04 moose/mi^2 density value underestimated actual densities. However, in the absence of more complete data upon which to base a revised estimate, I too used the 0.04 moose/mi^2 value. That assumption primarily affected the estimate in Subunit 20B West where 26% of the total area was stratified as very low in 1985, but where 1989 intensive sampling revealed that some of those sample units actually contained good habitat with medium to high moose densities.

Moose densities and population composition in Subunit 20B before 1989 were estimated from aerial surveys conducted annually in small (19-105 mi^2) trend count areas distributed in good habitat (Crain and Haggstrom 1987; McNay 1989, 1990). Trends in moose density resulting from TCAs were sometimes difficult to interpret because surveys were often incomplete or not always completed in a consistent and comparable manner. In some cases, localized shifts in moose distribution may have affected survey results.

During 1989 I began obtaining moose density and composition by stratified random sampling of survey areas of approximately 1,000 mi^2 on a 2-3 year rotation. First in 1989, a population estimation survey (census)(Gasaway et al. 1986) was conducted on the Minto Flats (967 mi^2) of Subunit 20B West. Then during 1990, we surveyed a 1,072 mi^2 portion of the Chena drainage and a 915-mi^2 portion of the Salcha drainage using a modification of Gasaway's census method, which I termed the Superstratification Survey (Superstrat).

In the Chena and Salcha Superstrat survey areas, we randomly selected 18 sample units among the low, medium, and high strata and surveyed at $\geq$ 4 minutes/mi^2. The Chena survey was stratified at a rate of 17.6 seconds/mi^2, and the Salcha survey was stratified at 39 seconds/mi^2 to test if increased precision would result from increased stratification intensity. We did not fly sightability correction plots in either survey area, which resulted in estimates not corrected for moose missed at regular search intensities.

The 1990 population estimates of the western, central, and eastern portions of Subunit 20B were based on the 1989 Minto census densities, the 1990 Chena Superstrat, and the 1990 Salcha Superstrat, respectively (Table 1). To estimate moose numbers outside surveyed areas, I applied 1989 and 1990 densities to the 1985 stratification, with one exception. I applied the 1989 and 1990 low stratum densities to sample units that had been stratified as "very low" in 1985 because none of the 1989 and 1990 sample units were classified as "very low."

A mean sightability correction factor (SCF) of 1.15 was obtained for 9 census surveys conducted in Units 12 and 20 between 1982 and 1991 (Table 2). I applied this SCF to all 1985 population estimates and the 1990 population estimates for Subunits 20B Central and 20B East. I applied the SCF (1.14) from the 1989 Minto Flats census to the 1989 estimate for Subunit 20B West.

Aerial surveys to assess overwinter survival of calves were conducted over the Minto Flats in Subunit 20B West on 7 and 11 May 1990. These surveys consisted of 10- to 15-mile transects flown at one-half mile intervals within sample units previously established for fall population estimation surveys. All moose encountered along the transects were circled to determine sex and age. A similar survey was conducted near Big Minto Lakes on 25 May 1990 to assess twinning rates.

Harvest estimates were based on harvest report returns from hunters in the general season hunt and from mandatory permit reports required from hunters holding registration or Tier II permits. One reminder letter was sent to nonreporting general season hunters through a statewide mailout, and up to 2 reminder letters were sent to permit holders who failed to report. No correction factor was applied for nonreporting.

Estimates of poaching, road/train kills, and other mortality sources were taken from Department of Public Safety records, Alaska Railroad records, and reports from the public of winter-killed moose along roadways and on private property. A computer database containing all substantiated reports of moose mortality, other than hunter kill, was created by Ed Crain and Robin Eagan for 1985 through 1991.

RESULTS AND DISCUSSION

Population Status and Trend

Development of Survey Techniques: Faced with the year-to-year variability in some traditional trend count surveys and with surveys often having prohibitive costs (Gasaway et al. 1986), we investigated alternative moose survey techniques in 1989. We purposely oversampled during the 1989 Minto census and conducted two independent stratification surveys before sampling to provide data for subsequent computer simulations. By simulating various stratification/sampling strategies we hoped to evaluate cost-saving survey strategies that would meet acceptable precision levels. The Superstrat proved the most promising strategy. We used a stratified random sampling design similar to the census technique, but the Superstrat involves more intense stratification, less sampling, and does not include a SCF. It is based on the assumption that more accurate stratification can be obtained by increasing stratification intensity (seconds/mi^2). With more accurate stratification, an acceptable precision level can be obtained at reduced sample sizes. The added cost of increasing the stratification effort is compensated for by the reduced sampling cost, which reduces overall cost. Additional savings are gained by not flying the intensive searches needed to produce a SCF.

Erroneous management decisions may result if survey data are biased because of differences in the sightability of moose from year to year. After a review of sightability correction factors from 16 Gasaway censuses conducted in Units 12, 20, 21, and 24 between 1982 and 1991 (Table 2), I concluded that sightability between areas and between years was neither poor nor highly variable among eastern interior Alaskan moose census areas ($_{scf}$ = 1.15, SE = 0.02). Greater variability was observed among western Interior survey areas, but that variability may have resulted from the less rigorous application of the census technique because of pilot and observer inexperience. The mean SCF obtained for western Interior censuses should be used with caution.

The surveys conducted in the Chena and Salcha drainages in 1990 were the first field trials of the Superstrat Survey. Computer simulations of the Superstrat survey techniques have been conducted using census data from the 1989 Minto census and the 1988 Subunit 20A census and are planned using 1991 Subunit 20A census data. Progress in developing the Superstrat survey will be detailed in future reports.

Population Size: During November 1990, Subunit 20B was believed to contain a population of 9,800 moose. The estimate was based on stratified random sampling of 2,947 mi^2 in 1989 and 1990 and upon the assumption that the general distribution of moose was similar in 1990 to that observed in a 1985 total subunit stratification.

During November 1989, 1,598 moose ± 13.9% (90% C.I.) were estimated in a 967-mi^2 census (SCF = 1.14) of Minto Flats in Subunit 20B West. During November 1990, 1,795 ± 18.7% (80% C.I.) and 1,061 ± 18.0% (80% C.I.) moose were estimated in 1,072-mi^2 and 915-mi^2 Superstrat surveys (no SCF) of the Chena (Subunit 20B Central) and Salcha (Subunit 20B East) drainages, respectively. If the mean SCF of 1.15 from Table 2 is applied, the estimates for the Chena and Salcha survey areas become 2,064 ± 18.7% and 1,220 ± 18.0%, respectively. An additional 4,900 moose are thought to occur throughout the remaining 5,745 mi^2 of Subunit 20B moose habitat that was not surveyed in 1989 or 1990 based on extrapolation of densities obtained during the above-mentioned surveys.

During 1990, I estimated 3,400 moose were distributed in Subunit 20B West, 4,200 in Subunit 20B Central, and 2,200 in Subunit 20B East. Approximately 2,500 moose older than calves were in Subunit 20B West, 3,300 in Subunit 20B Central, and 1,800 in Subunit 20B East (Table 3). Therefore, the moose population had not reached the population objectives by fall 1990, but moose numbers were increasing and will probably reach the objectives by fall 1993.

My revised 1985 Subunit 20B estimate is 7,300 moose with 2,650 moose in Subunit 20B West, 2,750 moose in Subunit 20B Central, and 1,900 moose in Subunit 20B East. I believe Haggstrom's earlier estimate of 6,600 and the revised estimates reported here are both low, resulting from insufficient stratification and survey effort in the very low strata during 1985.

Using the 1985 moose estimate (excluding calves) within the Minto survey area as the starting estimate (T_1) and the lower and upper limits of the 90% C.I. from the 1989 Minto census as ending estimates (T_2), the lower and upper estimates of finite annual growth in the Minto survey area were 14% and 23%, respectively. Based on the 1989 point estimate of 1,161 moose excluding calves, the growth rate averaged 18.5% from 1985 to 1989. Yet, the recruitment index in the Minto survey area ranged from 17.5% to 19.5% and averaged 18.5% during the 4-year period; meaning that if the population estimates were correct, natural mortality of adults averaged near 0% between 1985 and 1990. That seems improbable given that wolf numbers increased rapidly between 1986 and 1989. I believe the 1985 Subunit 20B West population estimate was low and that the finite growth rate in Subunit 20B West between 1985 and 1989 was below 15%.

In Subunit 20B Central, the finite annual growth rate in the Chena survey area was estimated between 5% and 13% per year from 1985 to 1990. The recruitment index averaged 13% between 1985 and 1990, but because hunting pressure in Subunit 20B Central is high, the recruitment index probably underestimated actual recruitment. In Subunit 20B East, the finite growth rate in the Salcha survey area was estimated between -4% and 7%. The recruitment index averaged 15.2%.

The differences in moose population growth rates reflect the history of wolf population reduction programs in Subunit 20B. The greatest growth in moose numbers occurred in Subunit 20B West (14-23%) where wolf numbers were reduced in 1984-86. A moderate growth rate was apparent in Subunit 20B Central (5-13%) where wolves were less intensively controlled from 1980 to 1982, and the lowest growth rates occurred in Subunit 20B East (-4 to +7%) where wolf numbers were not controlled.

Population estimate surveys have not been conducted in Subunit 25C. About half of the subunit is mountainous, non-moose habitat, or open mountainous tundra bisected by small drainages with good moose habitat. Overall, I believe densities are low within Subunit 25C and estimate the total Subunit 25C moose population to be between 500 and 2,000 moose. A Superstrat survey was planned for Subunit 25C during 1991 but was precluded by poor survey conditions. We will attempt to complete the survey in November 1992 in cooperation with the Steese/White Mountains District of the Bureau of Land Management.

Population Composition: During 1989, in the lightly harvested Minto Flats portion of Subunits 20B West and 20B East, bull:cow ratios were 49:100 and 44:100, respectively. In Subunit 20B, where hunting pressure was high, bull:cow ratios were 28:100. Average bull:cow ratios were 40:100, well above the management objective of 30:100 (Table 4).

Calf survival to fall was highest in Subunit 20B West where calf:cow ratios were 56:100 during 1989 in the Minto survey area. Short yearling:cow ratios were 36:100 in May 1990 on the Minto Flats suggesting moderate overwinter survival of calves during winter 1989-90 (Table 5). Calf:cow ratios in November 1990 were 36:100 and 35:100 in the Chena and Salcha survey areas, respectively. Except for one 1988 survey of the Ninety-eight Creek count area (Table 6), composition data collected in small trend count areas between 1986 and 1988 were previously reported (McNay 1990).

Composition data in Subunit 25C were collected in the 57-mi^2 O'Brien Creek count area in 1986-88 (Table 7). This count area is located on the wintering grounds of the lightly hunted White Mountains moose population. Bull:cow ratios averaged 103 bulls:100 cows over the 3-year period. Calf:cow ratios averaged 27 calves:100 cows.

Distribution and Movements: Moose are distributed throughout most of Subunits 20B and 25C, and consist of both migratory and nonmigratory subpopulations. Radio-telemetry studies documented movement of moose from Subunits 20B Central and 20B East, and from Subunit 25C to calving areas on the Tanana Flats in Subunit 20A (Gasaway et al. 1983, Hobgood and Durtsche 1990). A reverse movement to wintering areas occurred during fall. However, 10 cow moose captured and radio-collared on the Minto Flats on 27 and 28 March 1984 (Crain and Haggstrom 1987) failed to leave the Minto Flats during 2 years of monitoring that ended in August 1985. Crain and Haggstrom (pers. commun.) observed that migratory moose do use Minto Flats, but that the capture effort occurred too late in the winter after most migratory moose left the area. Moose were extremely scarce during capture efforts, but were more plentiful during midwinter.

Mortality

Harvest:

Season and Bag Limit. Seasons and bag limits in Subunits 20B and 25C during regulatory year 1989 were as follows:

Units and Bag Limits	Subsistence	Res./Nonres.
Subunit 20B, that portion within the Fairbanks Management Area One bull by bow and arrow only		Sept.1-Sept.30 Nov.21-Nov.27
Subunit 20B, that portion within the Minto Management Area One bull by registration permit only. Season will be closed when 15 bulls have been taken		Sept.1-Sept.20 Jan.10-Feb.28
Subunit 20B, the drainage of the Middle Fork of the Chena River and that portion of the Salcha	Sept.1-Sept.20	Sept.1-Sept.20

River drainage upstream from and including Goose Creek One bull		
Remainder of Subunit 20B One bull	Sept.1-Sept.20	Sept.1-Sept.15
Subunit 25C One bull	Sept.5-Sept.15	Sept.5-Sept.15

Seasons and bag limits during regulatory year 1990 were as follows:

Units and Bag Limits	Subsistence/ Resident	Nonresident
Subunit 20B, that portion within the Fairbanks Management Area One bull by bow and arrow only by registration permit	Sept.1-Sept.30 Nov.21-Nov.27	Sept.1-Sept.30 Nov.21-Nov.27
Subunit 20B, that portion within the Minto Management Area One bull by Tier II permit only; up to 50 bulls may be taken	Sept.24-Oct.10 Jan.10-Feb.28	No open season
Subunit 20B, the drainage of the Middle Fork of the Chena River and that portion of the Salcha River drainage upstream from and including Goose Creek One bull	Sept.1-Sept.20	Sept.1-Sept.20
Remainder of Subunit 20B		
One bull	Sept.1-Sept.15	
One bull with 50-inch antlers		Sept.5-Sept.15
Subunit 25C		
One bull	Sept.1-Sept.15	
One bull with 50-inch antlers		Sept.5-Sept.15

Board of Game Actions and Emergency Orders. In its March 1990 meeting, the Board of Game implemented a registration permit hunt within the Fairbanks Management Area (FMA) of Subunit 20B. To obtain a permit, hunters had to complete an ADF&G-approved bowhunter education course. The course included a proficiency test added to the program required for certification by the International Bowhunters Education Program.

At an emergency meeting in July 1990, the board implemented a Tier II subsistence hunt in Subunit 20B for Hunt 985 on Minto Flats. A federal subsistence hunt was implemented by the newly created Federal Subsistence Board. Both hunts resulted from December 1989 court decisions on the McDowell case regarding subsistence priorities.

State Hunt 985T ran from 24 September to 10 October in 1990 because of a delay in issuing Tier II permits. Subsequent seasons for Hunt 985T, without further changes by the Board of Game, will run from 1 September to 30 September. The fall federal subsistence hunt ran from 1 September to 20 September. Both the federal and state winter hunts ran from 10 January to 28 February.

Also, as a consequence of the McDowell case, the board at its emergency meeting shortened the nonresident moose hunting season in the rest of Subunit 20B to 5 September to 15 September and required nonresidents to take only 50-inch bull moose.

The board increased the season length in Subunit 25C at its July 1990 emergency meeting from 5-15 September to 1-15 September. The nonresident season in Subunit 25C remained 5 to 15 September, but nonresidents were required to take bulls with antler spreads of $\geq$ 50 inches.

Hunter/Trapper Harvest. During the 1989 general hunting season, 2,246 hunters reported taking 417 moose in Subunit 20B. During the 1990 general season, 2,237 hunters reported taking 387 moose. Those harvests represent increases over the previous 3-year mean annual harvest of 339 bulls taken by an average of 2,060 hunters. That increase occurred despite a 5-day reduction in season beginning in 1988, but is consistent with survey data that indicated an increasing moose population during the last 5 years.

During 1989, 120 hunters reported taking 26 moose in Subunit 25C. During 1990, 183 hunters reported taking 42 moose. The 1986-88 Subunit 25C moose harvest averaged 34 moose taken by 109 hunters. Moose hunting in Subunit 25C is expected to increase in coming years as road and trail access into the Steese-White Mountain National Recreation Area is developed by the Bureau of Land Management.

Permit Hunts. In 1990, 342 permits were issued and hunters reported taking 22 bull moose in the FMA, Hunt 986 (Table 8). Sixteen bulls were reported taken in the September season, and 6 bulls were reported taken in the November season. Permits were issued separately for fall and winter hunts; many permit holders in the winter hunt also obtained permits for the fall hunt. Before 1990 hunters were not required to obtain a permit for hunting within the FMA.

The success rate among permittees who hunted was 10% (16/153) in September and 5% (6/126) in November. Fifteen percent (28/181) and 16% (24/150) of the permittees did not hunt in September and November, respectively.

Twelve moose were reported taken by 129 permit holders in the Minto Management Area (MMA) Hunt 985 during 1989 (Table 7). Eleven moose were taken in the September season and one moose was reported for the winter season. Forty-three percent of the permit holders did not hunt. Only residents of Minto and Nenana were eligible to participate in Registration Hunt 985 during 1989.

During 1990, the Minto hunt became a Tier II hunt. Many hunters who would have otherwise applied for permits were unaware of the Tier II hunt because it was created during the July 1990 Board of Game emergency meeting. Although 150 permits were available, only 140 were issued. Eighty-seven of 140 permits (62%) went to hunters from Nenana and Minto. Thirty-one (22%) Fairbanks/North Pole hunters obtained permits, and 10 (7%) permits went to Manley hunters. Twelve permits (9%) went to nonlocal hunters.

Tier II permit hunters reported taking 21 moose and an additional 7 moose were reported taken by 30 hunters holding federal subsistence permits in the MMA. Forty-nine (35%) of the Tier II permit holders did not hunt and 9 of 30 (30%) federal subsistence permit holders did not hunt.

Hunter Residency and Success. During 1989, 87% of the total hunters and 89% of the successful hunters reporting from Subunit 20B were local residents. During 1990, 88% of the total hunters and 89% of the successful hunters were local residents. Only 7% and 4% of total hunters were nonresidents in 1989 and 1990, respectively (Table 9).

Hunter success averaged 19% in 1989 and 17% in 1990. During the previous 3 years (1986-88) hunter success averaged 17%. Hunter success was lower in Subunit 20B than elsewhere in Unit 20 because many Fairbanks residents obtain harvest tickets but hunt only along the road system where hunting pressure is high and the number of legal animals is limited.

Residents of Subunit 25C accounted for 8% of hunters reporting from Subunit 25C in 1989 and for 9% of the total hunters in 1990 (Table 10). Most hunters hunting in Subunit 25C access hunting areas along the Steese Highway and reside in Fairbanks. Only 4% and 7% of the hunters reporting from Subunit 25C in 1989 and 1990, respectively, were nonresidents. Hunter success in Subunit 25C was 22% in 1989 and 23% in 1990.

Harvest Chronology. Moose harvest in both Subunit 20B and Subunit 25C is evenly distributed throughout the 2-week season (Tables 11 and 12). 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.

Transport Methods. During 1989 and 1990, 44% of the successful hunters in Subunit 20B reported using highway vehicles as the primary means of hunting access (Table 13). Boat access was used by an average of 24% of the hunters in 1989 and 1990, and off-road vehicles (ORVs) were used by 26% of successful hunters. Airplanes were only used by 2% of the Subunit 20B successful hunters in 1989 and 1990.

The Steese Highway and associated trails are the primary hunting access routes in Subunit 25C. Accordingly, 77% of the 1989 and 1990 successful hunters used a highway vehicle or ORV as the primary means of hunting transport in Subunit 25C (Table 14).

Other Mortality: Winter 1990-91 was the most severe on record in Fairbanks with a total snowfall of 145 inches, and 30 inches that fell during March. On 1 March the snow pack was 36 inches, but by 26 March snow reached its maximum depth on the ground of 54 inches. Normal snowfall for Fairbanks averages 65 inches per year with a normal 1 March snowpack of 19 inches. Normal moisture content for Fairbanks is 3.6 inches water equivalent, but in March 1990 the water equivalent was 8.9 inches at Fairbanks.

Fall composition counts were not flown in Subunit 20B during fall 1991, but we conducted a census on the Tanana Flats in adjacent Subunit 20A. Although calf:cow ratios and yearling bull:cow ratios were lower in 1991 than those observed in the 1988 Subunit 20A census, there was no evidence of widespread adult mortality or of a population decline resulting from the severe winter of 1990-91.

During wolf surveys in Subunit 20B in March and April 1991, cows with calves were commonly sighted and snow depths in most areas of Subunit 20B West appeared significantly lower than those in the immediate Fairbanks area. Snow depth did not appear to significantly impede moose movement in Subunit 20B West. With the exception of the immediate Fairbanks area, I do not believe winter 1990-91 resulted in significant winter-related mortality among Subunit 20B moose.

From 1986 to 1988, moose killed in vehicle or train collisions averaged 87 per year in Subunit 20B, but during the deep snow winters of 1989 and 1990, highway and train collisions killed 155 moose and 194 moose, respectively (Table 15). Forty-one additional moose mortalities were documented in Subunit 20B in 1989; 2 were known poaching mortalities, 1 moose was killed in defense of life or property, and 38 moose appeared to be winter-induced starvation. In 1990, 105 additional moose mortalities were documented; 8 mortalities were from known poaching, 21 moose were killed in defense of life or property related to deep snow inducing unprecedented human/moose conflicts, and the remainder appeared to be from winter-related starvation. No reports of vehicle-moose collisions or cases of additional mortality were received from Subunit 25C (Table 16).

CONCLUSIONS AND RECOMMENDATIONS

Moose numbers in Subunit 20B have increased from an estimated minimum of 7,300 moose in fall 1985 to 9,800 moose by fall 1990. The greatest increase in numbers occurred in Subunit 20B West where a wolf population reduction program occurred from

1984 to 1986. A more moderate increase in moose numbers occurred in Subunit 20B Central where wolf reduction occurred during 1980-82. Moose numbers appeared to be stable or increased slightly in Subunit 20B East where wolf numbers were not controlled.

The population objectives for moose will probably be met by the fall 1993 target date. To verify progress toward meeting those objectives, I recommend completing superstratification surveys in Subunits 20B West and 20B Central during fall 1992. If those surveys confirm an increasing trend in moose numbers, I recommend a 5-day increase in the Subunit 20B moose season beginning in fall 1993. Also, a general season hunt is now appropriate for the MMA.

A significant increase in road- and train-caused moose mortality occurred during the winters of 1989-90 and 1990-91. Natural mortality from winter-induced starvation also increased in the Fairbanks area. Moose population growth was probably suspended during 1990-91 because of high calf and yearling overwinter mortality, but I do not believe the adult segment of the Subunit 20B moose population was substantially affected. Surveys during fall 1992 will be necessary to confirm the absence of a significant effect.

The objective of establishing a moose density estimate in Subunit 25C by 1990 was not met. We planned a superstratification survey of approximately 1,000 mi^2 of southern Subunit 25C for November 1991 but did not complete it because of inadequate survey conditions. I recommend the survey be completed in November 1992.

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Table 1. Average moose densities by strata found within the Minto, Chena, and Salcha survey areas during 1989 and 1990.[a]

	Survey Area		
Stratum	Minto (1989) moose/mi^2	Chena (1990) moose/mi^2	Salcha (1990) moose/mi^2
Low	0.26	1.04	0.76
Medium	1.46	1.69	1.37
High	3.25	3.66	3.15
Very high	--	5.9	--

[a] All densities adjusted for sightability: for the Minto area a sightability correction factor (SCF) of 1.14 was calculated from sightability correction plots, for the Chena and Salcha surveys a SCF of 1.15 was applied based on previous surveys (Table 2).

Table 2. Mean sightability correction factors (SCF) found in 16 Population Estimation Surveys (Gasaway et al. 1986) in Units 12, 20, 21, and 24 between 1982 and 1991.

Census Area	Years	GMU	Geographic Location	SCF
Tanana Flats	1982	20A	Eastern Interior	1.14
Tanana Flats	1988	20A	Eastern Interior	1.11
Tanana Flats	1991	20A	Eastern Interior	1.25
AK Range Foothills	1984	20A	Eastern Interior	1.20
AK Range Foothills	1988	20A	Eastern Interior	1.12
AK Range Foothills	1991	20A	Eastern Interior	1.10
Minto Flats	1989	20B	Eastern Interior	1.14
Southwest 20E	1988	20E	Eastern Interior	1.13
Tetlin	1990	12	Eastern Interior	1.14
x SCF eastern Interior = 1.15; SE = 0.02				
Lower Nowitna	1986	21B	Western Interior	1.20
Lower Nowitna	1990	21B	Western Interior	1.14
Kaiyuh Flats	1987	21D	Western Interior	1.13
Galena	1987	21D	Western Interior	1.06
Huslia River	1988	24	Western Interior	1.02
Kanuti NWR	1989	24	Western Interior	1.00
Bear Mountain	1989	24	Western Interior	1.33
x SCF western Interior = 1.13; SE = 0.4				

Table 3. Subunit 20B moose population estimates, 1985 and 1990.

Year	20B West		20B Central		20B East		Total Subunits	
	Total	w/o calves	Total	w/o calves	Total	w/o calves	Total	w/o calves
1985	2,650	2,100	2,750	2,100	1,900	1,500	7,300	5,700
1990	3,400	2,500	4,200	3,300	2,200	1,800	9,800	7,600

Table 4. Subunit 20B fall aerial moose stratified random surveys 1989 and 1990 (90% confidence limits given for Minto census, 80% confidence limits given for Chena and Salcha Superstrat surveys).

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)
1989	49	14.5	56	437	27	1,161	961	1.65	1,598	967
Minto Flats	42-55	12-17	52-59	370-504	25-29	996-1,326			1,374-1,821	
1990	28	10	36	375	22	1,348	460	1.61	1,723	1,072
Chena[a]	22-34	7-13	30-41	310-441	19-25	1,141-1,555			1,476-1,970	
1990	44	11	35	208	20	919	344	1.16	1,061	915
Salcha[a]	30-58	8-14	30-40	169-246	17-22	820-1,018			918-1,205	

[a] These values not corrected for moose not seen during regular search efforts. A sightability factor of 1.15 should be applied to total calf, adults, estimated population size, and density values.

Table 5. Subunit 20B spring aerial moose composition count, Minto Flats, 7 and 11 May 1990.

Classification and Ratios	7 May 1990 (S.U. 226, 224) 208, 209, 210) Minto Lakes	11 May 1990 (S.U. 88, 95 136, 131) Swanneck Slough	Both Surveys Combined
Bulls	22	7	29
Cows	51	21	72
Calves (11 mos.)	15	11	26
Total	88	39	127
Bulls:100	43	33	40
Calves:100	29	52	36
% Calves	17	28	20
% Twinning	7	29	14

Table 6. Subunit 20B, Ninety-eight Creek Count Area fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2	Survey area size(mi^2)
1986-87	23	8	23	36	16	194	230	2.98	77.2
1987-88	16	6	32	42	22	151	193	2.96	65.2
1988-89	22	10	28	50	18	220	270	3.50	77.2
1989-90	--	--	--	--	--	--	--	--	--
1990-91	--	--	--	--	--	--	--	--	--

Table 7. Subunit 25C, O'Brien Creek Count Area fall aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /mi^2	Survey area size(mi^2)
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	--	--	--	--	--	--	--	--	--

Table 8. Subunit 20B moose harvest data by permit hunt, 1986-91.

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	Cows	Unk.	Total harvest
985	1986-87	118	42	51	7	9	0	0	9
	1987-88	118	51	35	14	17	0	0	17
	1988-89	131	44	41	15	20	0	0	20
	1989-90	129	43	47	9	12	0	0	12
	1990-91[a]	170	48	35	16	20	0	0	28
986	1986-87	0	--	--	--	--	--	--	--
	1987-88	0	--	--	--	--	--	--	--
	1988-89	0	--	--	--	--	--	--	--
	1989-90	0	--	--	--	--	--	--	--
	1990-91	342	18	75	6	22	0	0	22

[a] In 1990, the Minto Hunt was Tier II, 985T. Federal Subsistence Hunt 920 was also in effect in 1990; their data are included in the Hunt 985 data for 1990-91.

Table 9. Subunit 20B moose hunter[a] residency and success, 1986-91.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total[c]	Local[b] resident	Nonlocal resident	Nonresident	Total[c]	
1986-87	283	7	12	306	1,499	56	109	1,700	2,006
1987-88	Residency Data Unavailable								
1988-89	268	13	15	356	1,339	51	51	1,735	2,091
1989-90	371	20	21	417	1,582	82	143	1,829	2,246
1990-91	343	31	8	387	1,625	107	82	1,850	2,237

[a] Excludes hunters in permit hunts.
[b] Resident of Unit 20.
[c] Difference in total and sum of residency categories equals number of hunters with unknown residency.

Table 10. Subunit 25C moose hunter[a] residency and success, 1986-91.

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total[c]	Local[b] resident	Nonlocal resident	Nonresident	Total[c]	
1986-87	--	--	--	--	--	--	--	--	--
1987-88	--	--	--	--	--	--	--	--	--
1988-89	3	30	0	44	7	61	3	79	123
1989-90	2	21	2	26	9	81	3	94	120
1990-91	5	32	4	42	12	117	8	141	183

[a] Excludes hunters in permit hunts.
[b] Resident of Subunit 25C.
[c] Difference in total and sum of residency categories equals number of hunters with unknown residency.

Table 11. Subunit 20B moose harvest[a] chronology by time period, 1986-91.

Regulatory year	Harvest periods					$\underline{n}$[b]
	9/1-9/6	9/7-9/13	9/14-9/20	9/21-9/27	9/29-10/5	
1986-87	99	100	91	0	0	306
1987-88	101	128	104	0	0	356
1988-89	142	141	62	0	0	356
1989-90	187	127	85	0	0	417
1990-91	142	141	88	0	2	387

[a] Excludes permit hunt harvest.
[b] Difference between $\underline{n}$ and summation of harvests by week represents moose taken on unknown dates.

Table 12. Subunit 25C moose harvest[a] chronology by time period, 1986-91.

Regulatory year	Harvest periods 9/1-9/6	9/7-9/13	9/14-9/20	9/21-9/27	9/29-10/5	n
1986-87	--	--	--	--	--	--
1987-88	--	--	--	--	--	--
1988-89	--	--	--	--	--	--
1989-90[b]	7	14	4	--	--	26
1990-91	17	17	6	--	--	42

[a] Excludes permit hunt harvest.
[b] In 1989-90 one hunter did not report date of kill.

Table 13. Subunit 20B moose harvest[a] percent by transport method, 1986-91.

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	n
1986-87	3	<1	22	17	<1	11	42	5	306
1987-88	3	<1	24	12	0	8	48	4	356
1988-89	2	1	22	14	<1	7	47	7	356
1989-90	1	0	19	18	0	8	48	5	417
1990-91	3	<1	28	16	0	10	40	3	387

[a] Excludes permit hunt harvest.

Table 14. Subunit 25C moose harvest[a] percent by transport method, 1986-91.

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	n
1986-87	--	--	--	--	--	--	--	--	--
1987-88	--	--	--	--	--	--	--	--	--
1988-89	--	--	--	--	--	--	--	--	--
1989-90	4	4	23	27	0	12	31	0	26
1990-91	2	0	10	36	0	14	36	2	42

[a] Excludes permit hunt harvest.

Table 15. Subunit 20B moose harvest[a] and accidental death, 1986-91.

Regulatory year	Harvest by Hunters											
	Reported		Estimated			Accidental death						
	M (%)	F (%)	Unk.	Total	Unrptd	Illegal	Total	Road	Train	Other	Total	Total
1986-87	303	1	2	306	--	--	--	78	6	0	84	390
1987-88	356	0	0	356	--	--	--	64	3	6	73	429
1988-89	350	0	6	356	--	--	--	79	31	1	111	467
1989-90	409	3	5	417	--	--	--	125	28	41	194	611
1990-91	382	0	5	387	--	--	--	106	88	105	299	686

[a] Excludes permit hunt harvest.

[b] In 1987-88, other accidental deaths attributed to: starvation (1), drowning (2), unknown (3).
In 1988-89, other accidental deaths attributed to: poaching (1).
In 1989-90, other accidental deaths attributed to: poaching (2), DLP (1), weather-related mortality (38).
In 1990-91, other accidental deaths attributed to: poaching (8), DLP (21), weather-related mortality (76).

Table 16. Subunit 25C moose harvest[a] and accidental death, 1986-91.

Regulatory year	Harvest by Hunters										Total
	Reported				Estimated			Accidental death			
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	
1986-87	32	0	0	32	--	--	--	--	--	--	32
1987-88	27	0	0	27	--	--	--	--	--	--	27
1988-89	44	0	0	44	--	--	--	--	--	--	44
1989-90	26	0	0	26	--	--	--	--	--	--	26
1990-91	42	0	0	42	--	--	--	--	--	--	42

[a] Excludes permit hunt harvest.

LOCATION

Game Management Subunits: 20C (11,822 mi^2) and 20F (6,318 mi^2)

Geographical Description: Subunit 20C - 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; Subunit 20F - drainages into the north bank of the Tanana River west of Manley, and into the Yukon River between the Tanana and the Dalton Highway bridge.

BACKGROUND

Moose densities in Subunits 20C and 20F have been low for many years. However, factors limiting growth of these moose populations are not well understood. Harvest is considered low relative to the population size, although unreported harvest may be substantial. Predation is suspected as a major limiting factor, but we lack data on predator populations. 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. Moose are an important food source for many local rural residents. Hunters throughout the Interior also hunt moose in these subunits for food and/or trophies.

Trends in moose populations have been difficult to identify. Approximately 33% (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.

MANAGEMENT DIRECTION

Management objectives listed in the FY89 moose management report for this area were to: 1) estimate hunting mortality and document nonhunting mortality when possible; 2) manage for an annual posthunting sex ratio of at least 30 bulls:100 cows; 3) estimate moose densities by 1991; 4) promote moose habitat enhancement by allowing natural fires to alter vegetation succession; 5) establish definitive moose population objectives by 1992.

METHODS

We estimated annual moose mortality with data from harvest report cards (Anchorage Statistics), 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).

To provide for the taking of up to 3 moose/year for the Nuchalawoyya Potlatch, we issued a permit to the village of Tanana in June 1990. We did not issue a permit in 1991 as villagers cancelled the potlatch. To investigate concerns of local residents about the increased moose harvest in Fish Lake by nonlocal hunters, we operated a field check station in the area from 7 to 10 September 1990. We travelled between Manley Hot Springs and Fish Lake by riverboat and spoke to all hunters we encountered.

Annual trends in moose composition and density were not as well documented. Surveys have only been completed in DNPP since the last report period. Between 25 October and 1 November 1991, biologists with DNPP 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).

Data on fires are available at the Alaska Fire Service but are not in a usable format for our purposes. However, ADF&G biologist Dale Haggstrom compiled an incomplete list of recent fires in this study area by reorganizing Alaska Fire Service data.

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 that moose densities are 0.25-0.50 moose/mi^2, with roughly 4,250 mi^2 of moose habitat (M. McNay, pers. commun.).

Population Composition: We provided a summary of composition surveys completed in recent years in our last management report (Beasley 1990). Since then, only fall 1991 moose censuses in DNP provided updated information on composition (Table 1). During 1991 censuses, bull:cow ratios in the Kantishna and Slope areas were very high (125:100 and 108:100, respectively), but may have been because bulls had not moved out of the high country yet (T. Meier, pers. commun.). Compared to 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 3 areas censused. The 1991 data are preliminary and will be discussed more thoroughly in the next performance report. T. Meier (pers. commun.) thought it improbable that DNP biologists will have funding to complete additional moose censuses in the near future.

Distribution and Movements: Between 1984 and 1988, stratification surveys of over 6,000 mi^2 (approximately 33% of Subunits 20C and 20F) confirmed overall low-density moose populations in these subunits. During these surveys, 73% of the area stratified was considered "low density" stratum (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 moose densities included the burn in hills north of Minchumina and southwest of Wien Lake, the foothills of the Alaska Range in the southwestern subunit, the lower Kantishna River along the eastern floodplain, the low shrub area near Black Bear Lake, along the Tanana River, and the burn near Dune Lake.

Within DNP, surveys indicated a prevalence of bulls in the northwest foothills of the Alaska Range and a relative scarcity of bulls in the flats to the north, which suggests an interchange of moose between these two areas (Meier 1986). However, according to data from radio-collared 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 drainages in the Tozitna and Yukon rivers, in the Fish Lake/Harpers Bend area, and near the mouth of the Tanana River.

Mortality

Harvest:

Season and Bag Limit. In 1990, residents had a 1-15 September hunting season in both subunits. Nonresidents were limited in Subunit 20C to hunting 5-15 September for bulls with ≥ 50-inch antler spread and were prohibited from hunting moose in Subunit 20F.

In 1991, moose hunting was open in Subunit 20C for residents from 1 to 20 September and for nonresidents from 1 to 15 September with no antler restriction. In Subunit 20F, the resident season of 1-15 September remained the same, but the resident 1-10 December season was no longer Tier II and included only that portion of Subunit 20F drained by the Yukon River downstream from the mouth of Hess Creek. 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). Table 2 summarizes changes in the hunting seasons since 1984.

Board of Game Actions and Emergency Orders. At the spring 1990 Board of Game meeting, the board rejected two proposals from the Tanana-Rampart-Manley Advisory Committee. These proposals would have created controlled use areas (400 mi^2 in the Fish Lake vicinity, 375 mi^2 along the Yukon River near Rampart) prohibiting the use of airboats or floatplanes for hunting moose or waterfowl. The board rejected these proposals because of insufficient evidence of conflict to warrant a controlled use area.

During the July 1990 emergency meeting, the board made several changes to subsistence moose regulations in this area because of the McDowell decision. These changes included shortened seasons and a bag limit of one bull with a ≥ 50-inch antler spread for nonresidents in Subunit 20C, eliminating the longer subsistence hunt in September in Subunit 20C, prohibiting nonresident hunting in Subunit 20F, and changing the Subunit 20F winter moose hunt from a subsistence hunt to a Tier II hunt.

The board also amended the regulation providing for taking up to 3 moose for the Nuchalawoyya Potlatch (5 AAC 92.053). These changes require hunters to apply for a permit, for ADF&G to grant permits to individuals rather than to the village of Tanana, and for successful hunters to report to ADF&G within 3 days rather than 5 days.

At its spring 1991 meeting, the board eliminated the regulation requiring nonresidents to take bulls with ≥ 50-inch antler spread in Subunit 20C. It also changed the Subunit 20F winter moose hunt from a Tier II hunt to a hunt open to all residents, but limited to the portion of Subunit 20F drained by the Yukon River down from the mouth of Hess Creek.

Hunter Harvest. In 1990, 305 hunters reported killing 116 moose in Subunit 20C, and 124 hunters reported killing 38 moose in Subunit 20F (Figure 1). Reported harvests represent 6-8% and 2-4% of estimated moose populations in those areas, respectively. Distribution of antler sizes among harvested bulls is summarized in Table 3. Data from the 1991 season are not yet available.

Nuchalawoyya Potlatch. In spring 1989, the board authorized ADF&G to issue permits to take up to 3 moose/year for the Nuchalawoyya Potlatch in June. Under this regulation, 3 moose were taken during the first year (1989), 1 bull was taken the second year (1990), and the potlatch was cancelled during the third year.

Permit Hunt 989T. Hunt 989T provided a 1-10 December moose season in Subunit 20F for up to 75 Tier II permittees in 1990. Although we set a 20 bulls harvest quota for the hunt, only 3 permittees (6%) (residents of Manley, Rampart, and Tanana) took moose (Table 4). Most permittees did not hunt (57%) or were unsuccessful (37%). Because this permit hunt was undersubscribed (75 permits available, 51 applicants), all applicants received a permit. All permittees reported after up to 2 reminder letters.

Hunter Residency and Success. During the last 5 years, less than 6% of the hunters in Subunits 20C and 20F were nonresidents (Table 5). The 5-year average success rate for hunters was 34% (500/1465) in Subunit 20C and 27% (151/559) in Subunit 20F. Most successful hunters were "nonlocal" hunters, primarily from the Fairbanks area (Table 6). In Subunit 20C, 62% (72/116) of successful hunters were nonlocals (from communities other than Nenana, Tanana, Manley Hot Springs, Healy, Clear, Anderson, Lake Minchumina, or Denali Park). In Subunit 20F, 71% of the successful hunters were non-locals (from communities other than Tanana, Manley Hot Springs, or Rampart).

Residency of permittees for Tier II Hunt 989T included: Manley (16), Tanana (12), Fairbanks (8), Rampart (7), Big Lake (6), North Pole (1), and Fort Wainwright (1). One permittee from each local community (Manley, Rampart, and Tanana) harvested a moose during this hunt. Because this hunt was undersubscribed, all applicants received a permit.

During our 4-day trip to Fish Lake (7-10 September 1990), we found no evidence of even moderate hunting pressure in the Fish Lake area. We found 3 hunting parties (in riverboats) between Manley Hot Springs and Fish Lake, only one of which travelled into Fish Lake. We spoke with two of these parties; each had killed one bull along the Tanana River near the mouth of the Cosna River. One party was from Fairbanks and the other from Tanana. Based on this and observations in other years, we recommended not creating a controlled-use area at Fish Lake.

Harvest Chronology. In 1990, moose were harvested early or late in the season in Subunit 20C. Harvest in Subunit 20F was more evenly distributed throughout the season (Figure 2). No moose were reported taken during December in Subunit 20F.

Transport Methods. Although a variety of transportation types has been used by successful hunters in this area, boats have been the most common transport method used in both subunits, ranging from 36% to 47% in Subunit 20C and 30% to 63% in Subunit 20F during the last 5 years (Table 7). Airplanes are commonly used to land on numerous lakes and gravel bars, especially in Subunit 20C.

Other Mortality: Data compilation for nonhunting mortality of moose is incomplete. However, Table 8 provides summaries available to date. Note that in 1989-90, train collisions killed 41% as many moose as hunters reported killing in all of Subunit 20C.

Habitat: Data indicated at least 208 mi^2 of area habitat were affected by fire in 1991 (Table 9).

Nonregulatory Management Problems/Needs: Clearly, the importance of fire management to wildlife management has been established in recent years. To enable us to incorporate more fire data into our management planning, I recommend that we assign someone to work with Alaska Fire Service to obtain annual data on characteristics of fires throughout Region III. At the end of each summer, a map and datafile could be provided to each area biologist with this information.

Collisions with trains have been shown as a significant mortality factor for moose in some areas. We should continue to work with ARR personnel to reduce these mortalities.

CONCLUSIONS AND RECOMMENDATIONS

I have several recommendations for changes in management objectives. First, although we plan to periodically increase our knowledge of moose distribution and abundance in Subunits 20C and 20F, we do not anticipate doing so during the next few years. Demands for our limited resources will be higher in more intensely used areas. Hunting pressure is relatively low, and the distribution of antler spreads among harvested moose does not indicate missing cohorts. Because we will probably not be monitoring the population through surveys or censuses during the next reporting period, I recommend deleting the objectives to manage for an annual posthunt sex ratio of at least 30 bulls:100 cows and to estimate moose densities by 1991. I also recommend revising the objective to establish moose population objectives by 1992 so that we establish moose population objectives in concert with the area-specific wolf management planning process. Current regulations address our management objectives and I recommend no regulatory changes at this time.

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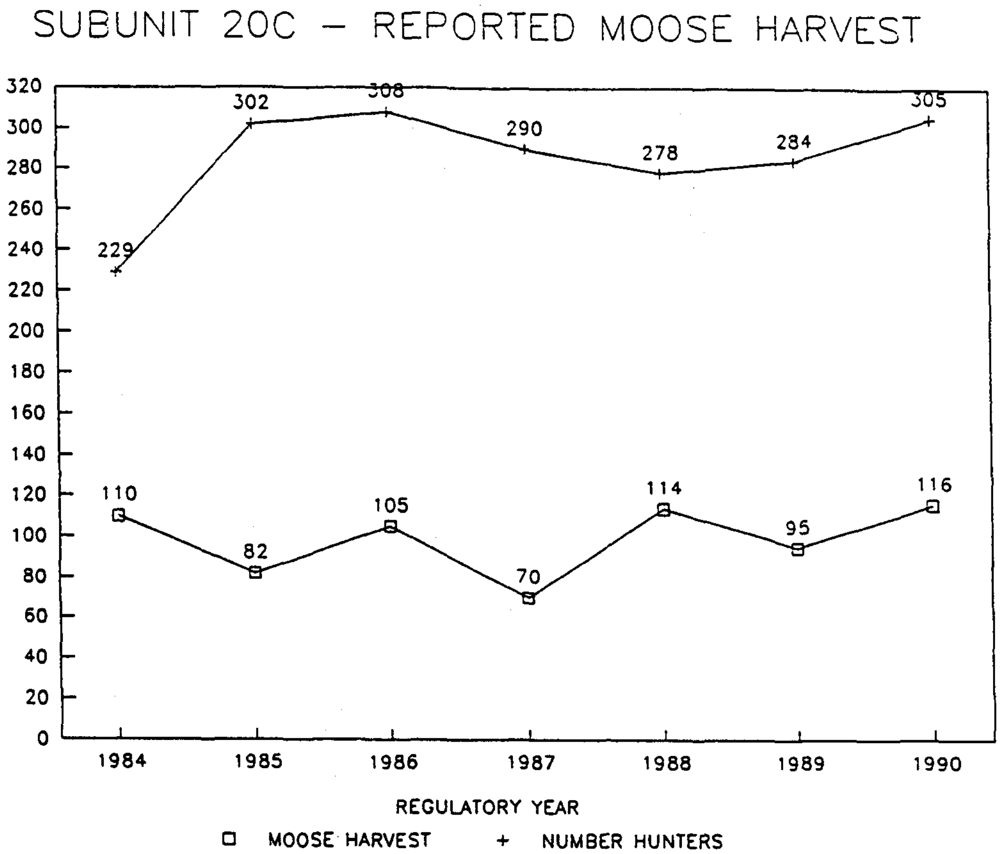

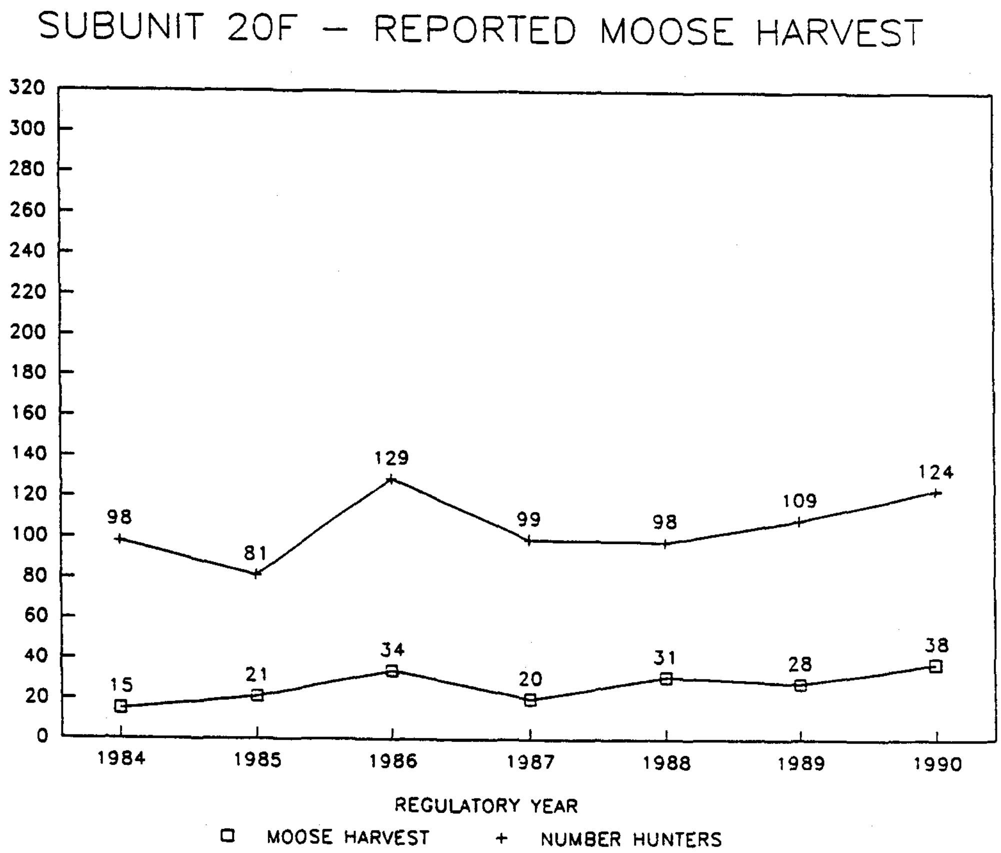

Figure 1. Annual moose harvest and hunting pressure in Subunits 20C and 20F, 1984-90.

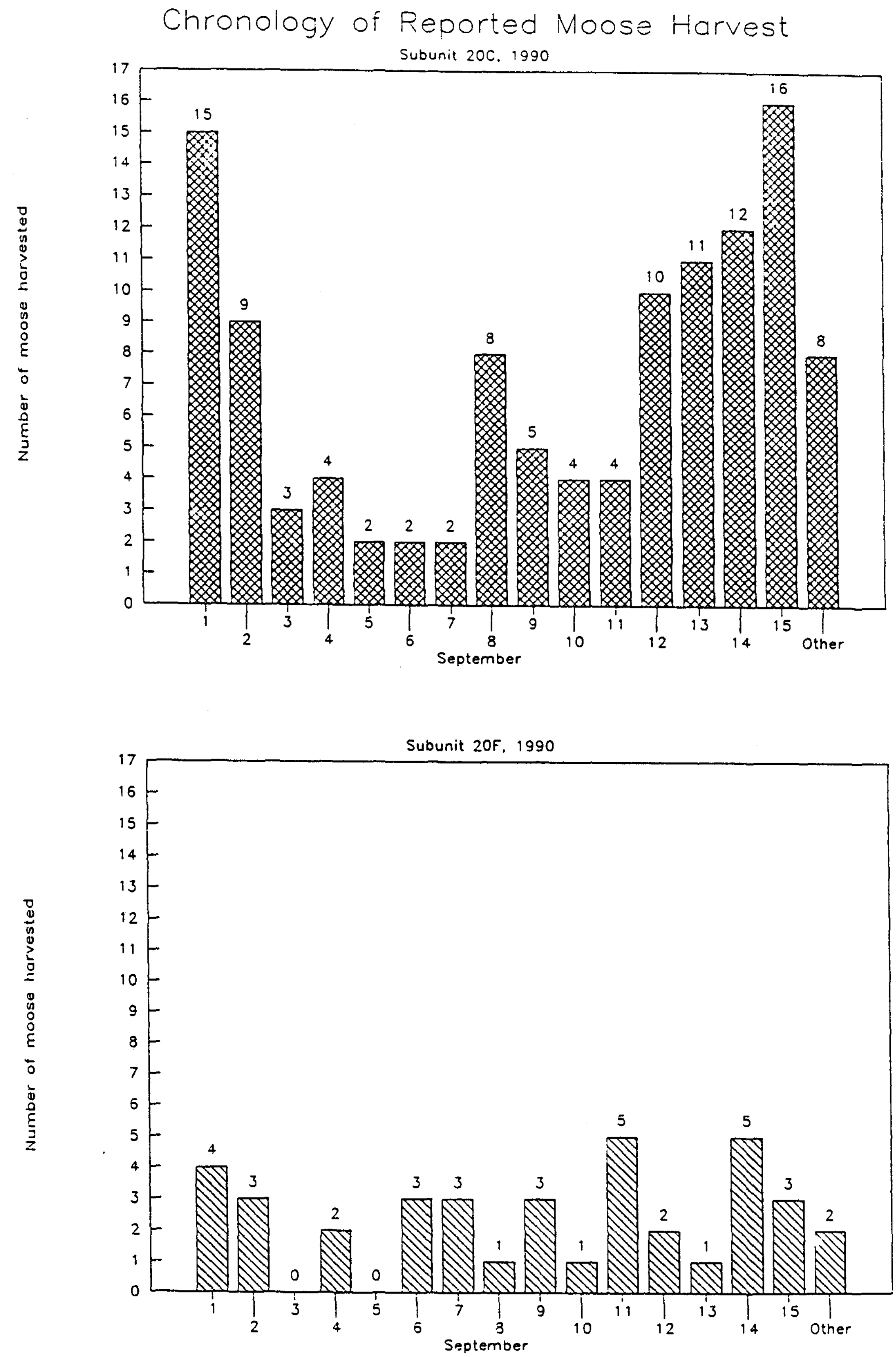

Figure 2. Chronology of reported moose harvest in Subunits 20C and 20F, 1990.

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	Bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Corrected Density (Moose /mi^2)	Estimated population size	Survey area size(mi^2)
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, therefore no variance.

Table 2. Moose hunting seasons for Subunits 20C and 20F, 1984-91. Bag limit was one bull in all years except 1990 (see footnote).

Regulatory year	Subunit 20C		Subunit 20F	
	Season[a]	Hunters Allowed[b]	Season	Hunters Allowed[b]
1984-85	1-20 Sept.	A	1-15 Sept.	A
			1-10 Nov.	A
1985-86	1-20 Sept.	A	1-15 Sept.	A
			1-10 Nov.	S
1986-87	1-20 Sept.	A	1-15 Sept.	A
			1-10 Nov.	SR
1987-88, 1988-89, and 1989-90	1-15 Sept.	RN	1-15 Sept.	A
	1-20 Sept.	S	1-10 Dec.	S
1990-91	1-15 Sept.	R	1-15 Sept.	R
	5-15 Sept.	N[c]	1-10 Dec.	R (Tier II)
1991-92	1-20 Sept.	R	1-15 Sept.	R
	5-15 Sept.	N	1-10 Dec.[d]	R
			1-25 Sept.	FS[e]

[a] Since 1987, the taking of white-phased or partial albino (more than 50%) white moose has been prohibited.
[b] A=all, R=residents, N=nonresidents, and S=subsistence.
[c] Bag limit bulls with ≥ 50-inch antler spread.
[d] Only that portion of 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.

Table 3. Antler size of moose harvested in Subunits 20C and 20F, 1984-90.

Regulatory year	Number of moose with antler size (inches)			
	<30	30-39.9	40-49.9	≥50
Subunit 20C:				
1984-85	17	31	25	34
1985-86	14	21	19	25
1986-87	8	26	29	41
1987-88	8	25	6	23
1988-89	13	36	25	33
1989-90	19	24	14	31
1990-91	23	42	15	32
Subunit 20F:				
1984	5	2	2	3
1985	4	6	6	3
1986	4	5	5	17
1987	3	7	5	4
1988	3	8	6	12
1989	6	10	4	8
1990	7	14	9	7

Table 4. Subunit 20F moose harvest data in Tier II Hunt 989T, 1990-91.

Hunt No.	Regulatory year	No. Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
989T	1990-91	51	57	37	6	3 (100)	0	0	3

Table 5. Number of successful and unsuccessful moose hunters by Alaska residency, Subunits 20C and 20F, 1986-91.

Reg.	Successful hunters				Unsuccessful hunters				Total
year	Resident	Nonresident	Unk.	Total (%)	Resident	Nonresident	Unk.	Total (%)	hunters
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[a]	4	4	116 (38)	178	6	5	189 (62)	305
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

[a] 38% were "local" residents (Nenana, Tanana, Manley Hot Springs, Healy, Clear, Anderson, Lake Minchumina, and Denali Park).
[b] Excludes hunters in permit hunts.
[c] 29% were "local" residents (Tanana, Rampart, Manley Hot Springs).

Table 6. Residency of successful moose hunters in Subunits 20C and 20F, 1990-91.

Subunit	Town	No. Successful Hunters	
20C	"Nonlocal"		
	Fairbanks, North Pole, Salcha, Two Rivers	49	
	Wasilla, Anchorage, Palmer	12	
	Nonresidents	4	
	Other residents/unknown	7	
	Subtotal	72	(62%)
	"Local"		
	Denali Park	3	
	Nenana	17	
	Tanana	1	
	Manley Hot Springs	1	
	Healy/Clear/Anderson	13	
	Lake Minchumina	9	
	Subtotal	44	(38%)
20F	"Nonlocal"		
	Fairbanks, North Pole, Ft. Wainwright	22	
	Healy	2	
	Palmer	1	
	Other residents	2	
	Subtotal	27	(71%)
	"Local"		
	Tanana	5	
	Manley Hot Springs	1	
	Rampart	5	
	Subtotal	11	(29%)

Table 7. Subunit 20C and 20F moose harvest[a] percent by transport method, 1986-91.

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
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

[a] Excludes permit hunt harvest. Data through 1988-89 are from FY89 moose survey-inventory.
[b] 3- or 4-wheeler and ORV combined.

Table 8. Subunit 20C preliminary data on human-caused moose mortality, 1988-91[a].

Regulatory year	Harvest by Hunters										
	Reported				Estimated			Accidental death			
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1988-89	--	--	--	114	--	--	--	--	17	17	131
1989-90	--	--	--	95	--	--	--	2	39	41	136
1990-91	116	0	0	116	--	1	1	3	23	26	142

[a] "--" represents unknown value. Values in this table should be used as minimum numbers because data are incomplete at this time.

Table 9. Location and size of known fires[a] in Subunits and 20C and 20F, 1991.

Location	Protection Zone	Minimum Size (mi^2)
Subunit 20C:		
Chitanana River, Redlands Lake	Limited	34
Lake Minchumina, Jim Lake	Full	28
Yoder Lake area	Modified	1
Moose Creek, Bear Creek	Limited	13
Between Teklanika River and Nenana River	Full	2
Subunit 20F:		
Hess Creek, Troublesome Creek	Modified	54
Stevens Creek, Texas Creek	Full	26
Tozitna River, Tozimoran Creek	Full	27
Tozitna River, Dagislakhna Creek	Limited	21
Tozitna River, Reindeer Creek	Limited	2
Total		208

[a] This is a very incomplete list but is provided for reference.

LOCATION

Game Management Subunit: 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 area moose hunting season 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 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 in this subunit and other portions of interior Alaska and set the stage for predation and hunting to compound and aggravate already widespread population declines. Moose hunting season was closed because the depressed moose population could no longer sustain a harvest that would result from even the most restrictive seasons (McIlroy 1974). Recruitment of yearling moose had remained poor, causing the continued bulls-only hunting to depress the bull:cow ratio to 4:100 in more accessible areas of the subunit.

Despite hunting restrictions, the moose population in Subunit 20D continued to decline from chronically high moose mortality from other causes. In 1973, the moose population south of the Tanana River between the Johnson and Delta rivers was estimated at only 600. When limited moose hunting was resumed in 1974, it was done under a registration permit system designed to keep harvest minimal. The population decline in the western subunit was gradually reversed by wolf control in adjacent Subunit 20A (1976-82) and western Subunit 20D (1980-83), combined with 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). This name was changed to the Delta Junction Closed Area (DJCA) in 1990.

Subunit 20D has been unofficially subdivided into 4 areas for moose management purposes: southwestern Subunit 20D, including the area south of the Tanana River from the Johnson River to the Delta River; southeastern Subunit 20D, including the area south of the Tanana River from the Robertson River to the Johnson River; northwestern Subunit 20D, including the area north of the Tanana River from Banner Creek to, and including, the Volkmar River; and northeastern Subunit 20D, including the area north of the Tanana River and east of the Volkmar River.

Hunting opportunities were gradually expanded in southwestern Subunit 20D by eliminating the registration permit requirement and then lengthening the season. Antler restrictions were implemented in 1988 to stabilize the harvest and improve the age structure in the bull segment of the population. The DJCA remains closed to moose hunting; this is because of local preference rather than biological necessity. In southeastern Subunit 20D, seasons have been gradually increased. In northern Subunit 20D the hunting season has been gradually shortened to reduce harvest levels.

MANAGEMENT DIRECTION

Management Goals and Objectives

Management goals and objectives for the area are to: 1) 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; 2) manage for a posthunting season bull:cow ratio of no less than 30 bulls:100 cows; 3) manage for a November calf:cow ratio of no less than 30 calves:100 cows; 4) 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; and 5) manage for at least 20% hunter success as long as moose populations are stable or increasing.

METHODS

We flew aerial composition surveys in a Piper Super Cub at an altitude of 300-500 feet above ground level and an airspeed of approximately 70 mph. A low pass was flown over all moose to determine sex and age, to look for additional moose, and in some areas to estimate antler spread and the number of antler brow tines for bulls. We identified yearling bulls 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 were classified as large bulls.

Density of moose and unbiased composition data were collected in TCAs. TCAs were subdivided into sample units (SU) with each SU having a mean area of 12 mi^2. One SU was surveyed at a time, with a search intensity of 4-8 minutes per mi^2. We estimated sex and age composition by flying contour surveys in specific areas. Sex and age composition data collected during contour surveys may be biased because different segments of the moose population have varying observer sightability during aerial surveys.

ADF&G staff cooperated with the U.S. Army to radio-collar moose at Ft. Greely to gather data on movements and seasonal habitat preferences there. Eleven moose were radio-collared in southern Subunit 20D, including 6 cows and 1 bull in October 1990 and 3 cows and 1 bull in October 1991. Staff darted moose from an Army UH-1 helicopter with 6 mg of carfentanil. Once moose were immobilized, we collected blood samples, took morphological measurements, and attached a radiocollar. The antagonist was 900 mg naloxone. Radio-collared moose were located from UH-1 helicopter, Piper PA-18 Super Cub, and a Cessna 180. Staff plotted locations on 1:250,000 USGS topographic maps.

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 moose population to 2,500 moose.

We collected moose density and trend data in the Donnelly TCA during 1990 and 1991, though we did not complete the survey in 1990. Moose density in the Donnelly TCA was 3.1 moose/mi^2 during November 1991, a decrease from 3.4 moose/mi^2 in 1989 (Table 1). The 3-year mean density (mean density during 1989-91) of moose in the Donnelly TCA is 3.3 moose/mi^2 and indicates a stable population. I believe the 1991 decrease is not significant and can be attributed to annual variation in the TCA data. It should be noted that moose calf survival in the Donnelly TCA has declined significantly the last 3 years, and further reductions in moose calf survival could reduce the population size in this area.

The Delta Agricultural Project TCA was surveyed in 1991 but the survey was not completed. The Delta Agricultural Project TCA had a density of 0.8 moose/mi^2 in 1991 compared with 1.5 moose/mi^2 in 1989 (Table 2). Because the survey is incomplete, no valid comparisons can be made between years.

Southeastern Subunit 20D. The moose population is stable in this area. Because the population is stable, no progress was made toward achieving the management objective of increasing the number of moose to 1,500.

We collected moose density and trend data in the Knob Ridge TCA during 1990 and 1991. Knob Ridge data indicate a stable population though Robertson River data indicate a slight decrease. Moose density in the Knob Ridge TCA has ranged from 1.4 to 2.0 moose/mi^2 during the previous 6 years (Table 3) and most recently was 2.0 moose/mi^2 in 1991. The 3-year mean density indicates a stable or slightly increasing population through 1990. Staff collected moose/hour data in the Robertson River drainage during 1990 and 1991. Moose/hour observed in the Robertson River drainage ranged from 25 to 41 moose/hour from 1986 to 1991 and most recently was 25 in 1990 and 33 in 1991 (Table 4). The 3-year mean was 28 moose/hour in 1990 indicating a slight decrease.

Northwestern Subunit 20D. The moose population is declining in northwestern Subunit 20D, therefore no progress was made toward the management objective of increasing the moose population to 3,000 in northern Subunit 20D. We collected moose density and trend data in the Central Creek TCA in 1990 and 1991. Moose density ranged from 2.6 moose/mi^2 in 1990 to 1.9 moose/mi^2 in 1991. The 1991 moose density was the lowest observed since 1988 (Table 5).

Northeastern Subunit 20D. The population trend in northeastern Subunit 20D appears stable based on moose/hour data and composition data. No progress was made toward achieving the management objective of 3,000 moose in northern Subunit 20D. We flew a contour survey in the Billy Creek survey area in 1991. The number of moose/hour ranged from 26 to 37 moose/hour from 1989 to 1991 and was 36 moose/hour in 1991 (Table 6). Although these figures indicate a stable population, the actual number of moose seen in the Billy Creek survey area declined significantly from 138 in 1986 to 64 in 1991. This survey was flown by 3 different individuals, and survey times have declined from 3.8 hours in 1986 to 1.8 hours in 1991, which may have resulted in the decreasing number of moose observed. The 1988 and 1989 surveys were flown by the same pilot-observer team, with comparable survey times of 2.5 and 2.8 hours, respectively. Moose/hour declined from 37 to 26 from 1988 to 1989. The 3-year mean moose/hour remained nearly constant from 1988 (x = 32 moose/hour) to 1990 (x = 31 moose/hour), and the population appears stable in northeastern Subunit 20D. The 50% decrease in moose seen is of concern but may be attributed to variable survey time.

Population Composition:

Southwestern Subunit 20D. Data collected in the Donnelly TCA indicated that calf survival to 6 months of age stabilized the last 2 years. During 1990 and 1991, ratios of 31 and 32 calves:100 cows were observed, and calves composed 21% and 22% of the moose classified. Although calf survival has declined in recent years, it meets the objective of 30 calves:100 cows after the hunting season (Table 1). Moose survival to 18 months of age continued to decline to 4 yearling bulls:100 cows in 1991. In this area hunters harvest many yearling bulls, so the observed ratio of yearling bulls:100 cows underestimated the actual recruitment of yearling moose more than in less heavily hunted areas. Six and 4 yearling bulls:100 cows were observed in 1990 and 1991, respectively.

The bull:cow ratio continued to decline below the objective of 30 bulls:100 cows (Table 1). Ratios of 18 and 16 bulls:100 cows were observed in 1990 and 1991. The declining bull:cow ratio has two known causes. First, the actual number of bulls in the Donnelly TCA declined significantly in 1991 and possibly 1990 (incomplete survey). From 1986 to 1989, the number of bulls observed was relatively constant and ranged from 56 to 62. However, we observed only 35 bulls during 1991. Harvest of bulls will be discussed in detail below; however, harvest has remained constant (range 58-60 from 1988 to 1990) since antler restrictions were implemented in 1988. Deep snow in winters 1989-90 and 1990-91 may have increased winter mortality of calves which was reflected in significant reductions in yearling bulls during winters 1990-91 and 1991-92 (Table 1). Because the bull segment of the population in southwestern Subunit 20D has been heavily skewed toward yearling bulls in recent years, increases in calf mortality would result in decreased recruitment of yearling bulls, and therefore result in lower bull:cow ratios. The number of yearling bulls observed in the Donnelly TCA ranged from 24 to 27 during 1986-89, but only 9 yearling bulls were counted in 1991.

The second factor contributing to the declining bull:cow ratio is the increasing cow segment of the population. The 3-year mean number of cows observed during surveys in the Donnelly TCA has increased from 195 cows in 1987 to 227 cows in 1990. During 1991, we counted 225 cows. Therefore, the cow segment of the population is increasing while the bull segment is decreasing. The result is that total population size is stable, but the bull:cow ratio is declining because fewer yearling bulls are being recruited because of winter mortality and there are more cows.

Antler restrictions adopted in southwestern Subunit 20D in 1988 are partly responsible for a change in the age class structure of bulls. In the Donnelly TCA, yearling bulls steadily decreased from 47% of all bulls in 1987 to 26% in 1991 (Table 7). Part of this decrease can be attributed to winter mortality of calves during 1989-90 and 1990-91, and part can be attributed to antler restrictions. Medium bulls steadily increased from 42% of all bulls in 1987 to 60% in 1991. Large bulls show no clear trend and appear stable.

Percent bulls for other portions of Subunit 20D are given later in this report for comparison. In Denali National Park, a 1986 population survey estimated 76 bulls:100 cows, with 13% yearling bulls, 61% medium bulls, and 26% large bulls ($\underline{n}$ = 197 bulls). A 1991 population survey in the park estimated 78 bulls:100 cows, with 8% yearling bulls, 50% medium bulls, and 42% large bulls ($\underline{n}$ = 432 bulls) (T. Meier, pers. commun.).

Although the Delta Agricultural Project TCA was not completed in 1991 and we observed only 83 moose, composition data indicate similar trends in the Donnelly TCA. Bull:cow ratios were below the management objective with 24 bulls:100 cows (Table 2). Because of lower predation rates in the more developed and populated area, calf survival was higher than in the Donnelly TCA with 42 calves:100 cows. Recruitment was poor, however, with only 2 yearling bulls:100 cows.

Southeastern Subunit 20D. Calf survival to 6 months of age is meeting the objective in the Knob Ridge and Robertson River areas. The Knob Ridge TCA survey had 39 and 31 calves:100 cows in 1990 and 1991, respectively (Table 3), while 29 and 35 calves:100 cows were observed in the Robertson River survey during 1990 and 1991, respectively (Table 4). Moose survival to 18 months of age was low with both areas having only 8 yearling bulls:100 cows in 1990 and declined to 4 yearling bulls:100 cows in 1991.

Bull:cow ratios met the objective in both survey areas during 1990 and 1991 but are steadily declining. Surveys in 1991 resulted in 33 bulls:100 cows in the Knob Ridge survey and 31 bulls:100 cows in the Robertson River survey. Because reported harvest is low in southeastern Subunit 20D, the declining bull:cow ratios probably result from factors other than reported hunting pressure.

In the Knob Ridge survey area, the declining bull:cow ratio is probably because of an increasing number of cows in the area. The number of bulls observed in the Knob Ridge TCA remained fairly constant in recent years, ranging from 29 to 36 bulls from 1989 to 1991, with 34 bulls observed during 1991. However, the number of cows observed has increased from 71 in 1989 to 104 in 1991. Annual variation in Robertson River data makes clear trends less obvious than the Knob Ridge data; however, the number of bulls has generally decreased while the number of cows remained fairly constant. Other factors that may be reducing bull:cow ratios in southeastern Subunit 20D are significant unreported harvest and higher natural mortality rates on bulls than cows.

Bulls observed in the Knob Ridge TCA during 1991 consisted of 12% yearlings, 41% medium bulls, and 47% large bulls. During the 1991 Robertson River survey, 11% of all bulls were yearlings, 70% were medium bulls, and 19% were large bulls.

<u>Northwestern Subunit 20D</u>. Calf survival to 6 months of age continued to be poor in the Central Creek TCA during 1990 and 1991 with only 10 and 15 calves:100 cows, respectively (Table 5). Survival of moose to 18 months of age was also poor with 4 and 6 yearling bulls:100 cows each year.

Bull:cow ratios increased in 1990 and 1991 to 63 and 69 bulls:100 cows, respectively. During 1991, yearling, medium, and large bulls composed 9%, 28%, and 63% of the bulls observed in the Central Creek TCA, respectively.

<u>Northeastern Subunit 20D</u>. No sex and age composition data were collected in this area during 1990. Calf survival to 6 months was good with 32 calves:100 cows in 1991 (Table 6). This was the highest calf:cow ratio observed in this area since at least 1981. Moose survival to 18 months of age also improved significantly to 14 yearling bulls:100 cows and was the highest recorded since 1985. Calf survival in this area has probably benefited from liberal grizzly bear seasons and bag limits in adjacent Subunit 20E.

The bull:cow ratio continued to be high with 96 bulls:100 cows in Billy Creek, indicating that little hunting pressure has been directed at this segment of the Subunit 20D moose population. Yearling bulls made up 15% of all bulls observed, whereas medium and large bulls made up 52% and 33% of all bulls, respectively.

<u>Distribution and Movements</u>: Moose radio-collared in southwestern Subunit 20D have mostly remained south of the Tanana River and most movements have been localized. One moose moved from the Jarvis Creek area to the Gerstle River, 1 moose moved north to winter in the Goodpaster River, and 2 moose moved west into Subunit 20A along the west bank of the Delta River.

Mortality

Season and Bag Limit. Table 8 lists moose hunting seasons in Subunit 20D during the 1989-90 and 1990-91 regulatory years. During the 1989 season, subsistence seasons were differentiated from resident/nonresident seasons. However, actual season dates were the same in all areas.

During the 1990 moose hunting season, subsistence/resident seasons were differentiated from nonresident seasons. Nonresident seasons in southwestern, southeastern, and northern Subunit 20D west of the Alyeska Pipeline were 5 days shorter than subsistence/resident seasons and had antler restrictions. Also, a Tier II hunt was established in southeastern Subunit 20D.

Board of Game Actions and Emergency Orders. The Board of Game made regulatory changes that provided preferences for subsistence moose hunters. These regulatory changes are listed in Table 8.

Human-induced Mortality: One hundred seventy-four moose were believed killed by human-related activities during 1989-90 (Table 9). This total includes 127 moose reported killed by hunters, 16 known and suspected mortalities because of collisions with vehicles, and 9 killed during illegal hunting activities. Gasaway (1992) estimated that the unreported moose harvest equals about 18% of the reported harvest, which equaled 22 moose during the 1989 hunting season.

One hundred fifty-four moose were believed killed by human-related activities during 1990-91 (Table 9). This total includes 118 moose reported killed by hunters, 11 known and suspected mortalities because of collisions with vehicles, 4 killed illegally, and an estimated unreported harvest of 21 moose.

Southwestern Subunit 20D. Reported harvest totaled 60 moose in 1989 and 58 moose in 1990 (Table 10). Harvest ranged from 58 to 60 moose since antler restrictions were adopted in the 1988 hunting season. Hunter success was 20% in 1989 and 21% in 1990.

Antler restrictions have not reduced the number of hunters in southwestern Subunit 20D. The mean number of hunters for the 3 years before antler restrictions was 260 hunters. The mean number of hunters for 3 years with antler restrictions was 272. There were 303 hunters in 1989 to 270 hunters during the 1990 season (Table 10).

Southeastern Subunit 20D. Both the harvest of moose and the number of hunters remained low in southeastern Subunit 20D (Table 10). Forty-seven hunters killed 11 moose in 1989 and 29 hunters killed 9 moose in 1990. Low numbers of hunters and harvest result in this area partly because of 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. Hunters in this area had a 23% success rate in 1989 and 31% in 1990.

Northwestern Subunit 20D. The number of moose killed in northwestern Subunit 20D has remained fairly constant despite a steady decline in the number of hunters since 1984. One hundred ninety-one hunters killed 41 moose during the 1989 season for a 21% success rate (Table 10). During the 1990 season, 195 hunters killed 40 moose for a 21% success rate. I believe the moose harvest is remaining constant despite a declining moose population and declining numbers of hunters; many people who continue to hunt north of the Tanana River have hunted the area for a long time and are familiar with the area and are efficient moose harvesters. I also believe that migratory moose from the large population that winters 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 39 hunters harvesting 10 moose in 1989 for a 25% success rate. During the 1990 season, 26 hunters harvested seven moose for a 27% success rate.

Hunter Residency. Most Subunit 20D moose hunters were Alaskan residents and residents of the subunit. During the 1989 hunting season, 76% of successful hunters and 82% of the unsuccessful hunters were subunit residents. During the 1990 season, 83% of successful hunters and 82% of unsuccessful hunters were subunit residents (Table 11).

Hunter Effort. During the 1989 hunting season, successful hunters hunted a mean of 4.6 days compared with a mean of 5.9 days for all unsuccessful hunters (Table 12). During the 1990 hunting season, successful hunters hunted a mean of 4.7 days and unsuccessful hunters hunted a mean of 5.9 days.

Effort by successful hunters increased steadily in southwestern Subunit 20D from 3.8 days in 1986 to 4.9 days in 1990 (Table 12). Antler restrictions in this area since the 1988 season and fewer bulls available have increased in hunter effort by forcing hunters to search longer to find a legal bull moose. Even though hunter effort increased in this area, it was still similar to mean days hunted for the entire subunit.

Permit Hunts. Permit hunt number 988 was conducted during the 1989 hunting season. The hunt took place from 1 January to 15 February 1990 for residents of Subunit 20D living between Bear Creek and Berry Creek. Fifteen permits were issued for a harvest quota of 5 bulls. Nine hunters reported hunting and one moose was killed (Table 13). All hunters were local residents of Subunit 20D.

Permit hunt number 987T was conducted during the 1990 hunting season as a Tier II hunt from 1 January to 15 February 1991. Fifteen permits were issued (Table 13). Seven hunters reported hunting, all local residents. One moose was harvested by a hunter using a highway vehicle for transportation.

Harvest Chronology. Reporting harvest chronology was changed from reporting 7-day periods in the past to reporting harvest in 5-day periods for the 1990 hunting season. Previous harvest chronology has not been converted to 5-day periods at this time, so only 1990 harvest is reported. During the 1990 hunting season, 58% of reported harvest occurred during the first 5 days of the season. Harvest during the next two 5-day periods was nearly equal with 21% and 24% of the harvest occurring in each (Table 14).

Transport Methods. Little change was evident from transportation means and success rates reported during the 1989 and 1990 hunting seasons. Highway vehicles were the most commonly used transport method, used by 29% of hunters in 1989 and 33% in 1990 (Table 15). Highway vehicles, boats, 3- or 4-wheelers, and off-road vehicles were the most commonly used modes of transportation used by all successful hunters during both years. These 4 modes of transportation were used by 83% of successful hunters during the 1989 season and 90% of successful hunters during the 1990 season.

Natural Mortality: We made no estimates of natural mortality during 1989-90 or 1990-91. 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.

Winters 1989-90 and 1990-91 resulted in overwinter mortality of moose in the Delta Junction area. During winter 1989-90, nine moose were reported dead around Delta Junction, and five were reported in winter 1990-91. Total snowfall was well above the 1961-85 average of 40.5 inches during these two winters with 58.5 inches in 1989-90 and 80.9 inches in 1990-91. Snowpacks and snow water equivalents (SWE = water content) were also above the average of 15-16 inches snow depth and 2.9-3.3 inches SWE. In 1989-90, April snowpacks ranged from 22 to 28 inches in Subunit 20D, with SWEs ranging from 4.3 to 6.1 inches (Table 16). During 1990-91, April snowpacks ranged from 29 to 37 inches and SWEs ranged from 6.7 to 8.6 inches (Arnegard, pers. commun.).

Habitat Assessment and Enhancement

No habitat assessment or enhancement was done during this report period.

CONCLUSIONS AND RECOMMENDATIONS

No progress was made toward meeting increased population objectives in Subunit 20D. Moose in southwestern and southeastern Subunit 20D are at moderate to high densities in winter and are stable. Bull:cow ratios are declining in all of southern Subunit 20D and are currently below the management objective in southwestern Subunit 20D. The bull:cow ratio is below the objective primarily because winter mortality during 1989-90 and 1990-91 decreased recruitment of yearling bulls into the population and because the cow segment of the population is growing in size. Density of moose continues to be low in northern Subunit 20D. In northwestern Subunit 20D, populations are probably declining based on poor calf survival and yearling recruitment. Moose calf survival and yearling recruitment has improved in northeastern Subunit 20D probably because of liberal grizzly bear seasons and bag limits in adjacent Subunit 20E, and populations may have stabilized at low densities based on improved calf survival and recruitment.

Moose harvest remained relatively stable in Subunit 20D and all areas meet the objective of 20% hunter success. Antler restrictions in southwestern Subunit 20D have stabilized the area harvest and are effecting changes in the age structure of bulls. Deep snow during winters 1989-90 and 1990-91 caused a decrease in the number of bulls. Regulatory changes may be necessary to allow area bull:cow ratios to increase.

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Table 1. Subunit 20D, Donnelly Trend Count Area fall aerial moose composition counts, 1986-91.

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	3.4
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[b]	311	--
1991-92	16	4	32	73	22	260	333	3.1

[a] Incomplete survey. Only 6 of 9 samples units were surveyed.
[b] Seven unidentified moose.

Table 2. Delta Agricultural Project Trend Count Area fall aerial moose composition counts, 1989-91.

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	34	14	41	46	25	145	191	1.5
1990-91	No data							
1991-92[a]	24	2	42	21	25	62	83	0.8

[a] Incomplete survey.

Table 3. Knob Ridge Trend Count Area fall aerial moose composition counts, 1986-91.

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	No Data							
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

[a] TCA has slightly different boundaries than later

Table 4. Robertson River fall aerial contour moose composition counts, 1986-91.

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	No data							
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

Table 5. Central Creek Trend Count Area fall aerial moose composition counts, 1986-91.

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	No Data							
1987-88	No Data							
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

Table 6. Billy Creek fall aerial contour survey for moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1986-87	77	3	17	12	9	126	138	36
1987-88	No data							
1988-89	93	4	13	6	6	87	93	37
1989-90	94	3	31	10	14	62	72	26
1990-91	No data							
1991-92	96	14	32	9	14	55	64	36

Table 7. Age structure of bulls in the Donnelly TCA of southwestern Subunit 20D based on estimated antler spread of bulls observed during aerial surveys. Values in parentheses are percentages.

	Antler Size			
Date	Yearling <30.0	Medium 30.0-49.9	Large ≥50.0	Total Bulls
1987	27 (47)	24 (42)	5 (9)	56
1988	24 (43)	26 (46)	7 (13)	57
1989	27 (44)	25 (41)	9 (15)	61
1990[a]	13 (36)	20 (56)	3 (8)	36
1991	9 (26)	21 (60)	5 (14)	35

[a] Incomplete survey.

Table 8. Moose hunting seasons in Subunit 20D during the 1989-90 and 1990-91 hunting seasons.

Year	Area	Season		Bag Limit
1989-90	Southwestern	Subsistence:	Sept. 1-15	1 bull with spike-fork or 50" antlers
		Res./Nonres.:	Sept. 1-15	1 bull with spike-fork or 50" antlers
	Southeastern	Subsistence:	Sept. 1-10	1 bull
		Res./Nonres.:	Sept. 1-20	1 bull
	Northern	Subsistence:	Sept. 1-10	1 bull
		Res./Nonres.:	Sept. 1-10	1 bull
1990-91	Southwestern	Subsis./Res.:	Sept. 1-15	1 bull with spike-fork or 50" antlers
		Nonresident:	Sept. 5-15	1 bull with 50" antlers
	Southeastern	Subsis./Res.:	Sept. 1-15	1 bull
			Jan. 1-15	1 bull by Tier II permit
		Nonresident:	no season	
	Northern West of Alyeska Pipeline	Subsis./Res.:	Sept. 1-15	1 bull
		Nonresident:	Sept. 5-15	1 bull with 50" antlers
	Northern Remainder	Subsis./Res.:	Sept. 1-10	1 bull
		Nonresident:	Sept. 1-10	1 bull

Table 9. Subunit 20D moose harvest[a] and accidental death, 1986-91.

Regulatory	Harvest by Hunters										
	Reported				Estimated			Accidental death			
year	M (%)	F (%)	Unk.	Total	Unreported[b]	Illegal	Total	Road	Train	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

[a] Excludes permit hunt harvest.
[b] Based on 17.7% unreported harvest estimated by Gasaway et al. (1992).

Table 10. Annual reported harvest of moose and number of hunters in southwestern, southeastern, northwestern, and northeastern Subunit 20D from 1984 to 1990.

Regulatory	Moose Harvest						Number of Hunters					
year	SW	SE	NW	NE	Unk	Total	SW	SE	NW	NE	Unk	Total
1984	39	9	40	14	0	102	236	47	294	48	10	635
1985	48	8	60	14	0	130	236	37	272	50	9	604
1986	76	10	40	10	1	137	250	45	232	57	12	596
1987	66	8	43	9	0	126	296	35	208	35	17	591
1988	60	12	39	12	3	126	244	45	201	37	28	555
1989	60	11	41	10	5	127	303	47	191	39	40	620
1990[a]	58	9	40	7	4	118[a]	270	29	195	26	28	548

[a] Does not include permit hunt in southeastern Subunit 20D.

Table 11. Subunit 20D moose hunter[a] residency and success, 1986-91.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	
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

[a] Excludes hunters in permit hunts.
[b] Local means reside in Subunit 20D.

Table 12. Mean days hunted for successful and unsuccessful hunters in southwestern, southeastern, northwestern, and northeastern Subunit 20D from 1986-87 to 1990-91.

Regulatory year	Successful					Unsuccessful				
	SW	SE	NW	NE	20D Combined	SW	SE	NW	NE	20D Combined
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

Table 13. Subunit 20D moose harvest data by permit hunt, 1989-91 for permit hunt 988 (1989) and 987T (1990).

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

Table 14. Subunit 20D moose harvest[a] chronology percent by time period, 1990.

Regulatory year	Harvest periods				
	9/1-9/5	9/5-9/10	9/10-9/15	Unk	n
1990-91	57	20	23	0	109

[a] Excludes permit hunt harvest.

Table 15. Subunit 20D moose harvest[a] percent by transport method, 1987-91.

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	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

[a] Excludes permit hunt harvest.

Table 16. Total snow depth and snow water equivalent (SWE) for four sites in Subunit 20D during April 1989-90 and 1990-91.

	1989-90		1990-91		Mean 1961-85	
Location	Snowpack	SWE	Snowpack	SWE	Snowpack	SWE
Ft. Greely	25"	5.6"	29"	6.7"	15"	3.3"
Granite Creek	28"	6.1"	30"	7.8"	16"	3.3"
Gerstle River	23"	5.2"	31"	7.5"	15"	2.9"
Shaw Creek	22"	4.3"	37"	8.6"	16"	3.1"

LOCATION

Game Management Subunit: 20E (11,000 mi^2)

Geographical Description: Charley, Fortymile, and Ladue River drainages

BACKGROUND

The moose population irrupted in Subunit 20E during the 1950s and early 1960s in response to an intensive federal predator control program. The population increased to at least 12,000 moose and declined rapidly between 1965 and 1976. By the end of the decline, the population numbered 2,200 moose. Since 1976, the population has remained low (0.2-0.4 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, ADF&G began more intensive predator management in the early 1980s. Wolf control done from 1981 to 1983 reduced the wolf population by 54% in a 3,800 mi^2 area of Subunit 20E. Grizzly bear hunting regulations were liberalized in 1978, causing moderate harvest 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 because of the combined effects of the wolf reduction program, more public harvest of grizzly bears and wolves, and an increase in the caribou population which served as alternate prey for predators and hunters.

Subunit 20E has been a popular hunting area for 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. In 1982, a 10-day bulls-only season was restored, but hunter success has been one-half that reported in 1970.

MANAGEMENT DIRECTION

Management Goals

Management goals for moose are to 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: 1) continued sustained opportunities for subsistence use of moose; 2) maximum sustained opportunities to participate in hunting moose; and 3) maximum opportunities for the nonconsumptive use of moose.

Management Objectives

Management objectives for the area are to: 1) maintain a posthunting sex ratio of at least 40 bulls:100 cows in the Charley River drainage; 2) 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; 3) 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; and 4) maintain a posthunting bull:cow ratio of at least 40 bulls:100 cows in all areas.

METHODS

We estimated sex and age composition in October and November 1991 using aerial contour and transect surveys. All moose observed were classified as large bulls (antlers ≥ 50 inches), medium bulls (antlers larger than yearlings but < 50 inches), yearling bulls (spike, cerviform, or small palmate-antlered), cows without calves, cows with one calf, cows with two calves, lone calves, or unidentified moose. The same areas have been surveyed annually in a comparable manner. Staff conducted population estimation surveys in southwestern Subunit 20E during fall 1981 and 1988 using techniques described by Gasaway et al. (1986).

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: During fall 1981, a census was conducted in a 2,973-mi^2 (7,700 km^2) area in southwestern Subunit 20E resulting in an extrapolated subunit population estimate of 2,530 moose (1,980-2,970). This same area was censused again in 1988 and the results indicated that the subunit moose population had increased to 4,400 (3,620-5,360). No other censuses were done in Subunit 20E since 1988, but based on indices obtained during sex and age composition counts, the population continued to increase (Fig. 1).

The annual rate of increase in Subunit 20E, based on the 1981 and 1988 censuses, was 1.09. However, based on models and estimates of mortality and recruitment the population probably grew at a rate of only 1.04 to 1.05 (Gasaway et al. 1992). I used data collected since 1988 in the model presented by Gasaway et al. (1992) and it appears that the calf mortality rate to 12 months has decreased slightly and that the population is still increasing at about the same rate. If this slow growth rate continues, the population objective will be reached in 13 years barring any environmental resistance.

Population Composition: We conducted fall moose composition surveys in Subunit 20E between 27 October and 13 November 1991 and classified 834 moose during 19.8 survey hours (42 moose/hour). This was the second highest total moose count for the subunit and the highest moose/hour count since 1973. The bull:cow and calf:cow ratios were 65:100 and 28:100, respectively (Table 1). Between 1986 and 1990 there was a decline in the bull:cow ratio, but it is at a level indicative of a lightly harvested population and well above the minimum population objective of 40:100. Based on bull/hour data, both medium (30.0-49.9 inch antler spread) and large bull (≥50 inches) numbers have declined during the past 3 years. The decline seems more severe for large bulls. The strong yearling cohort maintained the overall bull:cow ratio in 1991.

Calf survival to 5 months has generally improved since 1986, possibly because of lowering the grizzly bear population through increased harvest. Grizzly bears are the predominant predator on moose calves in this subunit.

The 1991 yearling:cow ratio, estimated by doubling the number of yearling bulls observed, was 33:100 exceeding the 5-year average of 25:100. The cause of increased survival for this age class is unknown as the wolf population increased 30% the past 2 years. Caribou availability has probably contributed to reduced wolf predation on moose.

Distribution and Movements: Moose were well distributed through Subunit 20E. While resident moose remained in the Mosquito Flats area, most others moved to seasonally lowland summer habitat and upland rutting areas, where they remained until winter conditions caused them to return to lower elevations. During fall 1988, 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 Sept.-15 Sept.

Nonresident Hunters:
One bull with 50" antlers — 5 Sept.-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 Sept.-25 Sept.

Nonresident Hunters:
One bull with 50" antlers — 5 Sept.-25 Sept.

Board of Game Actions and Emergency Orders. During the spring 1990 meeting the Board of Game extended the resident season in the southern Subunit 20E from 1-10 September to 1-15 September and also opened a nonresident season between 5 and 25 September in northern Subunit 20E and between 5 and 15 September in southern Subunit 20E. The board placed a 50-inch minimum antler restriction on bulls harvested by nonresidents. During the fall 1991 meeting, the board prohibited land-and-shoot hunting of wolves after 1 July 1992 but adopted a strategic wolf management plan that uses a zone system to manage the state in different ways to accommodate different public demands for the use of wolves, their prey, and habitat. Which zones of Subunit 20E will be placed in will be decided during the spring 1992 board meeting.

Hunter Harvest. Total reported harvest in Subunit 20E during the fall 1990 season was 46 bulls (Table 2) or about 1% of the estimated population. The average reported harvest for the last 5 years was 47. The preliminary harvest estimate for fall 1991 is 84, the highest since 1973. I believe that the 5-day longer season in 1991 was the main reason for the higher harvest.

Of the 46 moose harvested in 1990, 16 (35%) were taken along the Yukon, Charley, and Seventymile rivers (10, 5, and 1, respectively) in northern Subunit 20E. The Mosquito Fork drainage in the central subunit produced the biggest harvest; 14 (30%) moose were taken. The harvest of the remaining 16 moose was spread out equally over the mainstem of the Fortymile River, the Dennison Fork, the North Fork, and along the Ladue River.

The mean antler spread of bulls taken in Subunit 20E was 45.8 inches which is slightly lower than the 5-year mean of 47.1 inches. Two bulls (4.7%) were judged to have been yearlings (antlers <30 inches), 26 (60.5%) were 2-4 years old (antler spread 30.0-49.9 inches), and 15 (34.9%) were mature bulls (antler spread ≥ 50 inches). Of the mature bulls, six (7.0%) had antler spreads >60 inches. Antler spreads were estimated for 220 bulls observed during posthunting aerial surveys, and the age composition was 14% yearlings, 39% 2-4 year olds, and 47% mature bulls. Apparently, medium size bulls were more vulnerable and yearling and large bulls less vulnerable to hunters during 1990.

Hunter Residency and Success. Nonresident hunters have been prohibited from hunting moose in Subunit 20E since 1984. Starting in fall 1991, nonresidents are allowed to hunt in the subunit but are limited to bulls with an antler spread of >50 inches. Their contribution to the overall harvest is expected to be minimal as it was before 1984. Of the 46 bulls harvested in 1990, 16 (35%) were taken by residents of Unit 12 and 20E (Table 3) and 6 of those were taken by residents of Chicken and Eagle. Nonlocal residents reported taking 28 moose in Subunit 20E. Of these, 8 were from southcentral Alaska, 6 from southeast Alaska, and 14 from interior Alaska. Residency was not specified by two successful hunters.

During 1990, 295 hunters reported hunting moose in Subunit 20E, a slightly lower number of hunters than the 5-year average of 305. Hunter success was 16% during 1990 which equals the 5-year average. The success rate of local residents was 20% compared to a 14% success rate for nonlocals. Preliminary reports from the 1991 season indicate that hunter success increased substantially to about 30%. The increase is because of a higher than normal yearling bull cohort and to the longer season length.

Harvest Chronology. The moose hunting season in most of Subunit 20E between 1986 and 1990 was so short (10 days) that analysis of harvest chronology is of limited value. Most of the harvest occurs during the first part of the season when most hunting pressure occurs. During 1990, the harvest dates of the 46 moose were as follows: 24 (52%) 1-7 September, 7 (15%) 8-14 September, 9 (20%) 15-21 September, 3 (7%) 22-28 September, and 2 (6%) are unknown.

Transport Methods. During 1990, in Subunit 20E the transportation method used most by moose hunters were highway vehicles (41%), followed by 4-wheelers (19%), boats (15%), aircraft (12%), other ORVs (9%), and horses (3%). Hunters using highway vehicles had the lowest success rate (6%), while hunters using off-road vehicles and boats had the highest success rates with 33% and 24% success, respectively. The success rate of hunters using aircraft declined over the past 3 years from 33% to 21%. I suspect this lower success rate is because hunters concentrate in the few suitable landing areas, especially in the Mosquito Flats. Hunters using 4-wheelers continue to have a much lower success rate (11%) than expected.

Hunters who travel the farthest from the Taylor Highway and from the more popular areas along the few established trails generally experience greater success. The only real competition for Subunit 20E moose occurs along the Taylor Highway, along the Chicken Trail, and in the Mosquito Flats. Considering the lack of access into the subunit and that most hunters use highway vehicles as their mode of travel, the objective of a 35% success rate will be difficult to obtain even if the moose population increases substantially.

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 (0.4 moose/mi^2). Using the model presented by Gasaway et al. (1992), I estimated that 29% of the postcalving moose population is being killed by wolves and grizzly bears. Of this percentage, about half are being killed by each predator. In comparison, humans are harvesting about 1% of the postcalving population.

Habitat

Assessment: Presently in Subunit 20E the availability of browse is not limiting moose population growth. Recent browse studies have found that most of the preferred browse plants are not being utilized, and use of the current year's growth has been less than 5% (Boertje 1985). Over 10% of the subunit has burned within the last 25 years offering excellent browse. However, much of this habitat was created by a few large fires, so there is still a large part of the unit that was protected under a strict fire suppression policy that is unproductive because of an unnatural fire regime.

Enhancement: Implementing 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

We estimate the annual finite rate of increase for the Subunit 20E moose population since 1981 as 1.04 to 1.05. Even with this slow increase over the past 10 years, moose density is still low (0.33-0.49 moose/mi^2). Recent research has shown that predation by wolf and bear populations was the primary factor maintaining the moose population at low levels for this extended period. The combination of wolf and bear predation is taking about 30% of the postcalving moose population annually. Given the present low moose density and that the subunit's wolf population is rapidly growing, we can expect the moose population to continue to remain low and that the population objectives will not be reached by the year 2000.

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, but calf recruitment and yearling bull survival are presently high, and the bull:cow ratio is about 65:100. The number of medium and large bulls has declined during the past 5 years, and if the mortality rate for calves increases the bull:cow ratio will decline further. The extension of the hunting season apparently increased hunter success rate substantially during 1991. If calf recruitment begins to decline, hunting season length restrictions may have to be incorporated to maintain a high bull:cow ratio. At the present moose population level, human harvest and nonconsumptive use goals are not being met.

In an attempt to widen the ratio between moose and bears, liberal hunting regulations have been in place since 1978. As a result, the bear harvest has increased and caused bear numbers to decline in parts of the subunit. Moose calf survival has increased during this period. These liberal bear regulations should stay in place until the moose population further escapes the effects of predation.

The wolf population has been increasing by 8% per year the past 3 years. This increase is expected to negatively impact yearling moose survival as wolves selectively kill this age class (Ballard et al. 1987). During the spring 1992 Board of Game meeting, the board will delineate areas of the state that will receive intensive wolf management. Subunit 20E should be zoned the most intensive to enhance the Fortymile caribou herd and the area's moose population. If intensive wolf management is in place by 1993, the moose population and human use objectives that are strongly supported by area residents can still be met by the year 2000.

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.

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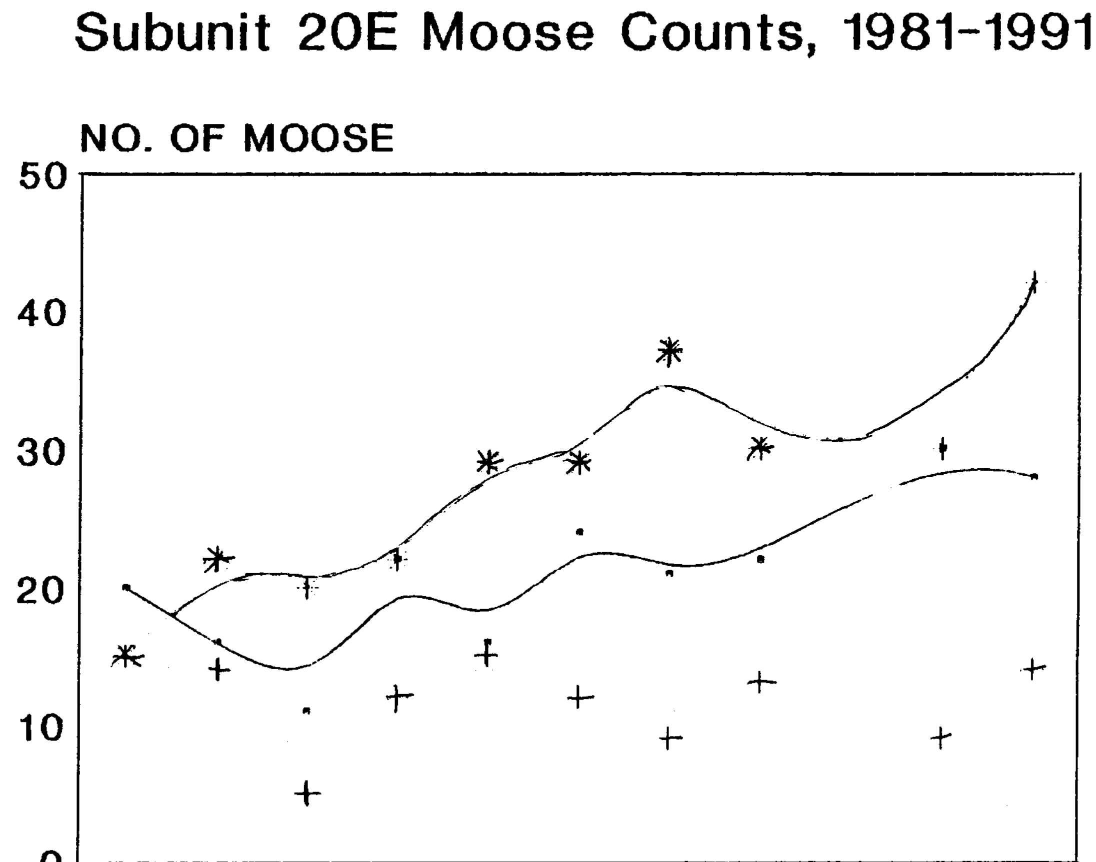

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Calf/100 Cow	20	16	11	22	16	24	21	22		30	28
Yrl Bull/100 Cow +	15	14	5	12	15	12	9	13		9	14
Moose/hr *	15	22	20	22	29	29	37	30		30	42

YEAR

Figure 1. Subunit 20E moose counts, 1981-1991.

Table 1. Subunit 20E aerial moose composition counts, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed	Moose /hour
1986-87	80	12	24	81	18	620	701	29
1987-88	79	9	21	74	11	620	694	37
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

[a] Includes 585 moose from census not used for moose/hour.

Table 2. Subunit 20E moose harvest and accidental death, 1986-91.

Regulatory year	Harvest by Hunters: Reported M (%)	Reported F (%)	Reported Unk.	Reported Total	Estimated Unreported	Estimated Illegal	Estimated Total	Accidental death Road	Accidental death Train	Accidental death Total	Total
1986-87	46(100)	0	0	46	4-7	5-15	9-22	0		0	54-68
1987-88	52(96)	0	2	54	6-10[a]	5-15	11-25	0		0	65-79
1988-89	52(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[b]	83	1	1	85	4-7	5-15	9-22	0		0	94-107

[a] Confusing wording in the regulations resulted in some moose being killed after the season closed.
[b] Preliminary data.

Table 3. Subunit 20E moose hunter residency and success, 1986-91.

	Successful				Unsuccessful				
Regulatory year	Local[a] resident	Nonlocal resident	Nonresident	Total[a](%)	Local[a] resident	Nonlocal resident	Total Nonresident	Total[a](%)	hunters
1986-87	23	23	--	46 (14)	114	173	--	287 (86)	333
1987-88	17	31	1[b]	54[c](20)	24	187	--	211 (80)	265
1988-89	14	36	2[b]	57[c](17)	44	243	--	287 (83)	344
1989-90	15	22	--	37 (13)	42	202	4	250[d](87)	287
1990-91	16	28	--	46[d](16)	65	176	2	249[e](84)	295

[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] Harvested illegally by nonresident.

[c] Includes five hunters with unknown residency.

[d] Includes two hunters with unknown residency.

[e] Includes six hunters with unknown residency.

LOCATION

Game Management Subunit: 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 the earliest human accounts of the area. Moose were 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 townsfolk and miners with meat. The area was believed to have supported a large moose population from the early 1900s to late 1970s. Several severe winters in the late 1960s and early 1970s initiated widespread declines in moose populations throughout the Interior.

Historically, naturally occurring wildfires have been a major force affecting the productivity and diversity of moose habitat in this area. A major portion of the area was burned by large fires before the 1950s when effective fire suppression substantially altered this fire regime. The 1982 Tanana-Minchumina Fire Plan provided the mechanism for return to a natural fire regime in most of this area by allowing some fires to burn with minimal interference.

The Nowitna River (Novi) drainage to the east of Ruby is the main hunting area for residents of Ruby, Tanana, and, to a lesser extent, Galena. It is also a popular hunting area for Fairbanks residents who use boats and aircraft for access. Because of its long history of use by both local and nonlocal hunters, this area has been the focus of much management effort in Subunit 21B over the years.

Aerial moose surveys in 1977-79 suggested that moose numbers declined in the Novi. Wolves were believed abundant compared with the number of moose available, and predation by wolves was believed responsible for the decline in moose numbers. A wolf control program was approved to augment the existing wolf 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.

A population estimate survey (Gasaway et al. 1986) in November 1980 indicated that 2,386 $\pm$ 429 moose were present in the 2,774 mi^2 portion of the subunit that includes the lower Novi. This was twice the number that biologists had been projecting from the less intensive surveys of previous years. Because the previous data were of poorer quality, it was not possible to ascertain whether the apparent increase in moose numbers was because of reductions in the wolf population and restrictions on hunting or whether the change was an artifact of the survey data.

Since 1981, hunters have had a 20-day long season and a bag limit of one bull moose per hunter. Harvest reports indicate that the number of hunters using the Novi remained stable and the harvest averaged 49 bulls over the last 10 years. We operated a moose hunter check station at the mouth of the river from 1979 to 1983 and from 1988 to the present.

In 1986, 783 $\pm$ 191 moose were estimated in a 1,556-mi^2 portion of the lower Novi using techniques similar to those used in 1980. Statistical comparison with the 1980 estimate suggested that the population had declined by as much as 44% in six years. Overwinter survival of calves was poor during this period. Yearling bulls comprised only 3-5% of the moose population surveyed from 1983 to 1986.

Low temperatures, deep snow, and ice crusting created severe conditions for moose in Subunit 21B during winter 1988-89. This harsher than normal winter was followed by severe flooding during May 1989.

Besides the lower 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 - areas that produce 36% to 46% of the reported harvest.

MANAGEMENT DIRECTION

Management Goals

Management goals for Subunit 21B are to: 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; and 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 Nowitna 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.
3. Determine the extent and sources of moose calf mortality from May 1988 through May 1990.

Remainder of the Nowitna 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

We conducted a standard ADF&G population estimation survey (Gasaway et al. 1986) in November 1990 to re-survey the same area included in a 1980 population estimate survey. Part of the survey area was treated separately to develop a concurrent estimate to compare with a 1986 population estimate for the smaller area. I used two-tailed student's t-tests to test for statistical difference among consecutive estimates for similar areas.

We surveyed established trend count areas from Piper PA-18 (or equivalent) aircraft to assess population status and trend. We searched contiguous survey units of approximately 12 mi^2 each at a rate of at least 5 minutes/mi^2 to ensure reasonably high sightability, minimal bias, and data comparability between years.

We monitored hunting mortality by checking moose harvest reports and collecting information on hunter residency, moose ages, and antler sizes at a moose hunter check station. We monitored predation-related mortality by interviewing wolf trappers, conducting a wolf survey (USFWS), and conducting a moose calf mortality study.

We located calves in the moose calf mortality study from a helicopter and captured them by hand. A radio transmitter sewn into an elastic-bandage material collar was placed on the neck of each calf. Calves were sexed and then left unattended to give the cows time to re-bond with their calves. Radio-collared calves were usually located daily with fixed-wing aircraft for the first six weeks of life. Then calves were usually monitored on alternate days between late June and late July, then twice per week during August and September. From October until May, we monitored calves 1-2 times a month. The transmitters had a mortality sensor with a 2-hour delay. Whenever possible we investigated all mortalities during the first six weeks within 24 hours of death using standard techniques (Ballard et al. 1979). Date of death was estimated as the midpoint between the last date confirmed alive and date of confirmed death. We investigated all mortality sites on the ground.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: A population estimation survey (Gasaway et al. 1986) was conducted during November 1990 in a 2,700-mi^2 portion of the lower Novi (D. Haggstrom, ADF&G files). An estimate of 1,719 ± 237 moose (90% CI = ± 13.8% of the point estimate) was obtained (Table 1). This was 535 moose (23%) less than the point estimate obtained in 1980 for approximately the same area. The difference was significant at the 80% level, but not at the 90% level. Thus, there is a 20% chance that the actual 1980 and 1990 population levels were the same.

Some insight to what may have occurred within this 10-year interval can be obtained by comparing subsets of the 1980 and 1990 data (Table 2) with data from a 1986 population estimation survey of approximately 1,600 mi^2 within the boundaries of the larger surveys (Table 3). This comparison suggests a significant ($\underline{P} \leq 0.10$) decrease in moose numbers from 1980 to 1986, and a significant ($\underline{P} \leq 0.10$) increase in moose numbers from 1986 to 1990. The population apparently decreased by an average of 7.4% annually from 1980 to 1986 and increased by an average of 8.5% annually from 1986 to 1990.

Moose density data collected from established trend areas along the lower Novi also suggest that the population has increased since 1986, although it is unclear whether that increase is continuing (Tables 4, 5).

From results of the 1990 population estimation survey, I estimate from 2,635 to 3,785 moose reside 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.

Population Composition: Composition data are available from aerial surveys conducted with the help of USFWS staff in established trend areas on the Nowitna National Wildlife Refuge (Tables 4, 5). The 1990-91 results indicate that bull:cow ratios are falling and poor; calf:cow ratios are good; and overwinter survival of calves to yearling age indicates average recruitment values. The occurrence of twin calves among moose observed in the early winter surveys has also increased. The twinning rates among cows with calves observed during May 1988 and May 1989 were 48% and 58%, respectively. A population with these attributes can reasonably be expected to grow. The fact that the bull:cow ratio has been decreasing suggests that localized overhunting may be occurring along the river corridor. The population estimate survey had a bull:cow ratio of 40:100 (90% CI = 30.5-49.2) for the whole area.

Distribution and Movements: Early winter surveys indicate that moose are numerous along the floodplains of the Nowitna and Yukon rivers at this time of year. Riparian areas contain extensive *Salix pulchra* and *S. alaxensis* stands, which are preferred browse species for moose. Most cow moose spend summer months around open grass and brush meadows on the floodplain, but away from the river. In October they move to riparian areas, where they remain until early May. Some cow moose winter in the hills north and south of the Nowitna.

Mortality

Harvest:

Season and Bag Limit.

Resident	Nonresident
5 Sept.-25 Sept.	5 Sept.-20 Sept.
1 bull	1 bull

Board of Game 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. No other changes were made during the report period.

Harvest. The reported harvest for the subunit remained fairly stable and averaged 95 moose annually the past 5 years (Table 6). We estimate the unreported harvest at 5 moose per year in the Ruby area and 10 moose per year in the Tanana area. The Nowitna drainage produced from 54% to 64% of the subunit's harvest in the last 5 years.

Check Station Results. Since 1988, a moose hunter check station at the mouth of the Nowitna River (operated in cooperation with the USFWS) has been used to interview hunters using boats on the Nowitna. Results (Table 7) indicate that most hunters were from Fairbanks. This represents a change in distribution of hunter residency since 1979-81 when similar data were collected from a moose hunter check station on the Nowitna.

Hunter Residency and Transportation Methods. Based on harvest reports (Table 8), the most hunters (66%) 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 9). Another 10% used aircraft, 8% hunted via vehicles on the Ruby-Poorman Road, and 14% were unknown.

Other Mortality: A moose calf mortality study commenced on the lower portion of the Nowitna River during May 1988 and continued through May 1990 in cooperation with the USFWS (Osborne et al. in press). Annual survival rates among all calves on the Nowitna National Wildlife Refuge were not significantly different between 1988 (0.34, n = 42) and 1989 (0.29, n = 47). Survival rates of male and female calves were not significantly different during any year, but annual survival of single calves was significantly higher than that for twins in 1989 (0.56 vs. 0.20), except in 1988.

Black bears killed 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 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 suggested that the population declined during the early 1980s and increased during the late 1980s. Data from the 1985-91 surveys of permanent trend count areas show the population has grown since 1986.

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.

The moose population level and harvest are currently at planned levels on the Nowitna River floodplain. However, the estimated unitwide 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 calf mortality study was completed in May 1990 and results are being published (Osborne et al. in press). These results will be used to justify increasing the black bear harvest, the major predator on moose calves.

The bull:cow ratio is poor and may be decreasing. The steady harvest of about 49 bulls appears to be 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. Summary of moose census data from the lower Nowitna River in Subunit 21B, 15-28 November 1990.

Statistic	Strata: Low	Medium	High	All strata combined
Sample units (N)	129	76	16	221
No. surveyed (n)	7	19	10	36
Total area (mi^2)	1,552	941	207	2,701
Stratum as % of total	57.5	34.8	7.7	100.0
Area surveyed (mi^2)	85.8	230.4	132.1	448.3
% of stratum surveyed	5.5	24.5	63.8	16.6
No. moose seen	13	199	328	540
Observed density (moose/mi^2)	0.15	0.86	2.48	0.58
Uncorrected[a] estimate (T_o)	235	813	514	
Variance $V(T_o)$	4,142	6,783	3,135	
Degrees of freedom $df(T_o)$	6	18	9	
Observed sightability correction factor[b] (SCF_o)	1.00	1.10	1.15	1.13
Variance $V(SCF_o)$	0.0000	0.00219	0.00378	
Degrees of freedom $df(SCF_o)$	4	14	4	
Corrected estimate (T_e)	235	895	589	1,719
Variance $V(T_e)$	4,142	9,659	5,103	18,904
Degrees of freedom[b] $df(T_e)$	4	14	4	20
90% CI[b] around T_e	58.3%	19.3%	25.9%	13.8%

[a] Not corrected for sightability

[b] The MOOSEPOP program (D. Reed 1989) was run separately for each stratum to take advantage of sightability differences between strata. Results were subsequently combined using the following formulas:

$$SCF_o = \frac{(SCF_o)_{Low}*(T_e)_{Low} + (SCF_o)_{Medium}*(T_e)_{Medium} + (SCF_o)_{High}*(T_e)_{High}}{(T_e)_{Combined}}$$

$$df(T_e)_{Combined} = \frac{V(T_e)_{Combined2}}{V(T_e)_{Low2}/df(T_e)_{Low} + V(T_e)_{Medium2}/df(T_e)_{Medium} + V(T_e)_{High2}/df(T_e)_{High}}$$

$$\text{Combined CI} = T_{eCombined} \pm [t_{41df} * SQRT(V(T_e)_{Combined})]$$

Table 2. Summary of data from the lower Nowitna River moose census (15-28 November 1990) in Subunit 21B that were collected within the same area surveyed in 1986.

Statistic	Strata: Low	Strata: Medium	Strata: High	All strata combined
Sample units (N)	67	41	16	124
No. surveyed (n)	6	9	10	25
Total area (mi^2)	820	533	207	1,560
Stratum as % of total	52.6	34.2	7.7	100.0
Area surveyed (mi^2)	73.1	114.8	132.1	320.0
% of stratum surveyed	8.9	21.5	63.8	20.5
No. moose seen	10	97	328	435
Observed density (moose/mi^2)	0.14	0.85	2.48	0.69
Uncorrected[a] estimate (T_o)	112	450	514	
Variance $V(T_o)$	1,375	5,880	3,135	
Degrees of freedom $df(T_o)$	5	8	9	
Observed sightability correction factor[b] (SCF_o)	1.00	1.14	1.15	1.15
Variance $V(SCF_o)$	0.0000	0.00561	0.00378	
Degrees of freedom $df(SCF_o)$	3	5	4	
Corrected estimate (T_e)	112	513	589	1,214
Variance $V(T_e)$	1,375	7,744	5,103	14,222
Degrees of freedom[b] $df(T_e)$	3	5	4	11
90% CI[b] around T_e	77.8%	34.6%	25.9%	17.6%

[a] Not corrected for sightability.

[b] The MOOSEPOP program (D. Reed 1989) was run separately for each stratum to take advantage of sightability differences between strata. Results were subsequently combined using the following formulas:

$$SCF_o = \frac{(SCF_o)_{Low}*(T_e)_{Low} + (SCF_o)_{Medium}*(T_e)_{Medium} + (SCF_o)_{High}*(T_e)_{High}}{(T_e)_{Combined}}$$

$$df(T_e)_{Combined} = \frac{V(T_e)_{Combined2}}{V(T_e)_{Low2}/df(T_e)_{Low} + V(T_e)_{Medium2}/df(T_e)_{Medium} + V(T_e)_{High2}/df(T_e)_{High}}$$

$$\text{Combined CI} = T_{eCombined} \pm [t_{41df} * SQRT(V(T_e)_{Combined})]$$

Table 3. Comparison of moose census data from the Subunit 21B portion of the Nowitna River drainage, 1980-90.

Statistic	Year of Census 1980	1986	1990
Sample units (N)	121	124	124
No. surveyed (n)	27	30	25
Total area (mi^2)	1,556	1,596	1,560
Area surveyed (mi^2)	331.9	387.5	320.0
Area surveyed as % of total census area	21.3	24.3	20.5
No. moose seen	275	412	435
Observed density (moose/mi^2)	0.77	0.43	0.69
Observed sightability correction factor, SCF_o	1.16[a]	1.27[a]	1.15[b]
Corrected estimate T_e	1389	878	1,214
Variance $V(T_e)$	41,582	14,506	14,222
Degrees of freedom $df(T_e)$	9[a]	18[a]	11[b]
90% CI around T_e	26.9%[a]	23.8%[a]	17.6%[b]
$\underline{t}$-test statistic for change between T_e at time 2 and T_e at time 1		2.159	1.987
Degrees of freedom for $\underline{t}$		15	27
Critical $\underline{t}$ values (2-tailed test, $\underline{P}$<0.10)		1.753	1.703
H_o: $T_e1 = T_e2$		reject	reject
Exponential rate of growth		-0.077	0.081
Finite rate of population change		0.926	1.085
Annual percentage change		-7.4	8.5

[a] The MOOSEPOP program (D. Reed 1989) was run for all strata simultaneously.
[b] The MOOSEPOP program was run separately for each stratum to take advantage of sightability differences between strata. Results were subsequently combined using the following formulas:

$$SCF_o = \frac{(SCF_o)_{Low}*(T_e)_{Low} + (SCF_o)_{Medium}*(T_e)_{Medium} + (SCF_o)_{High}*(T_e)_{High}}{(T_e)_{Combined}}$$

$$df(T_e)_{Combined} = \frac{V(T_e)_{Combined2}}{V(T_e)_{Low2}/df(T_e)_{Low} + V(T_e)_{Medium2}/df(T_e)_{Medium} + V(T_e)_{High2}/df(T_e)_{High}}$$

$$\text{Combined CI} = T_{eCombined} \pm [t_{41df} * \text{SQRT}(V(T_e)_{Combined})]$$

Table 4. Subunit 21B Novi/Sulatna confluence trend count area fall aerial moose composition counts, 1986-91.

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	25	4	32	22	21	85	107	1.6
1987-88	46	13	40	25	21	92	117	2.3
1988-89	25	14	53	30	30	71	101	2.0
1989-90[a]	--	--	--	--	--	--	--	--
1990-91	29	5	33	18	20	71	89	2.3
1991-92	21	9	29	39	20	161	200	2.6

[a] No survey.

Table 5. Subunit 21B Novi Mouth trend count area fall aerial moose composition counts, 1986-91.

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	22	2	54	35	31	79	114	2.6
1987-88	37	15	59	64	30	149	213	2.7
1988-89	22	11	26	28	18	131	159	3.8
1989-90[a]	--	--	--	--	--	--	--	--
1990-91	24	9	65	43	34	82	125	3.2
1991-92[a]	--	--	--	--	--	--	--	--

[a] No survey.

Table 6. Subunit 21B moose harvest[a], 1986-91.

Regulatory year	Harvest by hunters: Reported M	F	Unk.	Total	Estimated: Unreported	Illegal	Total	Accidental death: Road	Train	Total	Total
1986-87	79	0	0	79	15		15				94
1987-88	83	0	0	83	15		15				98
1988-89	102	0	0	102	15		15				117
1989-90	74	0	0	74	15		15				89
1990-91	81	0	0	81	15		15				96
1991-92[b]	47	0	0	47	15		15				62

[a] Excludes permit hunt harvest.
[b] Preliminary data.

Table 7. Residency (N), harvest (n), and success (S%) of moose hunters stopping at the Nowitna River hunter check station, Subunit 21B, 1988-91.

	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

Table 8. Subunit 21B moose hunter[a] residency and success, 1986-91.

Regulatory year	Successful Local resident	Successful Nonlocal resident	Successful Nonres.	Successful Unk	Successful Total	Unsuccessful Local resident	Unsuccessful Nonlocal resident	Unsuccessful Nonres.	Unsuccessful Unk	Unsuccessful Total	Total hunters
1986-87	18	59	1	1	79	8	30	1	1	40	119
1987-88	21	56	1	5	83	8	35	3	3	49	132
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[b]					47					46	93

[a] Excludes hunters in permit hunts.
[b] Preliminary data.

Table 9. Subunit 21B moose harvest[a] by transport method, 1986-91.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1986-87	4	0	61	0	0	0	6	6	77
1987-88	6	0	65	0	1	1	6	4	83
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[b]	4	0	38	1	0	0	3	1	47

[a] Excludes permit hunt harvest.
[b] Preliminary data.

LOCATION

Game Management Subunit: 21C (3,671 mi^2)

Geographical Description: Dulbi River above Cottonwood Creek and Melozitna River above Grayling Creek

BACKGROUND

Moose have occurred in Subunit 21C since historic times. Moose densities are considered generally low. Population trend is unknown. There has been little need to monitor this moose population extensively, as human use is low and not believed to adversely impact the population. The terrain in the subunit is mountainous, with peaks as high as 5,000 feet. Two large river drainages, the Melozitna and the Dulbi, dissect the mountains. Numerous fires have burned in the area, producing large expanses of excellent winter habitat. Moose harvests have ranged from 15 to 30 bulls during the past 15 years. Aircraft provide the only practical access to most of the subunit. A waterfall near the mouth of the Melozitna River restricts travel up that river and extensive sand bars impede boat access to the upper Dulbi River.

MANAGEMENT DIRECTION

Management Goals

Moose management goals for Subunit 21C are to: 1) protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem, and 2) provide the greatest sustained opportunity to participate in hunting moose.

Management Objectives

Management objectives for Subunit 21C moose are to: 1) increase the moose population to 2,500-3,000 moose in the Melozitna River drainage to increase hunting opportunity, and; 2) maintain the moose population of 550-750 in the Dulbi River drainage to sustain hunting opportunities.

METHODS

We monitored harvest levels by reviewing the moose harvest reports submitted by hunters. We assessed predation mortality by interviewing wolf trappers.

RESULTS AND DISCUSSION

Population Status and Trend

No new information was obtained this report period. Previous data indicated good bull:cow and calf:cow ratios (Table 1), but 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.

Board of Game Actions and Emergency Orders. The seasons and bag limits remained the same over the past 10 years. The board made no changes during this report period.

Hunter Harvest. The harvest in the subunit has been stable, ranging from 25 to 30 moose annually the past 5 years (Table 2).

Hunter Residency and Transportation Methods. 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: At least 50 to 60 wolves reside 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 considered low. Human use of the population remains low. A reasonable estimate of current moose density would be 0.5-1.0 moose/mi^2, based on the scant survey data to date and densities observed elsewhere in the Interior. If this estimate was correct, it would mean that historical harvest levels (15-30 moose/yr) take only 0.4-1.6% of the projected population of 1,836-3,671 moose each year. It would seem likely that existing hunting pressure could be sustained even if the population experienced a 50% reduction. Conversely, if nothing major happens to the population, it should be able to sustain double the current harvest without any management actions. I recommend minimal 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 and relative abundance and to determine areas for future trend surveys.

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Table 1. Summary of fall aerial moose survey data from Subunit 21C, 1983-91.

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
1983-84[a]	131	6	23		9		0.6	49.7	33
1984-85[b]	--	--	--		--		--	--	--
1985-86[b]	--	--	--		--		--	--	--
1986-87[b]	--	--	--		--		--	--	--
1987-88[c]	81	4	35		16		0.7	100.7	67
1988-89[b]	--	--	--		--		--	--	--
1989-90[b]	--	--	--		--		--	--	--
1990-91[b]	--	--	--		--		--	--	--
1991-92[b]	--	--	--		--		--	--	--

[a] Source: trend area survey at Sithdonit Creek (headwaters of the Melozitna River).
[b] No surveys flown.
[c] Source: Dulbi River moose population estimation survey.

Table 2. Subunit 21C moose hunter[a] residency and success, 1987-91.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonres.	Unk.	Total	Local[b] resident	Nonlocal resident	Nonres.	Unk.	Total	
1987-88	1[c]	12	4	1	18	2[c]	8	8	1	17	34
1988-89	0	13	7	1	21	2[c]	4	3	1	8	29
1989-90	0	14	4	0	18	0	5	1	0	6	24
1990-91	1[c]	18	5	1	25	0	9	3	0	12	36
1991-92[d]					19					16	35

[a] Excludes hunters in permit hunts.
[b] Resident of Subunit 21C.
[c] Resident of adjacent subunit.
[d] Preliminary data.

Table 3. Subunit 21C moose harvest[a] by transport method, 1987-91.

Regulatory year	Harvest								Total
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1987-88	12	0	5	0	0	0	0	0	17
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

[a] Excludes permit hunt harvest.

LOCATION

Game Management Subunit: 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 and through the 1960s. With statehood in 1959 federal wolf control ended. Passage of the Airborne Hunting Act in 1972 stopped legal aerial shooting. Faced with an abundance of food, wolves once again became abundant. The moose population peaked in number around 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 aircraft use. However, by 1986 the number of 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 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 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 indicate increasing moose density. Initially I thought the density increase was because of 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.

Four villages are within the subunit (Kaltag, Nulato, Koyukuk, and Galena), and residents of each village have traditional hunting areas. The area used by Galena residents overlaps those used by residents of the other villages because many Galena residents have larger boats and can travel farther. Although Huslia is 30 miles from Subunit 21D, its residents rarely hunt for moose in 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 to occur.

The reported harvest before 1981 was inaccurate because many local residents either did not obtain licenses or failed to report. In 1981, I made it easier for subunit residents to obtain harvest reports. Educational and enforcement efforts have increased the reporting rate by local residents.

MANAGEMENT DIRECTION

Management Goals

Management goals for Subunit 21D moose are to: 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; and 5) provide for scientific and educational use of moose.

Management Objectives

Koyukuk River Drainage: Moose management objectives for the Koyukuk River drainages are to: 1) maintain a population of at least 4,000 moose south and east of the river, including the Three-day Slough area; 2) maintain an early winter density of at least 4 moose/mi^2 within the Three-day Slough floodplain; 3) maintain a posthunting ratio of at least 30 bulls:100 cows in the population being monitored by the Three-day Slough TCA; 4) develop guidelines for maximum winter browse use within the Three-day Slough area; and 5) maintain a moose population level of 900-1,000 in the Kateel River drainage and develop a population level for the Gisasa River by 1991.

Yukon River Floodplain: The moose management objective for the Yukon River floodplain is to maintain an early winter density of at least 3 moose/mi^2 in floodplain areas along the Yukon River that are subject to September and February hunting seasons.

Elsewhere in the Subunit Including Yuki and Nulato Rivers: The moose management goal elsewhere in Subunit 21C (including the Yuki and Nulato rivers) is to determine the population level and density estimate by 1994.

METHODS

We surveyed established trend count areas from Piper PA-18 (or equivalent) aircraft to assess population status and trend. We searched contiguous survey units of approximately 12 mi^2 each at a rate of at least 5 minutes/mi^2 to ensure reasonably high sightability, minimal bias, and data comparability among years.

Neonatal calves were radiocollared using standard ADF&G equipment and techniques. We then monitored collared calves from fixed-wing aircraft to obtain information on mortality and movements. We monitored hunting mortality and distribution through harvest tickets and check stations. Local residents were encouraged to increase their harvest reporting through school visits and check stations. Predation was monitored by interviewing trappers, relocating radio-collared animals, and conducting track surveys.

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 upland areas.

Two population estimation surveys during November 1987 found 6,340 moose over a 4,883-mi^2 area. Extrapolation of these data suggest a subunit population of 9,000-10,000 moose. We collected no new data on population size during this report period.

Population Composition: We used the following guidelines to interpret sex and age indices within Units 21 and 24:

1. Bull:cow ratios usually average 30-40 bulls:100 cows after the hunting season. Higher numbers of bulls are good but sometimes misleading because the area is subject to either-sex hunting that can inflate bull numbers. Ratios in the 20s or less would be poor.

2. The calf:cow ratio observed during November surveys provides an index to calf survival during the 5 months after 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 indicate 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 1991 posthunt bull:cow ratio for Three-day Slough (Table 1) reflected continued heavy bull harvest in the area (Table 2). However, the ratio differed little from previous years. The yearling and calf numbers remained about average.

In November 1991, the bull segment surveyed in the Three-day Slough TCA included 29% small (≤ 30"), 55% medium, and 15% large- (≥ 50") antlered bulls. Considerably fewer large-antlered bulls were observed than in past years (Table 2). The bull segment has averaged 30% small, 43% medium, and 27% large-antlered bulls over the past decade.

The Pilot Mountain TCA had lowered bull:cow ratios in 1991, (Table 3) which indicated 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.

Distribution and Movements: In May 1990, 62 neonatal calves were radio-collared in the Three-day Slough area. Their movement patterns during the next 12 months were similar to those of adult moose collared in 1984. 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 north or south direction to 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.

Mortality

Harvest:

Season and Bag Limit.

	Subsistence and Resident	Nonresident
Resident:		
One moose, antlerless moose	Sept. 5-25 and Feb. 1-5	Sept. 5-25

may be taken only
from Sept. 21-25 and
Feb. 1-Feb. 5

Nonresident:
One bull with 50-inch
antlers

Board of Game Actions and Emergency Orders. The fall hunting season changed many 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 as the definition of who qualifies as a subsistence hunter has changed. In 1991, nonresidents were restricted to bulls with an antler spread of 50+ inches or 3 brow tines on one side.

The winter hunting season has been 5 days in February since 1989 and participation has been restricted to hunters who qualified as subsistence hunters. The area within one-half mile of the Yukon River has been closed to hunting to protect cow and calf moose that winter along the Yukon River. The purpose of these changes has been to provide a midwinter hunt to meet local needs while minimizing the take of cow moose concentrated in highly accessible riparian areas. 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 200-300 moose annually with another 40 unreported moose taken (Table 4). With the possible exception of the Yuki River drainage, moose populations in the subunit apparently can sustain current harvests.

Check Station Results. Stopping at the moose hunter check station on the Koyukuk River was made mandatory in 1990. Data have been collected on residency, harvest chronology, age structure of harvest, antler size, brow tine numbers, and transportation.

In 1991, the highest numbers of hunters were in the field during the 5-day period that began on Saturday, 14 September (Fig. 1). This coincided with the period when most large moose were taken (Table 2). On average, 60% of the bulls checked on the Koyukuk River in September have had antler spreads of at least 50 inches.

Despite a slight increase from 1987 to 1989, use by local residents is currently not much different from that observed in 1986 (Table 2). However, the local share of the moose harvest has dropped from 45% to 23%. The number of nonlocal and nonresident hunters using the Koyukuk River has risen dramatically. This gives local residents cause for concern. The increase in hunting pressure by nonlocal and nonresident hunters could eventually decrease local hunting success through increased competition, reduction in numbers of legal moose, or passage of more restrictive regulations.

The Three-day Slough area has been known as a good area to hunt for large (≥50-inch antlers) moose. Usually, about 25% to 33% of the bulls observed in the Three-day Slough TCA have large antler spreads (Table 2). In 1991, only 15% of the bulls observed in November had large antlers, following the record high harvest of this age class in September (Table 2). The decline in this age class in the harvest is evident (Fig. 2) when compared with the 9-year average. More younger bulls and fewer older aged bulls were harvested in 1991 than in most previous years.

Beginning with the 1991 fall season, nonresidents hunting in the subunit were required to only harvest bulls with 50-inch or larger antlers. We have been collecting data on antler size and number of brow tines since 1990 (Table 7). This regulation, as currently worded, will probably have minimal effect on the number of bull moose harvested by nonresidents, because the legal definition of a 50-inch bull includes all moose "with three or more brow tines on either side." Seventy-six percent of the bull moose checked on the Koyukuk met this requirement (Table 7).

Hunter Residency and Transportation Methods. The subunit hunter residency and success rate (Table 8) are slightly misleading as subunit 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 9). Snowmachines were the main transportation method used 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 the Nulato Hills and Kaiyuh Mountain. Wolves and grizzly bears prey heavily on both calf and adult moose. Black bears can be a substantial source of mortality for moose calves.

In May 1990, 65 neonatal calves were radio-collared in the Three-day Slough area and were tracked during the next 12 months. The causes and extent of mortality were from the following sources: black bears, 42%; grizzly bears, 5%; wolves, 5%; unknown predators, 8%; drowning, 1%; and unknown cause, 5%. Mortality was greatest during the first two months of life. The proportion of moose calves alive at the end of the interval 21 May-1 June was 64%, 44% were alive at the end of the interval 2 June-10 July, and 38% were alive by 20 May the following year.

The estimated subunit wolf population is 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 to 6 days per pack during winter (Gasaway et al. 1983). At this rate, wolves in Subunit 21D probably kill about 10-19% of the standing crop annually.

CONCLUSIONS AND RECOMMENDATIONS

Moose are numerous in riparian lowlands of Subunit 21D. I estimate 9,000 to 10,000 moose in the subunit. The populations are believed stable and appear able to support current harvest and predations levels. However, I do not recommend further liberalizing seasons or bag limits because natural predation remains very high.

The prior growth of the moose population was probably attributed to the steady and consistent harvest of wolves in the area. However, the growth of the moose population caused an increase in the number of moose hunters, especially within the KCUA. Although the bull:cow ratio remained above the minimum management objective, the proportion of large bulls in the herd declined, and some action may be necessary if the decline continues. A skewed age structure with large numbers of young bulls may adversely effect the population's productivity (Bubenik 1987).

All hunters in the KCUA use boats, and currently there is a congestion problem in suitable areas for camping sites and calling areas, as well as other problems associated with crowded hunting conditions. In previous years the area was known as a wildland site where people could 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 the cows more wary and is compromising our goal of viewing and photographing moose. One complaint from the most hunters is the noise associated with inboard jet boats.

We need to manage people in the area to relieve the congestion and stop the waste of moose meat. This could be accomplished through options that would either spread hunters out through time or reduce hunting opportunity.

1. A drawing permit for moose with antlers $\geq$ 50 inches would greatly reduce the number of nonresident hunters and cut the number of resident hunters by half.
2. Restricting the number of hunters allowed into the area would spread out the hunting pressure.
3. Closing the season for five days in the middle of the fall season would reduce the harvest and hunting opportunity by half.
4. Restricting the hours of boat traffic would reduce complaints of boat noise and probably cause some hunters to hunt elsewhere.
5. Requiring hunters to leave antlers in the field would greatly reduce the number of resident and nonresident hunters.
6. Requiring the meat to be left on the bone until leaving the KCUA would not reduce opportunity, but could reduce the harvest by cutting back on the number of moose some smaller boats could haul out in a single trip.

The amount of federal land in the area that could have a separate set of regulations complicates the matter. Any regulation we set should be general enough to apply to all lands. I would favor a registration hunt with the following restrictions:

1. Permits only available at Ella's cabin.
2. No motorized boat traffic between the Kateel and Dulbi rivers from 2:00 p.m. to 8:00 p.m.
3. All moose meat must be attached to the bone within the KCUA.

If these restrictions did not reduce congestion, I would then limit the number of permits valid at any one time.

Within Subunit 21D, we need to alter the brow tine section of the 50-inch bull definition to read 4 brow tines instead of 3 so that the regulation truly restricts the harvest to large-antlered bulls as intended. The current 3 brow tine provision allows young moose with medium-sized antler spreads to be harvested. Of all the moose harvested on the Koyukuk River in 1990 and 1991, only 49% had antler spreads of 50 inches or larger. However, an additional 27% were considered legal 50-inch bulls because they had 3 or more brow tines.

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Table 1. Summary of fall aerial moose survey data from the Three-day Slough count area in Subunit 21D, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults[a]	Total moose observed	Moose /mi^2
1986-87	39	7	45	162	25	448	660	7.9
1987-88	33	11	34	229	20	751	1,128	8.8
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

[a] Moose $\geq$ 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 (TDS) trend count area, Subunit 21D, 1982-91.

Regulatory year	% large bulls in harvest September[b]	Bull harvest Koyukuk River September	% large bulls TDS November
1982-83	66 (30)	74	26
1983-84	62 (55)	85	27
1984-85	54 (89)	116	15
1985-86	57 (49)	81	22
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	nd
1991-92	48 (196)	199	15

[a] $\geq$ 50-inch antler spread.
[b] Number of antlers measured in parentheses.

Table 3. Summary of fall aerial moose survey data from the Pilot Mountain Slough trend count area in Subunit 21D, 1986-91.

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	36	18	49	49	26	136	185	5.1
1988-89[a]	--	--	--	--	--	--	--	--
1989-90[a]	--	--	--	--	--	--	--	--
1990-91[a]	--	--	--	--	--	--	--	--
1991-92	24	8	54	49	30	112	161	6.9

[a] Survey not flown.

Table 4. Subunit 21D moose harvest[a], 1986-91.

Regulatory year	Harvest by hunters: Reported M (%)	F (%)	Unk.	Total	Estimated: Unreported	Illegal	Total	Accidental death: Road	Train	Total	Total
1986-87	152	21	0	173	40		40				213
1987-88	185	19	1	205	40		40				245
1988-89	229	20	2	251	40		40				291
1989-90	182	22	0	204	40		40				244
1990-91	256	22	1	279	40		40				319
1991-92[b]	225	19	0	244	40		40				284

[a] Excludes permit hunt harvest.
[b] Preliminary data. Excludes February 1992 hunt.

Table 5. Harvest chronology of moose with ≥50-inch antler spread taken on the Koyukuk River, Subunit 21D[a], 1988-91.

Regulatory year	Sept. 5-9 #	%	Sept 10-14 #	%	(Sept. 13-18) #	%	Sept. 15-19 #	%	Sept. 20-25 #	%	Total Harvest #	%
1988-89	27	30	30	34	(23)	(26)	17	19	15	17	89	53
1989-90	8	12	23	35	(31)	(48)	19	29	15	23	65	45
1990-91	8	9	12	15	(36)	(44)	40	49	18	22	82	47
1991-92	4	4	25	26	(44)	(46)	38	40	28	29	95	48

[a] Check station data.

Table 6. Moose harvest by hunters who stopped at the Koyukuk River Check Station[a], Subunit 21D, 1983-91.

Reg.	Unit 21 resident		Alaska resident[b]		Nonresident		Total	
year	Hunter	Moose	Hunter	Moose	Hunter	Moose	Hunter	Moose
1983-84	132	43	29	20	3	2	164	65
1984-85	92	61	67	36	9	9	168	106
1985-86	117	32	74	37	4	3	195	72
1986-87	140	48	80	51	9	7	229	106
1987-88	151	68	92	61	21	16	264	145
1988-89	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

[a] The station was only mandatory in 1990 and 1991. During the first two years, 5-10% of the boats passing the station did not stop.
[b] Other than Unit 21 residents.

Table 7. A comparison of the number of antler brow tines on 287 bull moose examined at the Koyukuk River check station, Subunit 21D, 1990-91.[a]

No. of tines	One side n	One side %	Both sides n	Both sides %
3	218	76	157	55
4	122	43	58	20
5	50	17	14	5
6	25	9	5	2

[a] All hunters were required to stop at the check station. In 1990, 106 bull moose were checked. In 1991, 181 bull moose were checked.

Table 8. Subunit 21D moose hunter[a] residency and success, 1986-91.

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	
1987-88	44	129	18	58	205	17	55	3	23	81	286
1988-89	94	193	27	31	251	30	64	3	10	77	328
1989-90	78	176	22	6	204	51	98	8	4	110	314
1990-91	100	232	35	12	279	33	59	4	6	69	348

[a] Excludes hunters in permit hunts.
[b] Local means resides in Subunit 21D.

Table 9. Subunit 21D moose harvest[a] by transport method, 1986-91.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1986-87	N/A								
1987-88	8	1	178	0	7	2	1	8	205
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

[a] Excludes permit hunt harvest.

LOCATION

Game Management Unit: 22 (23,000 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 to the Seward Peninsula in the mid to late 1930s, and by the late 1960s, had successfully expanded into much of the unit's suitable habitat. Moose numbers continued to increase at substantial rates during the 1970s and early 1980s. Limited data suggest densities have leveled off or declined in most areas.

Demand for moose, primarily by recreational and subsistence hunters residing in the unit, is high. Gravel roads and navigable rivers provide easy access to suitable moose habitat. Annual recorded harvest from 1969 to 1990 ranged from 44 moose (1972) to 408 moose (1986). Unit residents usually take at least 70% of the reported harvest annually.

MANAGEMENT DIRECTION

Management goals and objectives developed for moose in Unit 22 are outdated and need to be re-evaluated. Until more meaningful goals and objectives are developed, those broad range goals and objectives established earlier by the Division of Wildlife Conservation will remain in effect. Current objectives are to: 1) protect, maintain, rehabilitate, enhance, and develop Alaskan wildlife resources and their habitats; 2) provide for the optimum sustained use, both consumptive and nonconsumptive, of Alaska's wildlife resources consistent with the social, cultural, aesthetic, environmental, and economic needs of the public; and 3) maintain and/or increase viable unit moose populations consistent with environmental conditions, legal mandates, and public desires.

METHODS

We flew aerial surveys in early spring to estimate moose densities and short yearling recruitment. During March 1990 we conducted a census in Subunit 22C using methods developed by Gasaway et al. (1986). All available moose habitat found throughout Subunit 22E was surveyed during spring 1991. We summarized harvest data from harvest reports submitted by hunters.

RESULTS AND DISCUSSION

Population Status and Trend

Although moose numbers in Subunits 22A, 22C, and 22E increased recently, densities compared to Subunits 22B and 22D remain low. It is unclear what factors (i.e., habitat, natural predation, overharvest, or poor recruitment) are restricting herd growth. Moose densities in much of Subunits 22B and 22D increased dramatically since the mid-1970s, and are now near or above winter range carrying capacity. Calf survival, particularly in those areas of high moose concentrations, appears to be declining. The winters of 1989 and 1990 were severe, and limited data suggest that winter mortality was higher than normal. Reports of dead or starving moose were common, particularly where winter concentrations of moose were known to be high.

Population Size: A census using techniques developed by Gasaway et al. (1986) was conducted in Subunit 22C during March 1990. Because of its moderate size (1,368 mi^2), the whole subunit was the census area. The stratification flight results were: 63 sample units (714 mi^2) labeled as low density strata; 48 sample units (551 mi^2) as medium density strata; and 9 sample units (103 mi^2) as high density strata. During the census, 47 (536 mi^2) of the 120 sample units were censused. Of these, 12 were low density strata (136 mi^2), 26 medium density strata (296 mi^2), and 9 high density strata (103 mi^2).

The population estimate for the census area was 407 moose. Confidence intervals surrounding this population estimate are as follows: at the 80% confidence level (± 10.4%), 365-449 moose; at the 90% confidence level (± 13.4%), 352-461 moose; and, at the 95% confidence level (± 16.2%), 341-473 moose. The short yearling recruitment for the census area was estimated at 21%. Confidence intervals surrounding this short yearling recruitment estimate were as follows: at the 80% level (± 14.8%), 17.9-24.1%; at the 90% level (± 19.1%), 17.0-25.0%; and, at the 95% level (± 23%), 16.2-25.9%

During a 4-day period in April 1991, we conducted a complete survey in Subunit 22E. The decision to conduct a survey rather than a census was based on topography, available moose habitat, and perceived low densities of moose. A total of 226 moose were observed, and short yearlings constituted 8% of the moose observed.

Population Composition: Inclement weather and a lack of snow early during the falls of 1989 and 1990 made it impossible to obtain reliable sex composition data.

Mortality

Season and Bag Limit:

Unit 22A	Aug. 1-Sept. 30 Dec. 1-Dec. 31	One bull

Unit 22B	Aug. 1-Jan. 31	One moose; antlerless moose may be taken only from Dec. 1-Dec. 31.
Unit 22C	Sept. 1-Sept. 14	One bull
Unit 22D west, all drainages into the north only sides of Port Clarence, Grantley Harbor, and Imuruk Basin, excluding the Kuzitrin Pilgrim, and Kougarok River drainages.	Aug. 1-Sept. 30	One moose; antlerless moose may be taken only from Aug. 1-Dec. 31 Antlered moose may be taken from Jan. 1-Jan. 31
Remainder of 22D	Aug. 1-Dec. 31	One moose
22E	Aug. 1-Mar. 31	One moose

Harvest:

Human-Induced Mortality. During the 1989-90 season, 290 moose (208 males and 82 females) were harvested from Unit 22 (Tables 1 and 2). This reported harvest was considerably lower than the 10-year harvest average of 354 moose and was probably in response to the inclement weather that occurred during August, September, and October. Sex composition by subunit was: Subunit 22A, 24 males and no females; Subunit 22B, 69 males and 11 females; Subunit 22C, 18 males and no females; Subunit 22D, 81 males and 57 females; and, Subunit 22E, 16 males and 14 females. The 1990-91 harvest of 350 moose (280 males and 70 females) was similar to the 10-year average harvest of 354. Sex composition of that harvest by subunit was: Subunit 22A, 28 males and no females; Subunit 22B, 87 males and 9 females; Subunit 22C, 37 males and no females; Subunit 22D, 104 males and 46 females; and, Subunit 22E, 22 males and 15 females. Harvest ticket information indicated 2 additional male moose were harvested at unknown locations in the unit.

Hunter Residency and Success. Unit 22 residents took 79% of the harvest in 1989-90, and 72% in 1990-91 (Table 3). Alaska residents took 89% and 88% of the reported harvest, respectively. Hunter success was 41% during 1889-90, and 50% during 1990-91.

Harvest Chronology. Most hunter effort and reported harvest (69% in 1989-90 and 75% in 1990-91) occurred during August, September, and October when access to suitable moose habitat from roads and rivers was most favorable (Table 4).

Transport Methods. Although the use of highway vehicles, boats with jet units, and snowmachines as transportation accounts for 75% of the Unit 22 annual harvest, the use of ATVs and other off-road vehicles has become more popular (Table 5).

Natural Mortality. Snow depths during the winters of 1989 and 1990 were as deep or deeper than any recorded within the past 30 years. Many moose observed were thin and in poor condition, particularly during late winter and early spring. Although we lack quantitative data, we believe that natural mortality rates were considerably higher than in past years. We do not know what effect inclement weather had on spring calf production.

We did not conduct specific surveys to determine natural mortality rates among Seward Peninsula moose. Limited data gathered from observations reported by local residents and biologists conducting other field activities suggest that overwinter mortality rates were substantial during 1990-1991. At least 25 dead moose were observed during spring 1991 while conducting moose surveys and other similar flights. Although several grizzly bears were observed feeding on moose carcasses during April and May of both years, we do not know whether those moose were killed by bears or died of natural causes.

Board of Game Actions and Emergency Orders. No emergency orders affecting moose hunting regulations were enacted this report period. At ADF&G's suggestion, during spring 1989 the board removed the antlerless registration permit requirement for Unit 22 moose, and extended the antlerless seasons in Subunits 22D and 22E. The board reauthorized antlerless moose hunts in Unit 22 during its spring meetings in 1990 and 1991. The board made no other changes affecting Unit 22 moose this report period.

Habitat Assessment

Winter ranges, particularly in portions of Subunits 22B, 22C, 22D, and 22E, have been heavily browsed in past years. Until recently, the lack of palatable browse was not considered a significant factor affecting moose mortality. However, the severity of the last two winters may have changed that. Data and conclusions from several studies of moose/willow foraging relationships in the Kuzitrin and other river drainages within Subunit 22D have provided insight into the presently occurring interactions between moose and other herbivores, hares, and the willow communities (Alaska Cooperative Wildlife Research Unit, 1990). Many moose using willowed winter habitat in portions of Subunits 22B and 22D tend to move from these riparian areas in late March onto adjacent hillsides where they feed on sedges and dwarf willows. They stay in these areas until spring thaws reduce snowcover sufficiently in adjacent valleys and ravines. It is not uncommon during that time to see "herds" of moose in excess of 50 animals placidly grazing in these areas.

CONCLUSIONS AND RECOMMENDATIONS

Moose are the most important big game species available to Unit 22 residents. Moose not only provide successful hunters with a substantial amount of protein annually, but they also provide many individuals 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 1980s, and peaked in 1983 when approximately 1,300 people reportedly hunted (Table 1). Hunter effort has since declined. Despite this decline, hunter success increased during the past six years, presumably in response to increased use of boats, ATVs, and other off-road vehicles as transportation.

The moose population which has steadily grown larger over the years has probably already peaked in size, 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 1980s. Declines caused by winter mortality and reduced production have now probably shifted those figures downward. Based on the limited information available, I estimate that the unit's moose population to range between 5,000 and 7,000 animals.

Poor weather conditions during fall generally make it difficult to complete aerial surveys to determine sex composition and bull cow ratios. Limited data were obtained in only 4 of the last 10 years; the time spread and the inconsistencies surrounding the data make any comparisons or assumptions erroneous. Because the population may be declining, it is imperative to obtain these data. Others ways of gathering data are being evaluated. We need a sound moose management plan based on censuses, research programs, and public input to manage moose wisely. Steps need to be taken to initiate such a plan.

Illegal and/or unreported harvests continue to present problems for the unit because some local residents either fail to acquire harvest tickets before hunting or take moose out of season. It is difficult to measure this illegal harvest. However, I estimate it ranges from 10% to 20% of the reported harvest. Public education programs and a visible enforcement effort must be maintained to improve compliance with current regulations.

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Table 1. Unit 22 historical moose harvest, 1981-91.

Regulatory Year	Males	Females	Unknown sex	Total harvest	Total hunters[a]	Percent success
1981	225	72	1	298	696	43
1982	244	100	0	344	904	38
1983	291	68	46	405	1,292	31
1984	298	91	6	395	1,086	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

[a] Minimum known number of hunters.

Table 2. Unit 22 moose harvest by Subunit, 1989-90 and 1990-91.

	22A		22B		22C		22D		22E		Unknown	
Year	M	F	M	F	M	F	M	F	M	F	M	F
1989/90	24	0	69	11	18	0	81	57	16	14	0	0
1990/91	28	0	87	9	37	0	104	46	22	15	2	0

Table 3. Moose hunter residency and success by Subunit, 1989 and 1990.

1989-90

Sub Unit	Successful hunters Unit	State	Non	Unknown	Totals	Unsuccessful hunters Unit	State	Non	Unknown	Totals
22A	20	24	0	0	24	61	63	0	0	63
22B	50	61	17	2	80	55	73	3	1	77
22C	18	18	0	0	18	26	29	0	0	29
22D	113	126	8	4	138	154	171	3	0	174
22E	27	29	1	0	30	10	11	0	0	11
22Z	0	0	0	0	0	65	71	0	1	72

1990-91

Sub Unit	Successful hunters Unit	State	Non	Unknown	Totals	Unsuccessful hunters Unit	State	Non	Unknown	Totals
22A	26	27	0	1	28	45	49	0	0	49
22B	61	75	19	2	96	36	52	4	0	56
22C	31	35	2	0	37	20	26	0	0	26
22D	101	134	15	1	150	124	136	3	1	140
22E	33	36	0	1	37	5	5	0	0	5
22Z	0	0	2	0	2	66	79	1	0	80

Table 4. Chronology by Subunit of Unit 22 moose harvest, 1989-90 and 1990-91.

1989/90

Sub Unit	Month: Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Unk	Totals
22A	4	7	NS	NS	12	NS	NS	NS	1	24
22B	4	36	8	3	13	15	NS	NS	1	80
22C	NS	18	NS	NS	NS	NS	NS	NS	0	18
22D	28	59	27	11	6	4	NS	NS	3	138
22E	5	2	4	1	3	0	4	10	1	30
22Z	0	0	0	0	0	0	0	0	0	0

1990/91

Sub Unit	Month: Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Unk	Totals
22A	8	11	NS	NS	9	NS	NS	NS	0	28
22B	8	25	24	8	12	16	NS	NS	3	96
22C	NS	37	NS	NS	NS	NS	NS	NS	0	37
22D	22	81	27	2	12	5	NS	NS	1	150
22E	5	7	5	1	2	1	4	12	0	37
22Z	0	2	0	0	0	0	0	0	0	2

NS - No Season

Table 5. Transport method data by subunit, 1989-90 and 1990-91.

1989/90

Subunit	Aircraft	Horse	Boat	ATV	Snow machine	Off-road vehicle	Highway vehicle	Unknown	Totals
22A	1	0	54	6	15	1	2	8	87
22B	19	1	30	26	41	14	16	10	157
22C	1	0	9	4	0	3	23	7	47
22D	8	0	76	39	15	23	127	24	312
22E	6	0	15	1	14	2	0	3	41
22Z	3	1	3	3	1	3	52	6	72
Total	38	2	187	79	86	46	220	58	716

1990/91

Subunit	Aircraft	Horse	Boat	ATV	Snow machine	Off-road vehicle	Highway vehicle	Unknown	Totals
22A	1	0	58	3	9	0	1	5	77
22B	20	1	29	14	41	12	27	8	152
22C	2	0	13	12	0	3	29	4	63
22D	7	0	58	57	23	17	112	16	290
22E	5	0	12	1	20	1	0	3	42
22Z	4	1	8	5	0	5	47	12	82
Total	39	2	178	92	93	38	216	48	706

LOCATION

Game Management Unit: 23 (43,000 mi^2)

Geographical Description: Western Brooks Range and Kotzebue Sound

BACKGROUND

Although an extinct species of moose (*Alces latifrons*) inhabited northwest Alaska during the Pleistocene, the Alaska-Yukon moose (*Alces alces gigas*) began colonizing this region 35 to 45 years ago. Moose now rank second only to caribou as a source of red meat for most Unit 23 residents. Moose are avidly hunted by non-local resident and nonresident hunters. Moose hunting activity is a significant source of income to the unit's guide-outfitters and transporters.

MANAGEMENT DIRECTION

Management objectives for Unit 23 moose are to:

1. Develop a finalized management plan for moose in Unit 23 by December 1995.
   - A. Develop a draft a management plan listing management options for moose in Unit 23 by June 1993.
     - i. The draft plan will be a conceptual vehicle for determining what land owners and the public desire as moose management objectives in Unit 23.
     - ii. Potential effects on moose populations as well as on subsistence users, recreational hunters, commercial interests, and nonconsumptive users will be listed for each management option considered.
   - B. Solicit input from the public and Unit 23 land owners on the draft management plan by December 1993.
   - C. Finalize a management plan by December 1994 for submission to the Board of Game for approval during 1995. At a minimum, the final management plan will include:
     - i. Management goals and objectives;
     - ii. Specific management criteria (e.g. bull:cow ratios, maximum or minimum densities, predator:prey ratios); and
     - iii. Data necessary to evaluate management criteria, and how it will be collected.
2. Initiate a 2-3 year cooperative radiotelemetry project with the National Park Service (NPS) in the middle Noatak River drainage to:
   - A. Improve techniques for monitoring moose population size and sex/age composition; and
   - B. Evaluate the effects of human harvest on bull:cow ratios, and the age structure of bulls in the population.

3. By 1995, determine the feasibility of establishing 3 or 4 800-1,200 mi^2 census areas (one each in the Noatak, Kobuk, and Selawik river drainages, and on the Northern Seward Peninsula), and employing the Gasaway et al. (1986) technique for estimating fall population size and composition.
4. Until finalized management objectives are developed, attempt to maintain a minimum November bull:cow ratio of 40:100 in each major drainage in the unit.

METHODS

We conducted fall and spring aerial surveys of various trend count areas to determine population trend and sex/age composition. Trend count areas were established in 1986. However, data collected before 1986 were included in analyses when surveys were conducted during the same time of year near established trend count areas. All trend count areas include each major moose habitat type (e.g. riparian willow, tundra, spruce forest, etc.). Since 1988, all trend counts were flown in Piper PA-18 aircraft with 1 observer. The USFWS assisted with the Tagagawik trend count area, and the NPS assisted in surveys of the Middle Noatak and Nimiuktuk trend count areas.

We conduct fall trend surveys during late October through November to determine trends in population size the calve and bull ratios. Bulls are categorized as yearlings or, if older, by antler width. In 1990 and 1991, we surveyed only the Wulik, Nimiuktuk, and Middle Noatak trend count areas. Snowcover was inadequate during November to survey the Tagagawik, Buckland, and Inmachuk trend count areas in both years.

We conducted spring trend surveys during late March and April to evaluate population trend, recruitment of calves into the population, and overwinter mortality. During spring 1990 we surveyed the lower Kobuk, upper Kobuk, and lower Noatak trend count areas. During 1991 we completed spring trend surveys in these areas and established new trend count areas on the lower Nimiuktuk and lower Tagagawik rivers.

Since 1989 it has become evident that most, if not all, existing fall and spring trend count areas are too small to measure moose density accurately. Therefore, estimates of moose abundance should be viewed with caution. We believe, however, that data from these trend counts are probably adequate for assessing population composition. Harvest data were derived from harvest reports submitted by hunters.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size: No estimate of moose population size has been made for Unit 23. Anecdotal information indicates that the Unit 23 moose population increased steadily in size until 1990. Winter 1990-91 was exceptionally severe, and was the second severe winter within the last three years. Groundfast ice which formed during October was quickly covered by snow, and persisted throughout the winter. In northern portions of the unit, severe winter storms bringing deep snow and high winds began in mid-October. Chronically high winds made the snowcover extremely hard in exposed areas. Snow depth near Kotzebue reached a record 82 inches.

Few caribou overwintered in Unit 23 during 1990-91. As a result, subsistence hunters harvested more moose than usual. Wolf and brown bear numbers were high in Unit 23 compared to previous years. High densities of large predators, low numbers overwintering caribou in the unit, and severe winter caused high overwinter mortality of moose.

Quantitative estimates of moose abundance in Unit 23 show no clear trend (Tables 1-3). This may be because: 1) no clear 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., snow conditions) have masked actual changes in population size. After observing moose distribution during extremely heavy and light snow years, snow-induced movements probably largely explain the variability in the Unit 23 moose trend count data. Because of these extensive movements, existing trend count areas appear too small to reliably detect demographic changes.

One exception to this may be the middle Noatak River fall trend count area which is one of the largest trend count areas in the unit, and has the longest history of surveys (Tables 2 and 3). The decline in density from 1.8 moose/mi^2 during 1990 to 0.6 moose/mi^2 during 1991 probably reflects the actual magnitude of the moose population decline during winter 1990-91. Although this area was actually surveyed only once, it was searched by fixed-wing aircraft four additional times. A large area surrounding the trend count area was searched several times as well. None of these additional flights revealed significant numbers of moose to contradict results of the trend count surveys.

In contrast, during the April 1991 survey, moose density in the lower Noatak River trend count area exceeded earlier density estimates despite heavy overwinter mortality (Table 1). Virtually all moose in the area aggregated in large riparian willow thickets that comprise much of this trend count area. The fact that over four times the normal number of moose carcasses were observed during 1991 spring counts is more revealing than the density estimate itself. Virtually all moose observed during spring 1991 trend counts were listless and in very poor condition.

Spatial differences in moose density within Unit 23 are not clear from either spring or fall trend counts (Tables 1 and 3). Differences in density among trend count areas are probably attributable to variable snow conditions affecting the distribution of moose, and do not indicate actual differences in abundance.

Population Composition: Fall calf:cow ratios during 1989 and 1990, trend count surveys, were similar to ratios observed in previous years (Table 3). One exception was that relatively few calves were observed in the middle Noatak River trend count area during November 1989. During June 1989, extensive flooding occurred during breakup on the Noatak, Kobuk, and Selawik rivers, and peak flood levels persisted for 7-10 days. Long-time local residents reported that water levels in the Noatak River were higher than they had been in 30-50 years. These conditions inundated important calving habitat, and probably caused substantial neonate mortality. Fall calf:cow ratios in most other trend count areas were near the low range of observed ratios during 1989. This suggests that flooding affected neonate mortality throughout the unit, although mortality appears highest in the middle Noatak River drainage.

Extensive flooding of the major Unit 23 drainages occurred during June 1990. In fact, flood levels were even higher in 1990 than in 1989. Unlike 1989, however, calf:cow ratios were not depressed during fall 1990 trend counts. During 1990, peak flooding was limited to 3 or 4 days in early June, and neonate mortality was probably minimal.

Opportunistic observations in the middle Noatak River drainage during the 1987-89 calving periods suggest that at most 10% of maternal females produced twins (Ballard, pers. comm.). We have not observed any evidence of higher twinning rates since then.

Bull:cow ratios were generally lower in the middle Noatak and Wulik river drainages than in other trend count areas during the report period (Table 3). The middle Noatak River bull:cow ratio continued to decline steadily through 1990. During 1988 and 1989, we received several unsolicited reports from local hunters and guide-outfitters that substantially fewer large bulls were observed in the Kelly River/Wrench Creek area. Since that time, a long-time transporter in the unit has also expressed similar observations.

As previously noted, winter 1990-91 was exceptionally severe on moose in Unit 23. The increase from 31 to 36 bulls:100 cows in the middle Noatak River trend count area between 1990 and 1991 probably reflects disproportionately high natural mortality among cows rather than an actual increase in the number of bulls in the population. Many old bulls are removed from the population each year by trophy hunters. The few cows harvested are not selected by age; therefore, there are probably disproportionately more old cows in the population than old bulls. Because old moose are more susceptible to overwinter mortality than younger, prime adults, overwinter mortality rates among cows were probably higher than among bulls.

No clear spatial or temporal trends in density or calf:adult ratios were evident for the 1990 or 1991 trend count surveys (Table 1). The low calf:adult ratio observed during spring 1990 in the lower Noatak River trend count is consistent with the low calf:cow ratio observed in the middle Noatak River trend count area during November 1989, and suggests that the 1989 calf cohort was very low in this drainage.

Distribution and Movements: No quantitative home range or movement data have been collected for moose in Unit 23. However, incidental observations indicate that during late summer and early fall, most moose inhabit the upper stretches of small riparian willow thickets. During the rut (September and October), bulls travel extensively until they locate one or more cows to tend. Many moose remain in subalpine spruce and willow habitats until December when deep snow forces them into riparian areas at lower elevations. Most maternal cows remain in wet lowland areas at least through the June calving period. Bulls and nonmaternal cows return to subalpine areas as early as late April; cows with calves return by the time of rut. Quantitative home range and seasonal movement data are needed to improve population monitoring techniques currently employed in Unit 23.

Mortality

Seasons and Bag Limits:

1989-90		
Unit 23, that portion of the Seward Peninsula west of and including the Buckland River drainage, and the Noatak River drainage	Aug. 1-Mar. 31	One moose; antlerless moose may be taken from Sept. 1-Mar. 31; cows with calves may not be taken
Remainder of Unit 23	Aug. 1-Dec. 31	One moose; antlerless moose may be taken from Sept. 15-Oct. 31; cows with calves may not be taken
1990-91		
Unit 23, that portion north and west of and including the Noatak River drainage		
Subsistence/Resident	Aug. 1-Mar. 31	One moose; however, antlerless moose may be taken from Sept. 1-Mar. 31; no person may take a cow accompanied by a calf
Nonresident	Sep. 1-Mar. 31	One moose; however, antlered moose with spike-fork or 50-

		inch antlers may be taken only from Sept. 1-Sept. 20; no person may take a cow accompanied by a calf
Remainder of Unit 23		
Subsistence/Resident	Aug. 1-Mar. 31	One moose; however, antlerless moose may be taken from Sept. 1-Mar. 31; no person may take a cow accompanied by a calf
Nonresident	Sep. 1-Mar. 31	One moose; however, antlerless moose may be taken from Sept. 1-Mar. 31; no person may take a cow accompanied by a calf

Harvest:

Human-Induced Mortality. The 1989-90 harvest of 213 moose is the second highest on record (Table 4). Bulls comprised 95% of the of moose reported taken (200 of 211, 2 moose of unspecified sex taken). Most of the reported harvest (48%) came from the Noatak River drainage (Table 5).

Personal interviews with hunters indicate a substantial number of moose harvested by unit residents are not reported. Some residents estimated that as little as 10% of the actual harvest is reported. Quimby and James (1985) estimated that residents of Unit 23 reported only 14-24% of their actual harvest. If their estimate of unreported harvest is accurate, the actual harvest attributable to only Unit 23 residents could range from 225 to 386 moose during 1989-90. Harvest data for nonlocal hunters appears more accurate.

The 1990-91 harvest of 200 moose is approximately the same as reported during the previous 3 years (Table 4). If only 14-24% of the local harvest is reported, the actual harvest by Unit 23 residents could be 167-286 moose in 1990-91. Bulls comprised 93% of moose reported taken (185 of 199, 1 moose of unspecified sex taken). Most of the reported harvest (46%) came from the Noatak River drainage (Table 5). No change over time in mean antler width among harvested bulls has been evident (Tables 6 and 7).

The demand for transporter services by nonlocal hunters greatly exceeds the capabilities of operations established in Unit 23. If transporters or guide-outfitters become more active in Unit 23, the number of hunters could increase dramatically, and possibly exceed sustainable levels. The total number of hunters who reported hunting moose in Unit 23 was higher during 1989-90 and 1990-91 than in any previous year on record (Table 8).

Hunter Residency and Success. In 1989-90, 213 of 365 hunters (58%) reported harvesting moose. In 1990-91, 200 of 336 hunters (60%) reported harvesting moose (Table 9). Since 1979-80, the number of nonlocal moose hunters has increased substantially in Unit 23 (Table 8). Most nonlocal hunters seek trophy bulls. Because of its good access, proximity to Kotzebue, and ease of hunting, the middle Noatak River drainage has received much of this additional hunting pressure (Table 5). Therefore, the decline in the middle Noatak River bull:cow ratio is probably partially attributable to this increase in trophy hunting.

The low number of Unit 23 residents who reported hunting relative to the number of nonresidents and nonlocal residents (Table 9) may be a function of poor compliance with licensing and reporting requirements by unit residents. Many local leaders and subsistence users have remarked that unit residents prefer caribou to moose, and as the Western Arctic caribou herd has grown in size, local hunters rely less on moose. This may explain the long-term decline in number of local resident moose hunters (Tables 8 and 9). The decline in local resident moose hunting activity has not offset the increase in nonlocal hunting activity, and the net effect has been a substantial increase in hunting pressure.

Harvest Chronology. Despite an 8-month long hunting season, most reported harvest occurred in September (Tables 10 and 11). Seventy-seven and 80% of the 1989-90 and 1990-91 harvest, respectively, occurred during September. Local hunters rarely harvest mature bulls after the rut begins during mid-September. However, females are taken by local hunters throughout the season.

Transport Methods. Hunters using aircraft harvested 69% (146 moose) of the reported harvest during 1989-90; in 1990-91, 138 (69%) of all reported moose were taken using aircraft (Table 12). Harvest attributed to aircraft users was higher than the 52% reported in 1987-88. Snowmachines and boats were the next most commonly used transport means.

Natural Mortality. Natural mortality of moose has not been quantitatively monitored in Unit 23. Reports from ADF&G staff and the public indicate that the 1990-91 winter was exceptionally severe on all Unit 23 ungulates. Coming only two years after the severe winter of 1988-89, effects on moose populations in the Noatak and Kobuk river drainages, and on the northern Seward Peninsula were drastic. Although no estimates were made to quantify this overwinter mortality, at least 2-4 times as many carcasses were observed during spring composition surveys as were seen during the preceding 5 years.

Board of Game Actions and Emergency Orders. In fall 1988, the Alaska Supreme Court ruled that exclusive use guide areas were unconstitutional. Currently, any guide registered to operate in Unit 23 before 1988 can do so even if he or she did not hold an exclusive guiding area in the unit at that time. Although this opened the door for over 100 guides to begin operating in Unit 23, little increase in guiding activity has occurred because of this ruling. During the last 3 years, 5-7 guides have operated in Unit 23. The NPS and FWS are currently developing their own procedures to allocate areas to guides. Until these agencies finalize their policies, the number of guides on federal lands will remain at or below the number active during 1988.

Emergency Order 5-02-91, issued 23 July 1991, closed the antlerless moose hunting season for nonresidents throughout Unit 23. It also restricted the nonresident hunting season for antlered moose from 1 September - 31 March to 1-20 September, and imposed a spike-fork or 50-inch antler size restriction on nonresident hunters throughout the unit. This action was taken in response to the heavy overwinter mortality of winter 1990-91, the high number of predators in the unit, and increasing hunting pressure on moose. The Board of Game re-authorized the antlerless moose season in Unit 23 during both 1989-90 and 1990-91. In 1990-91, the board extended the resident/subsistence antlerless hunting season to 1 September-31 March throughout the unit.

Habitat Assessment

Moose habitat has not been critically examined in Unit 23. Opportunistic observations indicate that "clubbing" and obvious browse lines occur in some riparian willow areas; however, this is not ubiquitous throughout the unit. Many areas show little or no evidence of heavy use by moose. Highly variable snow conditions within and between years strongly affect availability of riparian willow habitat. This undoubtedly excludes moose from some areas and prevents chronic overbrowsing.

CONCLUSIONS AND RECOMMENDATIONS

It is imperative that the ADF&G develop a moose management plan for Unit 23 within the next several years. This should be a high priority when allocating staff time and funds for moose management activities.

The trend count survey technique currently being used in Unit 23 to monitor moose population size and composition needs improvement. A moose telemetry project to examine seasonal and annual movements should be initiated in the middle Noatak River drainage to determine how large trend count areas need to be to assess population status adequately. We need to evaluate the feasibility of establishing large trend count areas in the Noatak, Kobuk, and Selawik river drainages, and on the northern Seward Peninsula. Techniques developed by Gasaway et al. (1986) should be adopted for estimating moose population size and sex and age composition in count areas.

Hunting pressure in the middle Noatak River drainage remained high. Bull:cow ratios need to be closely monitored in this area to avoid skewing the population against bulls, particularly large bulls. A ratio of at least 40 bulls:100 cows should be maintained until a moose management plan is adopted. This will prevent certain management options, such as managing for high quality trophy hunts, from being precluded. Local compliance with harvest reporting requirements remains poor. ADF&G personnel should continue to inform the public of the need for accurate harvest information. We should evaluate alternative methods to collect harvest information.

In summary, I recommend that ADF&G:

1. Draft a moose management plan for Unit 23 by December 1993;
2. Initiate a telemetry project in the middle Noatak River drainage to examine moose movements, distribution, productivity, and mortality;
3. Continue to monitor moose abundance and population composition in the middle Noatak River drainage, especially during September and October when hunting pressure is most intense;
4. Explore the feasibility of adopting techniques developed by Gasaway et al. (1985) technique to monitor moose population size and sex/age composition in 3 or 4 large census areas. Census areas would be located in the middle Noatak, middle Kobuk, and Selawik river drainages, 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 fall bull:cow ratio of 40 bulls:100 cows in each major drainage until a management plan can be implemented.

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Table 1. Moose sex and age composition from aerial spring trend surveys, Unit 23, 1982-91.

Location Date	Calves	Adults	Total	Calves: 100 Adults	Area Surveyed (mi^2)	Density ($\#/mi^2$)
<u>Upper Kobuk</u>						
04/03/89	18	42	60	43	22	2.7
03/21/90	13	39	52	33	22	2.4
04/05/91	17	49	66	35	22	3.0
<u>Lower Kobuk</u>						
03/01/82	8	27	35	30	101	0.4
04/23/86	19	65	84	29	101	0.8
03/03-04/87	48	138	186	35	101	1.8
03/18/88	48	146	194	33	101	1.9
04/05/89	62	159	221	39	101	2.5
04/01/90	26	119	145	22	101	1.7
04/16/91	30	113	143	27	101	1.6
<u>Lower Noatak</u>						
04/07-08/86	80	314	394	25	249	1.6
02/12-14/87	65	261	326	25	249	1.3
03/23-24/88	70	355	425	20	249	1.7
04/27-28/89	73	286	359	26	249	1.4
03/23/90	31	327	358	9	249	1.4
04/17/91	91	434	525	21	249	2.1
<u>Lower Tagagawik</u>						
04/22/86	31	212	243	15	101	1.4
04/04/91	46	153	199	30	115	1.7
<u>Lower Nimiuktuk</u>						
04/03/91	16	88	104	18	143	0.7

Table 2. Fall moose sex and age composition from aerial trend counts, Unit 23, 1984-91.

Location and Date	Males				Females				Total calves	Total adults	Total moose
	Sp-Fk[a]	<50 in	>50 in	Total	w/0 calf	w/1 calf	w/2 calf	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	43	29	108	134	42	6	182	54	290	344
11/07/89	39	57	35	131	152	60	5	217	70	348	418
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
11/06-07/91	3	18	18	39	74	30	3	107	36	146	182
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
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

Table 2. (Continued)

Location and Date	Males				Females				Total calves	Total adults	Total moose
	Sp-Fk[a]	<50 in	>50 in	Total	w/0 calf	w/1 calf	w/2 calf	Total			
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
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
Upper Kobuk[b]											
10/17-20/84	14	14	18	46	50	21	3	74	27	120	147

[a] Spike or fork antlers
[b] Not an established trend count area

Table 3. Sex and age ratios for fall moose trend count data, Unit 23, 1984-91.

Location and Date	Bulls:100 Cows				Calves: 100 Cows	% of All Cows with Calves	Size of Area Surveyed (mi^2)	Density (moose/mi^2)
	Sp-Fk[2]	<50 in	>50 in	Total bulls				
Tagagawik								
11/22/86	9	22	15	46	37	30.8	190	1.4
11/09-10/87	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
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
11/06-07/91	3	17	17	36	34	30.8	278	0.6
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
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

Table 3. (Continued)

Location and Date	Bulls:100 Cows Sp-Fk[2]	<50 in	>50 in	Total bulls	Calves: 100 Cows	% of All Cows with Calves	Size of Area Surveyed (mi^2)	Density ($moose/mi^2$)
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
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
Upper Kobuk[b]								
10/17-20/84	19	19	24	62	36	32.4	25	0.2

[a] Spike or fork antlers
[b] Not an established trend count area

Table 4. Annual reported moose harvest from Unit 23, 1979-80 through 1990-91.

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

Table 5. Moose harvest by sex and drainage in Unit 23, 1989-90 and 1990-91.

	1989-90				1990-91			
Drainage	Males	Females	Unspec.	Total	Males	Females	Unspec.	Total
Noatak River	97	6	1	104	88	3	1	92
Kobuk River	55	2	0	57	52	5	0	57
Selawik River	27	2	1	30	23	3	0	26
Northern Seward Peninsula	9	1	0	10	15	2	0	17
Kivalina/Wulik Rivers	9	0	0	9	7	1	0	8
Unspecified	3	0	0	3	2	0	0	2
Total	200	11	2	213	185	14	1	200

Table 6. Mean antler widths, standard deviations (SD), and sample sizes (n) for harvested moose by drainage and year, Unit 23, 1984-85 through 1990-91.

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	107b
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	130b
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	173b
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	193b
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	187b
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

[a] All drainages combined.
[b] Includes antler widths for additional moose taken in Unit 23 where drainage was not reported.
[c] Nonresident hunters could only take bulls with spike/fork antlers, or antlers 50 inches or wider.

Table 7. Number (percentage, excluding unknowns) of bull moose harvested in various antler width (inches) categories, Unit 23, 1985-86 through 1990-91 hunting seasons.

Season	<20"	20-<30"	30-<40"	40-<50"	50-<60"	>60"	Unk[a]	Total
1985-86	3 (3)	12 (11)	15 (14)	15 (14)	37 (34)	26 (24)	4	112
1986-87	1 (1)	8 (6)	28 (21)	29 (22)	49 (38)	15 (11)	9	139
1987-88	2 (1)	9 (5)	17 (10)	26 (15)	66 (38)	51 (30)	20	191
1988-89	1 (1)	4 (2)	24 (11)	35 (16)	82 (38)	41 (19)	23	210
1989-90	7 (4)	8 (4)	21 (11)	32 (17)	90 (47)	34 (18)	21	213
1990-91[b]	1 (1)	7 (4)	15 (8)	32 (17)	71 (40)	53 (30)	21	200
Total	15 (2)	48 (5)	120 (12)	169 (17)	395 (41)	220 (23)	98	1065

[a] Antler width not reported

[b] Nonresident hunters could only take bulls with spike/fork antlers, or antlers 50 inches or wider

Table 8. Unit 23 moose harvest data summary.

	No. of Hunters			Hunter Residency		
Year	Successful	Unsuccessful	Total	Unit 23 resident	Alaska resident[a]	Nonresident
1979-80	139	100	239			47
1980-81	110	101	211			24
1981-82	176	153	329	161	80	47[b]
1982-83	128	139	267	141	81	45
1983-84	141	165	306	152	115	39
1984-85	180	165	345	137	127	81
1985-86	124	99	223	72	98	53
1986-87	150	124	274	106	99	69
1987-88	210	137	347	101	104	142
1988-89	222	98	320	59	114	147
1989-90	213	152	365	81	117	167
1990-91	200	136	336	69	117	150

[a] Does not include residents of Unit 23.

[b] 41 hunters of unknown residence not included in residency breakdown.

Table 9. Hunter residency and success rates during the 1989-90 and 1990-91 moose seasons, Unit 23.

Residency	Successful	Unsuccessful	Total
1989-90			
Nonresident	99	42	141
Alaska resident (outside Unit 23)	40	61	101
Alaska resident (within Unit 23)	54	43	97
Unknown	20	6	26
Total	213	152	365
1990-91			
Nonresident	86	47	133
Alaska resident (outside Unit 23)	63	54	117
Alaska resident (within Unit 23)	40	30	70
Unknown	11	5	16
Total	200	136	336

[a] % hunter success

Table 10. Chronology of 1989-90 moose harvest in Unit 23.

Week ending		Males	Females	Unspecified	Total
August	4	2	0	0	2
	11	2	0	0	2
	18	6	0	0	6
	25	6	0	0	6
September	1	19	1	0	20
	8	35	0	0	35
	15	39	0	0	39
	22	46	2	0	48
	29	20	1	0	21
October	6	8	1	0	9
	13	0	0	0	0
	20	1	0	0	1
	27	0	0	0	0
November	3	1	1	0	2
	10	0	0	0	0
	17	0	0	0	0
	24	1	0	0	1
December	1	2	1	0	3
	8	0	1	0	1
	15	1	0	0	1
	22	1	0	0	1
	29	0	0	0	0
January	5	0	0	0	0
	12	0	1	0	1
February	16	1	0	0	1
	23	1	0	0	1
March	2	0	0	1	1
	9	1	0	0	1
	16	0	0	0	0
	23	0	0	0	0
	30	0	1	0	1
Unknown		7	1	1	9
Total		200	11	2	213

Table 11. Chronology of 1990-91 moose harvest in Unit 23.

Week ending		Males	Females	Unspecified	Total
August	4	2	0	0	2
	11	7	0	0	7
	18	0	0	0	0
	25	3	0	0	3
September	1	6	0	0	6
	8	32	5	0	37
	15	55	2	0	57
	22	40	1	0	41
	29	20	0	0	20
October	6	3	0	0	3
	13	1	0	0	1
	20	0	0	0	0
	27	2	0	0	2
November	3	0	0	0	0
	10	1	1	0	2
	17	0	0	0	0
	24	3	0	0	3
December	1	0	0	0	0
	8	1	0	1	2
	15	0	0	0	0
	22	0	0	0	0
	29	0	0	0	0
January	5	0	1	0	1
	12	0	1	0	1
	19	1	0	0	1
February	2	0	1	0	1
	16	1	0	0	1
	23	0	0	0	0
March	2	1	0	0	1
	9	0	0	0	0
	16	0	0	0	0
	23	1	0	0	1
	30	0	0	0	0
Unknown		5	1	0	6
Total		185	14	1	200

Table 12. Transportation means used by moose hunters in Unit 23, 1989-90.

Vehicle	Successful	Unsuccessful	Total
1989-90			
Aircraft	146	83	229
Horse	0	1	1
Boat	38	51	89
3-Wheeler	6	1	7
Snowmachine	14	2	16
Off-road vehicle	0	0	0
Highway vehicle	1	1	2
Unknown	8	13	21
Total	213	152	365
1990-91			
Aircraft	138	86	224
Horse	0	0	0
Boat	32	29	61
3-Wheeler	10	0	0
Snowmachine	15	4	19
Off-road vehicle	0	1	1
Highway vehicle	0	1	1
Unknown	5	15	20
Total	200	136	336

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 moose 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. Habitat is excellent along the Koyukuk River lowlands, and provides expansive areas of winter browse. Lightning-caused fire occurs frequently and burns large upland areas which then produce good moose browse. Browse availability is not limiting the size of the moose population.

Historical reported harvests during the past 25 years ranged from 44 to 134, but did not exceed 100 moose until 1980. The unreported harvests during this period probably ranged from 60 to 150 moose per year. Since 1980, reported harvests 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

Moose management goals for Unit 24 are to: 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; and 5) provide for scientific and educational use of moose.

Management Objectives

Moose management objectives for Unit 24 are to: 1) manage a moose population at the current level of 5,000-7,000 south of Hughes, including the Koyukuk Controlled Use Area (CUA); 2) increase the moose population to 5,000-6,000 from Hughes to Bettles, including the Kanuti CUA and the South Fork drainage; 3) increase the moose population north of Bettles, excluding the Gates of the Arctic National Park, to 3,000-3,500; and 4) maintain the population in the Gates of the Arctic National Park at 1,300-1,500.

METHODS

We conducted three standard ADF&G population estimation surveys (Gasaway et al. 1986) in Subunit 24 in cooperation with the USFWS, National Park Service (NPS), and Bureau of Land Management (BLM). We monitored hunting mortality and distribution through harvest tickets and check stations. We encouraged local residents to increase their harvest reporting through school visits and check stations. We monitored predation by interviewing trappers and conducting track surveys.

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 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 is declining. This trend is believed because of predation and some localized overhunting within the Kanuti CUA. 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. However, moose numbers may be slowly declining within the park.

Population Size: We conducted three population estimation surveys (Tables 1-3) during the report period in cooperation with personnel from the USFWS, NPS, and BLM. These surveys, when combined with one completed in November 1988, include 40% of the unit. They produced a combined population estimate of 8,339 moose (CI = ± 20-25%) and an average density of 0.43 moose/mi^2. By extrapolation, the unit population probably numbers between 12,000 and 17,000 moose. I estimate about 5,000-7,000 moose in the southern part of Unit 24, based on results of the population estimation surveys and extrapolations of density estimates obtained during trend count surveys.

I estimate 3,000-4,000 moose reside in the middle portion of Unit 24. I base this estimate on population estimation surveys of the Kanuti National Wildlife Refuge (NWR) and the Dalton Highway Corridor. These surveys indicated a rather low overall early winter density of 0.4 moose/mi^2. I estimate 3,000-4,150 moose in the northern portion of Unit 24, including 1,500-2,000 moose within the Gates of the Arctic National Park. This estimate is based on the distribution of moose seen during a 1987 stratification survey and density estimates arbitrarily assigned each stratum.

Population Composition: Composition data obtained from trend count areas and population estimation surveys in central and northern parts of the unit (Table 4) indicate poor recruitment in 1991. The low yearling bull:cow ratio indicates that few calves survived. The bull:cow ratio remained acceptable, but may be misleading because substantial numbers of cow moose are taken illegally in parts of the unit. Historically, I have interpreted the population indices in Unit 24 similarly to those in Subunit 21D.

Distribution and Movements: There are little data on movements of moose within the unit. Moose radio-collared in northern Subunit 21D migrated in summer to southwestern parts of Unit 24. Moose are found at treeline in the northern part during early winter and appear to move into the river bottoms during late winter and summer.

Mortality

Harvest:

Season and Bag Limit. The hunting season and bag limit for the portion of the unit that includes the Gates of the Arctic National Park and lands adjacent to the park were different than those provided for the rest of the unit. The former area was described as the Alatna River drainage upstream from and including the 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. Within this area, only hunters who qualified under federal regulations were allowed to hunt in the park, but all hunters could hunt outside the park boundaries. The bag limit was one moose whether or not the hunter was inside or outside the park. Alaskan residents could hunt antlered moose from 25 August through 25 September and from 1 through 10 March, and could hunt antlerless moose from 21 through 25 September and from 1 through 10 March. Nonresidents are restricted to harvesting bull moose with antlers ≥ 50 inches from 5 through 25 September. In the remainder of Unit 24, the season for all hunters was 25 August through 25 September, regardless of residency or subsistence status. The bag limit for resident hunters was one bull moose and for nonresidents one bull with 50-inch antlers.

Board of Game Actions and Emergency Orders. In 1991, the board required nonresidents to harvest bulls with ≥ 50-inch antler spread. No other board actions were taken and no emergency orders were issued.

Hunter Harvest. The hunting seasons in the unit are diverse and reflect the various moose densities and consumptive use patterns. The annual reported harvest since 1980 has ranged from 106 to 144 moose (Table 5). Generally 96% of the reported moose were taken during September.

Illegal and unreported harvests by local residents continue to hamper ADF&G efforts to manage moose. The actual harvest is estimated to be about twice the reported harvest (Table 5). Moose taken during winter are rarely reported even when the season is open. Hughes does not have a license vendor which contributes to the problem of hunters hunting without licenses or harvest tickets. I am working to increase public awareness of the importance of accurate reporting and am attempting to obtain additional license vendors. Fortunately, most 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 172 moose according to Marcotte (1986), Marcotte and Haynes (1985), and my personal estimates. We estimate that the residents of Huslia, Hughes, Allakaket/Alatna, Bettles, and Wiseman take 84, 33, 35, 10, and 5 moose, respectively. An additional five moose are probably taken by unit residents who do not live in one 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 have increased (Table 5), except for 1985 when off-road vehicle restrictions were enforced.

Harvest data for 1991 were not available for this report. However, over the previous four years the reported harvest averaged 136 annually, with unit residents accounting for 42 of those. Nonresident hunters averaged a harvest of 18 moose per year. An average of 259 hunters reported during the preceding four 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. During 1987-90, boats, aircraft, and highway vehicles (primarily Dalton Highway access) were used by 49%, 21%, and 15% of the reporting hunters, respectively. Snowmachines were the main transportation method used during the winter hunt.

Other Mortality: At least 400-440 wolves in 55-60 packs and a large population of black bears occur in the middle and southern portions of the unit. Grizzly bears are common throughout the montane areas. Predation on moose is thought to be high except around the villages of Huslia and Bettles where predators are kept at lower numbers. Predation is keeping the moose population low throughout much of the unit.

CONCLUSIONS AND RECOMMENDATIONS

The previous population objective in the southern portion of the unit was intended to reflect the current population size. Recent surveys indicated that the population probably numbers 5,000-7,000 instead of 3,000-5,000. The status of the population relative to its habitat and human use demands has not changed. Our ability to estimate population size accurately has changed. The population objective was 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. We may do a population estimation survey in cooperation with NPS during October 1992. The Dalton Highway corridor moose population estimation survey indicates that the bull harvest is 3-5% of the estimated population. The bull:cow ratio of 50:100 is high enough to indicate that the present harvest probably does not affect the population, but the area will need monitoring.

Habitat is excellent throughout much of the unit, with abundant successional willow regrowth because of fire or riverine erosion. Browse availability is not currently limiting the moose population. With the exception of limited areas around 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. Unit residents are not following reporting and licensing procedures. 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 Dalton Highway corridor in Unit 24, 25-30 October 1991.

Statistic	Strata Low	Strata Medium	Strata High	All strata combined
Sample units (N)	157	120	7	284
No. surveyed (n)	9	29	7	45
Total area (mi^2)	1,864	1420	88	3,373
Stratum as % of total	55.3	42.1	2.6	100.0
Area surveyed (mi^2)	109.8	342.1	88	539.9
% of stratum surveyed	5.9	24.1	100	16.0
No. moose seen	8	222	134	364
Observed density (moose/mi^2)	0.07	0.65	1.52	0.42
Uncorrected[a] estimate (T_o)	135	921	134	
Variance $V(T_o)$	6,489	11,585	0	
Deg of freedom $df(T_o)$	8	28	6	
Observed sightability correction factor (SCF_o)	1.0	1.20	1.25	
Variance $V(SCF_o)$	0.0000	0.01114	0.06261	
Degrees of freedom $df(SCF_o)$	9999	25	6	
Corrected estimate (T_e)				1,416
Variance $V(T_e)$				33,842
Degrees of freedom[b] $df(T_e)$				35
90% CI around T_e				21.9%

[a] Not corrected for sightability.

Table 2. Summary of moose population estimation survey data from Bear Mountain in Unit 24, 31 October-3 November 1989.

Statistic	Strata: Low	Medium	High	All strata combined
Sample units (N)	103	85	32	220
No. surveyed (n)	5	14	13	32
Total area (mi^2)	1,288	1064	406	2,757
Stratum as % of total	46.7	38.6	14.7	100.0
Area surveyed (mi^2)	62.2	173.2	164.4	399.8
% of stratum surveyed	4.8	16.3	40.5	14.5
No. moose seen	5	179	707	891
Observed density (moose/mi^2)	0.08	1.03	4.30	1.04
Uncorrected[a] estimate (T_o)	103	1099	1745	
Variance $V(T_o)$	4,480	50,821	51,225	
Deg of freedom $df(T_o)$	4	13	12	
Observed sightability correction factor (SCF_o)	1.0	1.20	1.41	1.29
Variance $V(SCF_o)$	0.0000	0.01210	0.01222	
Degrees of freedom $df(SCF_o)$	9999	10	9	
Corrected estimate (T_e)				3,888
Variance $V(T_e)$				230,617
Degrees of freedom $df(T_e)$				18
90% CI[b] around T_e				21.4%

[a] Not corrected for sightability.

Table 3. Summary of moose population estimation survey data from Kanuti National Wildlife Refuge in Unit 24, 25-28 October 1989.

Statistic	Strata: Low	Medium	High	All strata combined
Sample units (N)	151	47	21	219
No. surveyed (n)	14	10	9	33
Total area (mi^2)	1,787	577	250	2,614
Stratum as % of total	68.3	22.1	9.6	100.0
Area surveyed (mi^2)	165.7	119.9	106.5	392.1
% of stratum surveyed	9.3	20.8	42.5	14.9
No. moose seen	41	64	179	284
Observed density (moose/mi^2)	0.25	0.53	1.68	0.43
Uncorrected[a] estimate (T_o)	442	308	420	
Variance $V(T_o)$	16,634	10,059	2,221	
Deg of freedom $df(T_o)$	13	9	8	
Observed sightability correction factor (SCF_o)	0.9	1.00	1.01	1.00
Variance $V(SCF_o)$	0.01699	0.00000	0.00060	
Degrees of freedom $df(SCF_o)$	13	9	8	
Corrected estimate (T_e)				1,137
Variance $V(T_e)$				29,117
Degrees of freedom $df(T_e)$				25
90% CI[b] around T_e				25.6%

[a] Not corrected for sightability.

Table 4. Summary of fall aerial moose survey[a] data from Unit 24, 1986-91.

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Total Calves	Percent Calves	Adults	Total moose observed
1986-87	70	9	29	32	15	187	219
1987-88	62	15	25	47	13	307	354
1988-89	82	19	37	145	77	724	869
1989-90	74	14	18	29	9	282	311
1990-91[b]	--	--	--	--	--	--	--
1991-92	54	9	20	42	12	322	364

[a] Count areas differ year to year.
[b] No surveys completed.

Table 5. Unit 24 moose harvest[a] and Dalton Highway hunter success, 1987-91.

	Harvest by Hunters									
Regulatory	Reported				Estimated				Dalton Highway	
year	M	F	Unk.	Total	Unreported	Illegal	Total	Total	Success	Unsuc.
1987-88	130	6	0	136	123		123	259	39	42
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[b]	87	1	0	88	120		120	208	55	33

[a] Excludes permit hunt harvest.
[b] Preliminary data.

Table 6. Unit 24 moose hunter[a] residency and success, 1987-91.

Regulatory year	Successful: Local[b] resident	Nonlocal resident	Nonres.	Unk	Total	Unsuccessful: Local[b] resident	Nonlocal resident	Nonres.	Unk	Total	Total hunters
1987-88	45	112	17	7	136	21	80	7	7	94	230
1988-89	41	98	16	23	137	13	76	18	25	119	256
1989-90	40	108	17	3	128	28	135	16	4	155	283
1990-91	43	114	22	8	144	17	98	16	9	123	267

[a] Excludes hunters in permit hunts.
[b] Preliminary data.

Table 7. Unit 24 moose harvest[a] by transport method, 1987-91.

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	n
1987-88	32	--	65	5	3	2	7	12	136
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

[a] Excludes permit hunt harvest.

LOCATION

Game Management Subunits: Subunits 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 during most of historic 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.

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. Combined with the relatively great demand for moose by local residents, this has resulted in the use of a permit system that limits hunting largely or to residents of Subunit 25D West.

Trend surveys and observations by local residents indicate that moose numbers increased during the 1980s in Subunits 25D West and in 25D East. However, trend counts during 1991 suggest that this increase has slowed or stopped. This means that 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 1991. As discussed below, moose population status has not changed dramatically in most areas, although there are some trends that cause concerns.

The result of moose telemetry studies conducted 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 that predation by black bears, brown bears, and wolves are the primary causes of summer mortality, with wolves and illegal hunting of both cow and bull moose being important sources of winter mortality. Predation and illegal hunting are major factors determining moose population welfare. Moose browse is abundant and used at a low rate. The area is characterized by low to moderate snowfall, and malnutrition because of deep snow conditions seems 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: The unitwide moose management objectives are to estimate subsistence needs and harvest levels by 1991 and reduce the harvest of cows by 5-10% annually beginning in 1990.

Subunit 25A: The moose management objectives for Subunit 25A are to: 1) ensure that the average antler size of harvested bulls does not drop below 50 inches; 2) maintain a posthunting sex ratio of at least 50 bulls:100 cows; and 3) determine population size, composition, and distribution.

Subunit 25B: The moose management objective for Subunit 25B is to determine population size, composition, and distribution by 1991.

Subunit 25D West: The moose management objectives for Subunit 25D West are to increase the population to 1,300 by 1990; prevent the annual harvest from exceeding 50 bulls; and determine the effect of recent and older burns on moose distribution, movements, production, and survival by 1992.

Subunit 25D East: The moose management objectives for Subunit 25D East are to: 1) determine population size, composition, and distribution by 1990; 2) maintain a stable population of approximately 2,300 moose; and 3) determine productivity, mortality, distribution, movement patterns, and habitat use by 1992.

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. 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 provided insight into hunter effort and attitudes.

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). 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 that 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).

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.

Relatively good survey conditions in Subunit 25D East allowed complete trend counts in 1989 and 1991. Poor conditions limited surveys in 1990. Although trends in indicators of population welfare are not uniform, it appears that 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. While the bull:cow ratio still exceeds 60, data suggest that the harvest has noticeably effected the proportion of bulls.

In Subunit 25D West, surveys in 1991 provide the only substantial new data on population composition. These surveys include trend counts in the Mt. Schwatka area at the northern edge of the White Mountains and the Meadow and Birch creek areas on the Yukon Flats. The data for high and low elevation habitats are presented separately and also combined (Table 4). Moose numbers in the Mt. Schwatka area were high compared with 1986, while in the trend areas on the flats the number of moose observed was generally lower than in previous years (Yukon Flats National Wildlife Refuge unpubl. data). The 1991 surveys were done in early November and may have occurred before migratory moose moved to lower elevation winter habitat. Fire and other changes in habitat have possibly altered distribution somewhat. An actual decline in numbers may have occurred, but the data are not clear on this point. Restratification and additional surveys would probably help determine whether moose numbers have declined.

Bull:cow ratios continue to be high in Subunit 25D West, but yearling recruitment appears to have declined even though calf survival is moderately high with 31 calves:100 cows in the 1991 sample. 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 in extent. A stratification effort in November 1991 found that 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 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	Sept. 5-Sept. 25	Sept. 5-Sept. 25
Subunit 25B; upstream from the Coleen River drainage	Sept. 20-Sept. 30	Sept. 20-Sept. 30

1 bull		
Subunit 25D West; all hunters, 1 bull by Tier II subsistence hunting permit only; up to 125 permits will be issued	Aug. 25-Sept. 25 Dec. 1-Dec. 10 Feb. 18-Feb. 28	No open season.
Subunit 25D East; remainder		
RESIDENT HUNTERS: 1 bull	Sept. 10-Sept. 20 Dec. 1-Dec. 10	
NONRESIDENT HUNTERS: 1 bull with 50-inch antlers		Sept. 10-Sept. 20

Board of Game Actions and Emergency Orders. In 1990, the Federal Subsistence Board was established and promulgated regulations for subsistence use on federal lands. These regulations took effect 1 July 1991. A federal subsistence moose permit system was established in 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 reported moose harvest has been relatively stable in most of Unit 25 during the past 5 years (Tables 5, 6, and 7), although the 1990 harvest was substantially higher than in the previous 2 years. The reported harvest for Subunits 25A, 25B, and 25D East totaled 156 moose in 1990, compared with 87 in 1989. The difference may be partly because of poor weather that reduced hunter effort and success in 1989, and also because of an increase in the number of hunters who are not Unit 25 residents traveling to the area to hunt. Access to various areas has been gradually developed by both commercial and private aircraft operators. Float trips have become more popular on several rivers, and the weather-related decline in moose in accessible areas in Southcentral Alaska has caused many hunters to travel to other parts of the state.

The reported harvest in connection with the Tier II permit hunt in Subunit 25D West in 1989 (7 moose) and 1990 (4 moose) is very small (Table 8). The reporting rate is poor for this hunt, with less than one-third of the permittees returning reports. The actual number of moose harvested in Subunit 25D West is unknown, but verbal reports by village residents indicate the number of bulls harvested is near 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.

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 vastly underrepresented because of a low reporting rate, especially in Subunit 25D East. Success among reporting hunters is high, approaching or exceeding 50% in Subunits 25A and 25B and ranging from 40% to 50% in Subunit 25D East.

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 opens 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 much 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. 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 that could be supported by the habitat.

Enhancement. The upper Yukon area has the shortest fire cycle in Alaska; extensive fires have created and maintained a 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 two years. However, signs of a decline in recruitment rates are evident in some areas, and a decline in numbers may have occurred in Subunit 25D West. 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 that some basic questions need to be addressed by the public and various governmental agencies involved. A basic issue that remain unsettled is whether the local public wants and would support measures to increase moose numbers to levels commensurate with habitat potential. The fact that moose are noticeably more abundant now than in earlier times, and many local residents are satisfied contributes to the confusion. More important, however, are political considerations relating to management authority and priority and exclusivity of wildlife uses.

These considerations override and generally dominate public discussions. The actual abundance and welfare of wildlife populations is generally less of an 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 various 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 USFWS 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.

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.

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 contact hunters by riverboat during the hunting season, as done in the past, are recommended.

Trend surveys in representative areas in various subunits should be continued to clarify trends in recruitment and moose numbers. A cooperative effort by ADF&G and USFWS to determine wolf numbers on the Yukon Flats is planned for early 1992. Knowledge of wolf numbers will help in assessing the probable effects of wolf predation on moose numbers. Existing management objectives will be revised in connection with the preparation of performance reports in early summer 1992.

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Wildlife Biologist II

Table 1. Subunit 25A early winter aerial moose composition counts, 1986-91.

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

[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.

Table 2. Subunit 25B early winter aerial moose composition counts, 1986-91.

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]								

[a] No survey.

Table 3. Subunit 25D East early winter aerial moose composition counts, 1986-91.

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	N/A
1987-88	81	18	27	29	13	196	225	N/A
1988-89[a]	--	--	--	--	--	--	--	--
1989-90	63	9	41	59	20	235	294	1.0
1990-91[b]	64	5	32	7	16	36	43	1.0
1991-92[c]	66	9	26	25	13	168	193	0.7

[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, 1986-91.

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

[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.

Table 5. Subunit 25A moose harvest and accidental death, 1986-91.

Regulatory year	Harvest by hunters: Reported[a] M	F	Unk.	Total	Estimated: Unreported	Illegal	Total	Accidental death: Road	Train	Total	Total
1986-87	47	0	0	47							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

[a] Source: moose harvest reports.

Table 6. Subunit 25B moose harvest and accidental death, 1986-91.

Regulatory year	Harvest by hunters: Reported[a] M	F	Unk.	Total	Estimated: Unreported	Illegal	Total	Accidental death: Road	Train	Total	Total
1986-87	27	0	0	27							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

[a] Source: moose harvest reports.

Table 7. Subunit 25D East moose harvest and accidental death, 1986-91.

Regulatory year	Harvest by hunters: Reported[a]				Harvest by hunters: Estimated			Accidental death			
	M	F	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1986-87	39	0	0	39							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

[a] Source: moose harvest reports.

Table 8. Subunit 25D West moose harvest data by permit hunt, 1986-91.

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	60	9 (15.0)	3 (5.0)	4 (6.7)	4 (100)	0(0)	0	4

Table 9. Subunit 25A moose hunter residency and success, 1986-91[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	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

[a] Source: moose harvest reports.
[b] Resident of Subunit 25A.

Table 10. Subunit 25B moose hunter residency and success, 1986-91[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	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

[a] Source: moose harvest reports.
[b] Resident of Subunit 25B.

Table 11. Subunit 25D East moose hunter residency and success, 1986-91[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

[a] Source: moose harvest reports.
[b] Resident of Subunit 25D.

Table 12. Subunit 25A reported moose harvest chronology,[a] percent by time period, 1986-91.

Regulatory year	Harvest periods					Dec.	Unk.	n
	9/1-9/7	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

[a] Source: moose harvest reports.
[b] No open season.

Table 13. Subunit 25B reported moose harvest chronology,[a] percent by time period, 1986-91.

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

[a] Source: moose harvest reports.
[b] No open season.

Table 14. Subunit 25D East reported moose harvest chronology,[a] percent by time period, 1986-91.

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

[a] Source: moose harvest reports.
[b] No open season.

Table 15. Subunit 25A moose harvest percent by transport method, 1986-91.[a]

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	n
1986-87	72.3	17.0	8.5	0	0	0	0.0	2.1	47
1987-88	60.9	12.2	17.1	0	0	0	2.4	7.3	41
1988-89	60.9	17.1	19.5	0	0	0	4.9	4.9	41
1989-90	56.0	16.0	24.0	0	0	0	4.0	0.0	25
1990-91	60.7	10.7	26.8	0	0	0	0.0	1.8	56

[a] Source: moose harvest reports.

Table 16. Subunit 25B moose harvest percent by transport method, 1986-91[a].

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	n
1986-87	29.6	0	63.0	0	0.0	0.0	0	7.4	27
1987-88	26.9	0	65.4	0	3.8	0.0	0	3.8	26
1988-89	28.6	0	61.0	0	3.6	0.0	0	7.1	28
1989-90	20.8	0	75.0	0	0.0	0.0	0	4.2	24
1990-91	23.4	0	68.1	0	6.4	2.1	0	0.0	47

[a] Source: moose harvest reports.

Table 17. Subunit 25D East moose harvest percent by transport method, 1986-91[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	66.7	0.0	5.1	0	2.6	12.8	39
1987-88	17.0	0	65.9	0.0	6.4	0	2.1	8.5	47
1988-89	28.1	0	46.9	0.0	15.6	0	0.0	9.4	32
1989-90	25.6	0	51.3	0.0	12.8	0	2.6	7.7	39
1990-91	26.4	0	64.1	1.9	1.9	0	0.0	5.7	53

[a] Source: moose harvest reports.

LOCATION

Game Management Subunit: 26A (56,000 mi^2)

Geographical Description: Western North Slope

BACKGROUND

Archeological evidence indicates that moose have been present on the North Slope sporadically or at low densities for many years. Since 1940 moose populations have increased in size and become well established in Subunit 26A. Although moose can be found throughout the subunit during summer, they are confined to riparian river corridors during winter. The largest winter concentrations of moose are found in 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 Subunit 26A were conducted in 1970, 1977, 1984, and 1991. The 1991 survey counted 1,535 moose. Regular harvest by airborne hunters began in the early 1970s. Reported harvest has increased from 37 in 1983 to 64 in 1991. Hunting pressure and wolf predation have increased during recent years.

MANAGEMENT DIRECTION

Population management goals and objectives established for moose populations in Subunit 26A are to: 1) conduct spring trend count surveys annually to monitor short-yearling survival, and fall counts biennially to monitor sex and age composition; 2) census the population at 7-year intervals; 3) maintain a hunter success level of greater than 50%; 4) manage the harvest for spatial and temporal separation of recreational and local hunters; and 5) establish a management plan and an upper harvest limit for moose.

METHODS

We completed sex and age composition surveys in trend count areas along the Colville, Chandler, and Anaktuvuk rivers during 27-30 October 1990 using a Cessna 185 aircraft. During 16-21 April 1991 we conducted a complete moose census to determine population status and short yearling recruitment. We used a Cessna 185 and a Piper PA-18 aircraft to survey all drainages in Subunit 26A thought to contain moose. We compiled harvest data from harvest reports submitted by hunters. Staff gathered additional harvest data 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 survey conducted in 1991 counted 1,535 animals. Counts of 1,219; 1,258; and 1,447 were observed in 1970, 1977, and 1984, respectively. The population has been very stable for 20 years, and may be increasing slightly (Table 1). The percentage of short yearlings observed during subunitwide censuses ranged from 25% in 1970 to 20% in 1991.

Population Composition: Of the 1,535 moose counted during spring 1991 census, we saw 1,231 adults and 304 calves, yielding a short yearling recruitment rate of 20%. This was much higher than the recruitment rate observed from 1987 to 1990 which ranged from 10% to 12%. In the 5 years before 1987, the mean recruitment rate was 18% (Table 2).

During fall composition surveys completed in 1990, we observed 371 moose. Of these, 69 were bulls (33 bulls:100 cows), 208 were cows, and 94 were calves (25% calves). The estimated antler sizes of the bulls were as follows:

Inches	<30	30-39	40-49	50-59	60+
Percent	17.4%	20.3%	18.8%	34.8%	8.7%

The bull:cow ratio has declined since 1983 from 54 to 32 bulls:100 cows (Table 3).

Distribution and Movements: Moose are widely dispersed during summer months, ranging from the northern foothills of the Brooks Range to the Arctic coast. During fall as snow covers the forbs, moose move to riparian corridors in the large river systems, primarily the Colville River system. During April, when snowcover begins to disappear in the foothills, moose move away from riparian corridors.

Mortality

Season and Bag Limit:

**Resident Hunters:		
Unit 26A	Aug. 1 - Dec. 31	One moose. No person may take a cow accompanied by a calf
Nonresident Hunters:		
	Sept. 1 - Dec. 31	One bull with 50-inch antlers

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

Harvest:

Human-Induced Mortality. Harvest report data indicate that 64 moose (60 bulls and 4 cows) were harvested during fall 1990. The harvest was larger than for any other year except 1985 when 65 moose were reported taken (Table 4). Antler sizes were as follows: <25" (1%); 25-29.99" (2%); 30-34.99" (5%); 35-39.99" (8%); 40-44.99" (5%); 45-49.99" (3%); 50-54.99" (18%); 55-59.99" (39%); 60-64.99" (9%); >65" (2%); and unknown (6%). The number of bulls with antler spreads larger than 50" increased the last 3 years, reflecting the increased use of the area by nonresident hunters (Table 5).

Hunter Residency and Success. Of the 99 people who reported hunting during fall 1990, 13 (13%) were Subunit 26A residents, 40 (40%) were non-local Alaska residents, 43 (43%) were nonresidents, and 3 (2%) were of unknown residency. Of the 64 successful reporting hunters, 8 (12%) were North Slope residents, 19 (30%) were other Alaskan residents, 35 (55%) were nonresidents, and 2 (3%) were of unknown residency. The number of hunters reporting who were local Subunit 26A residents decreased after 1987 from a high of 40 in 1988 to 10-13 during the last 3 years. This probably reflects poorer reporting rates rather than a decrease in hunting effort. The number of nonlocal Alaska residents has fluctuated since 1985, and the number of nonresident hunters has increased during the last 3 years (Table 6). The success rate of reporting hunters for 1990 was 65%. The success rate was very stable for the last 3 years at 66% for 1989 and 69% for 1988, and is well above the population objective of 50%.

Harvest Chronology. Most of the harvest occurred during the first 2 weeks of September. Moose were taken during the following periods: 1-7 August (2); 1-7 September (27); 8-14 September (24); 15-21 September (3); 22-28 September (3); and 30 October (1). This pattern is similar to previous years (Table 7).

Transport Methods. Of the 61 successful hunters who reported transportation means, 38 (62%) used aircraft, 17 (28%) boats, 2 (3%) used 3- or 4-wheelers, 1 (2%) snowmobile, and 2 (3%) used ORVs. More people hunted using boats and fewer used aircraft in 1990 than in the 3 previous years (Table 8).

Natural Mortality: Natural mortality was higher than normal during 1990-91. We counted 33 moose carcasses during the spring 1991 moose census. The last time a complete census was conducted in 1984, 11 moose carcasses were counted. During 1991 we counted 14 moose carcasses along the Colville River between Umiat and the mouth of the Killik River, compared to 4 in 1989 and 4 in 1990. Although some moose were apparently killed by predators, it was impossible to determine the actual cause of death.

Wolf and grizzly bear numbers appear to be increasing. Increasing numbers of wolves were observed while conducting moose surveys in recent years. During the 1991 moose census, we counted 26 wolves, compared to 3 in 1984. Grizzly bear research conducted in another part of the north side of the Brooks Range in Subunit 26A indicates the grizzly bear population is increasing in size (Reynolds 1989).

Board of Game Actions and Emergency Orders: The Board of Game made two regulatory changes this period. The bag limit for nonresident hunters was changed from 1 moose to 1 bull with 50 inch antlers. All of Subunit 26A is now a controlled use area where hunters may not hunt moose in August using aircraft for transportation or for carrying meat. Subunit 26A was designated as a controlled use area in response to the change in state regulations which made all state residents subsistence hunters. This change was needed to avoid an influx of nonlocal hunters in August. Residents of Nuiqsut need to hunt in August because the river is too shallow for boats during September.

CONCLUSIONS AND RECOMMENDATIONS

Surveys conducted in 1990-91 indicated a stable moose population in Subunit 26A. Spring census data indicated the population size may have increased slightly during the last 20 years. The short yearling recruitment rate was 20% and the reported harvest was less than 4%, so the population will probably not be significantly affected by hunting. The hunter success rate was 65%, well above the goal of 50%. Although the Subunit 26A moose population is in good condition overall, several problems areas need to be addressed.

The bull:cow ratio dropped from 54 bulls:100 cows to 33 bulls:100 cows between 1983 and 1990. Composition surveys should be conducted each fall and, if the bull:cow ratio continues to decline, hunting restrictions may be necessary to correct the situation.

Before 1991, the short yearling recruitment rate had been low for 4 consecutive seasons. This could be from predation by an increasing number of bears and wolves residing in the area. A wolf census and a bear census will be conducted during 1992, and should be repeated at 2- to 3-year intervals. Annual spring moose surveys should be continued to monitor recruitment and evaluate overwinter mortality.

Remote portions of Subunit 26A have become more accessible in recent years because more people are driving up the Dalton Highway and using transporters to fly in. Hunting regulations in Subunits 26B and 26C have also become more restrictive, which encourages more people to hunt in Subunit 26A. We need to continue to examine harvest patterns, and conduct population surveys to determine whether more restrictive moose regulations are needed in Subunit 26A.

The number of local hunters returning harvest reports declined the last 3 years. Efforts to make licenses and harvest tickets available, and to inform people about reporting requirements and the reasons for these requirements need to be increased. The inability of the state to resolve the current subsistence dilemma has confused and alienated many

North Slope residents. It has greatly set back efforts to bring people into the regulatory system, and little progress will be made unless 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 Subunit 26A which stipulates that aircraft cannot be used to hunt during August, allowing local residents using boats to do much of their hunting before recreational hunters arrive. Local hunters tended to concentrate their efforts on the lower part of the Colville River, while recreational hunters flew to 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 above Nuiqsut and around Umiat. We recommend no changes in seasons and bag limits at this time.

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Table 1. Results of Subunit 26A spring subunitwide censuses, 1970-1991.

Year	Adults	Calves	Total	% Calves
1970	911	308	1,219	25
1977	991	267	1,258	21
1984	1,145	302	1,447	21
1991	1,231	304	1,535	20

Table 2. Colville River trend counts: Anaktuvuk River, Chandler River, and Colville River between Anaktuvuk and Killik rivers, 1970, 1974-81, and 1983-91.

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

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

Table 3. Subunit 26A fall aerial moose composition counts and estimated population size, 1983-91.

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

Table 4. Subunit 26A moose harvest[a], 1985-90.

	Reported hunter harvest		
Regulatory	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

[a] Excludes permit hunt harvest.

Table 5. Subunit 26A percentage of harvested moose in each antler spread category (inches), 1983-1991.

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

Table 6. Subunit 26A moose hunter[a] residency and success, 1987-90.

	Successful						Total hunters				
Regulatory year	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

[a] Excludes hunters in permit hunts.
[b] Local hunters are North Slope Borough residents.

Table 7. Subunit 26A moose harvest[a] chronology percent by time period, 1987-90.

Regulatory year	Harvest periods						
	Aug.	09/1-7	09/8-14	09/15-21	09/22-28	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

[a] Excludes permit hunt harvest.

Table 8. Subunit 26A moose harvest[a] percent by transport method, 1987-90.

Regulatory year	Percent of harvest					
	Airplane	Boat	3 or 4-Wheeler	Snowmachine	ORV	n
1987-88	80	15	2	1	2	59
1988-89	81	18	1			53
1989-90	84	14	2			40
1990-91	62	28	3	2	3	61

[a] Excludes permit hunt harvest.

LOCATION

Game Management Subunit: Subunits 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, probably contributed to the historical scarcity of moose. The reduction of wolf numbers by federal control programs during the late 1940s and early 1950s probably 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 USFWS, 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, and 1990.

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 to 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 have become more restrictive in the last 5 years. 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 and a more conservative approach may be warranted in the future.

MANAGEMENT DIRECTION

Management Goals

Management goals for area moose are to: 1) provide the greatest opportunity to participate in hunting moose, and 2) provide sustained opportunities for subsistence use of moose.

Management Objectives

Moose management objectives are to: 1) determine population distribution, composition, density, and trends by 1991; 2) determine movements and habitat use in heavily harvested drainages beginning in 1991; 3) maintain an annual posthunting season sex ratio of at least 50 bulls:100 cows; 4) Maintain a mean antler spread of at least 50 inches among bull moose harvested during the general season; 5) maintain an annual hunter success rate of at least 40%; and 6) determine subsistence needs and harvest levels by 1991.

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 when the most complete surveys were done were 629 in 1988 and 600 in 1989. The total population is thought to include 1,000-1,200 moose in Subunit 26B and 700-800 in Subunit 26C, for a total of 1,700 to 2,000 (F. Mauer, USFWS, pers. commun.).

Population Composition: Survey results in Subunit 26B suggest that moose population status has not changed dramatically during the past 5 years (Table 1). Although calf survival declined sharply in 1989, when calves were only 5% of the moose seen, 1990 surveys indicated that 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 in the Firth and Mancha areas in eastern Subunit 26C were accomplished in 1989 and 1991, and the upper Kongakut River was also surveyed 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 since 1985. Various indices to population welfare including total numbers observed, calf:cow, bull:cow, and large bull:cow ratios, and yearling recruitment suggest that recruitment into the population is chronically low, and that harvest of bulls has noticeably effected 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 major in 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
Resident Hunters:		
One bull	5 Sept.-15 Sept. 1 Nov.-31 Dec.	
Nonresident Hunters:		
One bull with 50-inch antlers		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 has declined in Subunit 26B from 52 in 1986 to 24 in 1990 (Table 4). In Subunit 26C, the harvest has declined substantially from 17 in 1987 to 1 in 1989 and 3 in 1990 (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 underrepresent actual harvest by a small amount.

The decline in harvest may also in part be because of changes in the number of hunters using the area, which has declined. 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 30% to 50% among those reporting. 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 ranged from 26% to 48% during 1986-90, 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.

Harvest Chronology. Most (74% to 91%) moose killed in Subunits 26B and 26C are taken during the first three weeks of September, and in 1990, 91% were killed during the 10-day open season from 5 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 and was used by 75% to 96% of the successful moose hunters (Table 9).

Natural Mortality: Although there have been no intensive studies of natural sources of moose mortality in the eastern Arctic, it is probable that predation by bears and wolves and periodic malnutrition during severe winters are most important. Wolves and bears are common in the region, particularly in 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 effected 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 there would appear to be no feasible enhancement because 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, but by an increasingly small margin. Hunter success is good but has also declined, and antler size of bulls harvested continues to exceed 50 inches. Major 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 appears to be 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 (F. Mauer 1990). A survey in 1991 accounted for about 30 bulls, with indications of continued poor recruitment (F. Mauer, pers. commun.). 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. I propose either closing the season or reducing it to 5 days in this drainage.

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 suggest that some 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. Existing management objectives are being reviewed and will be revised in connection with the preparation of performance reports in early summer 1992.

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Table 1. Subunit 26B early winter aerial moose composition, 1986-91.

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

[a] No survey.

Table 2. Subunit 26C, Kongakut and Firth rivers and Mancha Creek early winter aerial moose composition counts, 1987-91.

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

[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, 1986-91.

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

[a] No survey.

Table 4. Subunit 26B moose harvest and accidental death, 1986-91.

Regulatory year	Harvest by Hunters							Accidental death			Total
	Reported[a]				Estimated						
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	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

[a] Source: moose harvest reports.

Table 5. Subunit 26C moose harvest and accidental death, 1986-91.

Regulatory	Harvest by hunters										
	Reported[a]				Estimated			Accidental death			
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	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

[a] Source: moose harvest reports.

Table 6. Subunit 26B and 26C moose hunter residency and success, 1986-91[a].

	Successful					Unsuccessful					
Regulatory year	Local[b] resident	Nonlocal resident	Nonres.	Unk	Total(%)	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

[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, 1983-91.[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

[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 by time period, 1986-91[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]

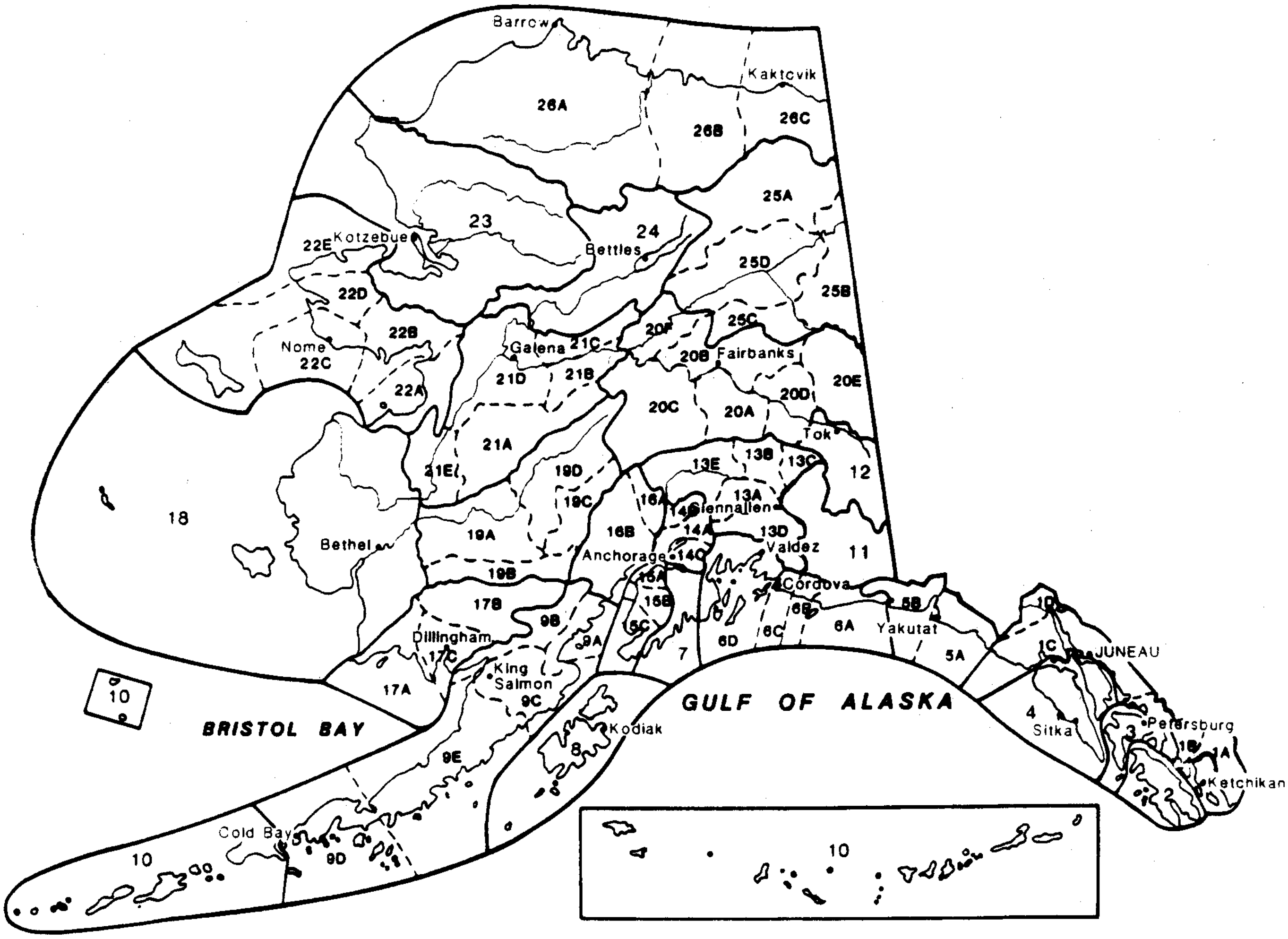
[a] Source: moose harvest reports.
[b] General season closed 30 September.
[c] Subsistence.
[d] General season opened 5 September.
[e] General season closed 15 September.
[f] No open season.
[g] Alaska resident only.
[h] Only 3 moose were reported taken in Subunit 26C.

Table 9. Subunits 26B and 26C moose harvest percent by transport method, 1986-91[a].

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
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

[a] Source: moose harvest reports.

Alaska's Game Management Units



Federal Aid in Wildlife Restoration

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 then allots the funds back to states through a formula based on each state's geographic area and the number of paid hunting license holders in the state. Alaska receives 5% of the revenues collected each year, the maximum allowed. The Alaska Department of Fish and Game uses the funds to help restore, conserve, manage, and enhance wild birds and mammals for the public benefit. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes necessary to be reponsible hunters. Seventy-five percent of the funds for this project are from Federal Aid.