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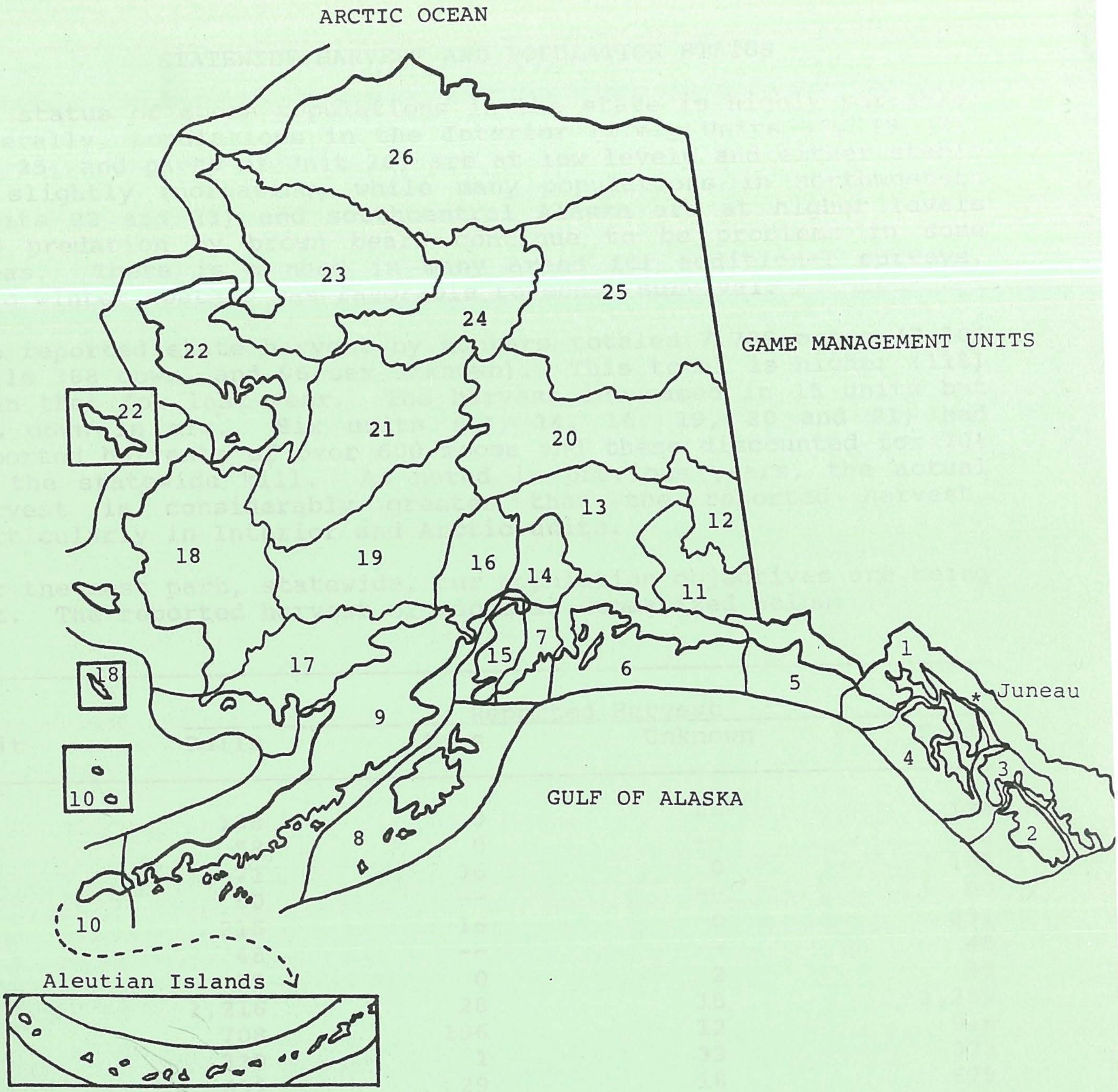
TABLE OF CONTENTS

Game Management Unit Map. iii
Statewide Harvest and Population Status iv
Game Management Unit/Geographical Description
GMU 1A, 1B, 2, 3 - Southeast mainland and adjacent islands from Cape Fanshaw to the Canadian border. . 1
GMU 1C - Southeast Alaska mainland from Cape Fanshaw to Eldred Rock. 12
GMU 1D - That portion of the southeast Alaska mainland lying north of the latitude of Eldred Rock, excluding Sullivan Island and the drainages of Berners Bay 23
GMU 5 - Cape Fairweather to Icy Bay, eastern Gulf Coast 33
GMU 6 - Prince William Sound and North Gulf Coast. . . . 46
GMU 7 - East Kenai Peninsula 64
GMU 9 - Alaska Peninsula 68
GMU 11 - Chitina Valley and the eastern half of the Copper River Basin. 78
GMU 12 - Upper Tanana and White River drainages. 89
GMU 13 - Nelchina and Upper Susitna Rivers 100
GMU 14A - Matanuska Valley 116
GMU 14B - Western Talkeetna Mountains (Williw to Talkeetna). 127
GMU 14C - Anchorage area 138
GMU 15A - Northern Kenai Peninsula 150
GMU 15B - Kenai Peninsula. 154
GMU 15C - Southern Kenai Peninsula 158
GMU 16 - West side of Cook Inlet 165
GMU 17 - Northern Bristol Bay. 177
GMU 18 - Yukon-Kuskokwim Delta 186
GMU 19 - Upper Kuskokwim River watershed, including all drainages into the Kuskokwim River upstream of Lower Kalskag. 200
GMU 20A - Tanana Flats, central Alaska Range 215
GMU 20B, 25C - Fairbanks and central Tanana Valley . . .239
GMU 20C, 20F, - Drainages into the south bank of the Tanana River west of the Nenana River, the west bank of the Nenana River, and the Central Yukon River 260
GMU 20D - Central Tanana Valley near Delta Junction. . .278
GMU 20E - Charley, Fortymile, and Ladue River drainages 305
GMU 21A, 21E - Drainages of the Innoko River upstream from and including the Iditarod River drainage and that portion of the Nowitna River drainage upstream from the confluence of the Little Mud and Nowitna Rivers. Drainages of the Yukon River from a straight line drawn between Lower Kalskag and Paimiut Rivers upstream to but not including the Blackburn Creek drainage, and the Innoko River drainage downstream from the confluence of the Iditarod and Innoko Rivers. 316

GMU 21B - Lower Nowitna River and Yukon River between Melozitna and Tozitna Rivers. 324
GMU 21C - Dulbi River above Cottonwood Creek and Melozitna River above Grayling Creek. 337
GMU 21D - Yukon River from Blackburn to Ruby and Koyukuk River drainage below Dulbi Slouth 341
GMU 22 - Seward Peninsula and that portion of the Nulato Hills draining west into Norton Sound. . . .353
GMU 23 - Western Brooks Range and Kotzebue Sound 363
GMU 24 - Koyukuk River drainage above Dulbi River. . . .385
GMU 25A, 25B, and 25D - Upper Yukon River Valley 394
GMU 26A - Western North Slope. 407
GMU 26B, 26C - North slope of the Brooks Range and arctic coastal plain east of the Itkillik River . .413


ARCTIC OCEAN
GAME MANAGEMENT UNITS
GULF OF ALASKA
Aleutian Islands
Juneau
26
25
24
23
22
22
21
20
19
18
18
17
16
15
14
13
12
11
10
10
9
8
7
6
5
4
3
2
1

1 July 1988 - 30 June 1989

STATEWIDE HARVEST AND POPULATION STATUS

The status of moose populations in the state is highly variable; generally, populations in the Interior (i.e., Units 12, 19, 21, 24, 25, and parts of Unit 20) are at low levels and either stable or slightly increasing, while many populations in northwestern (Units 22 and 23) and southcentral Alaska are at higher levels and predation by brown bears continue to be problems in some areas. There is a need in many areas for additional surveys. Mild winter weather was favorable to moose survival.

The reported state harvest by hunters totaled 7,789 moose (7,305 bulls 388 cows, and 96 sex unknown). This total is higher (11%) than that for last year. The harvest increased in 15 units but was down in six. Six units (13, 14, 16, 19, 20 and 21) had reported harvests of over 600 moose and these discounted for 70% of the statewide kill. As noted in previous years, the actual harvest is considerably greater than the reported harvest, particularly in Interior and Arctic units.

For the most part, statewide, our population objectives are being met. The reported harvest of moose is summarized below:

	Reported Harvest			
Unit	Bulls	Cows	Unknown	Total
1	138	0	--	138
5	58	0	--	58
6	71	36	0	107
7	50	--	--	50
9	215	16	0	231
11	48	--	--	48
12	79	0	2	81
13	1,216	28	15	1,259
14	708	196	12	916
15	339	1	33	373
16	632	29	18	679
17	187	0	1	188
18	68	0	0	68
19	637	0	0	637
20	1,285	0	1	1,286
21	658	26	7	691
22	332	36	7	375
23	202	14	0	216
24	137	0	0	137
25	151	0	0	151
26	94	6	0	100
TOTAL	7,305	388	96	7,789

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Senior Staff Biologist

STUDY AREA

GAME MANAGEMENT UNIT: 1A, 1B, 2 and 3 (15,300 mi^2)

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

BACKGROUND

The Unuk and Chickamin River drainages in Subunit 1A both support small, apparently stable populations of moose. The Unuk moose herd is indigenous, while the Chickamin herd is the result of a 1963-64 transplant from Cook Inlet and Chickaloon Flats. Although a hunting season exists for both populations, their remoteness, low numbers, and the difficulty in finding them attract little hunter interest. As a result the harvest is low and sporadic, normally not exceeding two or three per year.

Moose occur throughout Subunit 1B wherever appropriate habitat exists. The primary concentrations occur in the Thomas Bay area in northern Subunit 1B and the Stikine River in central Subunit 1B. Separate hunting regulations exist for each.

The Thomas Bay moose herd is relatively isolated from populations in mainland Canada by the Coast Mountains. The herd is unique in Southeast Alaska because it occupies an area that has been heavily logged. Available population trend information suggests that Thomas Bay moose may be more susceptible to periodic reproductive failures and/or extreme neonatal mortality than other Southeast moose populations. Also, the Thomas Bay population may decline significantly, as conifer regrowth in clearcut areas matures. The average annual harvests of Thomas Bay moose during the decades of the 1950's, 1960's, 1970's, and 1980's (i.e., through 1988) were five, eight, 10, and 16, respectively.

Moose inhabiting the Alaska portion of the Stikine River represent the westernmost tip of a population, which extends up the drainage into Canada. The Stikine population in Alaska was estimated at 300 in 1983 (Craighead et al. 1984). Since 1983 winters have been mild and the population, based on harvest and subjective impressions, has appeared to increase. The average annual harvest of Stikine River moose during the decades of the 1950's, 1960's, and 1970's was about 27. From 1980 to 1988 the average annual harvest was 39 moose.

Reported sightings of moose are rare in Unit 2, and there does not appear to be any trend of increasing numbers. There is no open hunting season.

Moose occur in low densities on the major islands of Unit 3. An increasing number of sightings of moose during the 1980's suggest that the population is increasing. From 1960 to 1967, the season was open from 15 September to 15 October; the limit was 1 bull. There is no open hunting season.

POPULATION OBJECTIVES

To maintain posthunting populations of 35, 450, and 200 moose in Subunit 1A, Subunit 1B (Stikine River), and Subunit 1B (Thomas Bay), respectively, by 1994.

To provide for annual harvests of three, 40, and 20 in Subunits 1A, Subunit 1B (Stikine River, and Subunit 1B (Thomas Bay), respectively, by 1994.

To maintain hunter success rates of 15%, 13%, and 12% for Subunits 1A, 1B (Stikine River), and 1B (Thomas Bay), respectively, by 1994.

METHODS

Fall and winter aerial surveys were scheduled in Unit 1B to estimate sex and age composition of the Stikine River and Thomas Bay moose populations. Registration permits for the Thomas Bay (i.e., northern Subunit 1B) and harvest reports for Stikine River (i.e., central Subunit 1B) and Subunit 1A were used to estimate harvest. Hunter check stations were maintained in the Thomas Bay and Stikine River areas to monitor and administer the hunt and to obtain accurate harvest information. Reported sightings of moose were recorded to document the continuing expansion of moose into Unit 3.

RESULTS AND DISCUSSION

Population Status and Trend

The data are insufficient to make a quantitative determination of population trends during the past 5 years. Subjectively, the moose populations appeared to be stable in Subunit 1A (low density), Unit 2 (very low density), and Thomas Bay (moderate-to-high density). The Stikine River population (high density) was stable. The number of moose in Unit 3 (low density) increased.

Population Size:

In Subunit 1A there were 20 to 30 moose in the Unuk River drainage and probably not more than five in the Chickamin River drainage (R. Wood, pers. commun.). The Stikine River population in Subunit 1B was estimated to be 300 and increasing in 1983 (Craighead et al. 1984). Harvest levels and subjective impressions after 1983 suggested the Stikine population has slowly increased. Based on aerial survey data and recruitment estimates from harvest data, there was an estimated 450 moose following the 1988 hunting season.

According to harvest data, the Thomas Bay population appeared to be much larger than it had been in the late 1970's; i.e., about 180 moose (ADF&G files). No population data are available for Unit 3.

Population Composition:

Sex and age composition data of the Stikine and Thomas Bay moose populations for the past 5 years are shown in Table 1. The Stikine River bull:cow and the calf:cow ratios are insufficient to reliably indicate trends. Even though the 1988 ratio of 25 bulls:100 cows suggested moderate harvest levels, care must be exercised because the sample size was very small and the identifying criteria (i.e., apparent absence of a vulvar patch) may have caused an inflated count of bulls. The ratio of 11 calves:100 cows was substantially lower than any previous surveys; however, it has historically fluctuated widely (Paul and Flynn 1989). The proportion of calves in the sample fell well below the range of values obtained during the previous 5 years, suggesting reproduction was much lower in 1988 or that predation and/or weather caused a much greater loss of calves.

Meaningful interpretation of the Thomas Bay data is impossible, because survey sample sizes were too small (Table 1); i.e., the largest sample since 1980 was 39 moose. Thick vegetation precluded successful surveys, constituting a major constraint on the Thomas Bay moose management program; however, aerial surveys have provided an indication of the relative number of calves.

Distribution and Movements:

Sightings of moose, primarily on Mitkof Island and to a lesser extent on Etolin, Kupreanof, and Kuiu Islands, are the bases for the conclusion that the moose population is increasing in Unit 3. Both the Stikine River and Thomas Bay populations occur on the mainland directly opposite Etolin, Mitkof, and Kupreanof Islands and are logical sources for these migrating moose. Bulls, cows, and calves have been observed in Unit 3, suggesting that reproduction of resident moose is also contributing to the overall increases.

<u>Mortality</u>

Season and Bag Limit:

The open season for subsistence, resident, and nonresident hunters in Subunit 1A and 1B south of LeConte Glacier (Stikine River) is 15 September to 15 October. The bag limit is 1 bull moose. The open season for resident and nonresident hunters in Subunit 1B north of LeConte Glacier (Thomas Bay) is 1-15 October.

The bag limit is 1 bull with a spike fork antler by registration permit only. There is no open season for Units 2 and 3.

Human-induced Mortality:

In Subunit 1A the Unuk and Chickamin River moose populations are relatively small, isolated, and difficult to hunt; they attract only a few hunters. The Unuk River population has supported an annual harvest of up to seven; 6 bulls were killed in 1988. Harvest ticket reports indicated 25 hunters participated.

The 1988-89 harvest of 57 bulls in the Stikine River was 21% more than the 47 recorded for the previous season (Table 2), greatly exceeding the previous 5-year (1983-87) average of 43. The average annual harvest for the 1980's thus far is 39, a substantial increase over the 1970's average of 27.

Eighty percent of the bulls harvested were yearlings (ADF&G files, Petersburg). Because each season's harvest has been heavily dependent on the previous year's calf production, there is an increasing likelihood that reproductive or recruitment failures may lead to restrictive regulations.

The Stikine River hunt is intensively monitored by ADF&G and Fish and Wildlife Protection (FWP) personnel during the entire 30-day season. The 1988 harvest ticket report data for the Stikine River indicated 270 hunters participated, while more accurate check station data indicated 305 hunters. All previous estimates of hunters should be considered as very conservative. The estimated illegal harvest was less than three for Thomas Bay and less than five for the Stikine River.

The 1988 harvest of 25 legal and 2 illegal bulls (i.e., failed to meet antler restrictions) at Thomas Bay was greater than those for the previous 3 seasons (Table 2). Although we anticipated a lower harvest because of the regulatory changes protecting larger bulls, the harvest increased. Mild winters and the effects of the previous 4 seasons of antler restriction are possible explanations for at increase.

One cow illegally killed in Unit 3 was reported by FWP; the case was successfully prosecuted. One cow and 2 calves were reported dead from natural causes on Mitkof Island during the winter of 1988-89.

Hunter Residency and Success. In the Stikine River the only clear trend during the past 5 years has been the increase in local residents who killed moose (Table 3). There were no commensurate increases in success rates of nonlocal residents or nonresidents. Also, there appeared to be no substantial change in the number of hunters participating.

Local residents have dominated the Thomas Bay hunt (Table 3) for the last 3 years (1986-87 to 1988-89). Nonlocal resident and nonresident participation and success also have been relatively consistent over the past few years. The total number of hunters was less than that in 1986, but it was more than that in 1987 when fewer hunters participated because of bad weather. The change in the regulations (i.e., antler restrictions) did not reduce hunter participation.

Harvest Chronology. The data indicated that most of the harvest in Subunit 1B occurred early in the season. As the season progressed, the harvest decreased.

Transport Methods. The majority of hunters used boats, a few (i.e., 1-3) used airplanes, and the remainder were not specified.

Habitat

Moose in Thomas Bay have made extensive use of young-age clear-cuts since logging began in that area in the 1950's. Conifer regrowth in the clear-cuts has progressively reduced moose habitat; because the rate of logging has also been greatly reduced, no new browse has been produced. It is unlikely that the moose population can be sustained at the present level without an enhancement program. Initial planning has begun with the U.S. Forest Service (USFS), and our progress will be documented in future reports.

The moose habitat in Subunit 1B is in the Stikine/LeConte Wilderness area, mostly within the Stikine River drainage. Moose habitat in this area was identified and described by Craighead (1984). Because it is located within a Wilderness area, it cannot be mechanically manipulated for habitat improvement.

Game Board Actions and Emergency Orders

The hunting regulations for the Stikine River have remained unchanged for the past 5 years. On the surface, the regulations have served well; hunter participation and harvest have both increased, and the population appears to be stable or increasing. However, the high proportion of yearlings in the harvest and the increasing-harvest trend associated with increasing numbers of hunters indicated that regulatory change may be required.

The Thomas Bay season was closed in 1982 because of low calf production in the early 1980's. To protect spike and fork-horned bulls, harvests were limited to only bulls with 3 points or more on at least 1 antler from 1984 through 1987. Under this restriction the harvest went from 12 to 22 bulls, and the proportion of yearlings in the harvest was reduced to about one-third of that occurring in the unrestricted Stikine hunt (ADF&G files).

After 4 years of this harvest regime, the age structure of bulls was still strongly skewed toward young age classes. Based on an ADF&G recommendation to develop an age structure containing more older bulls, the Board of Game approved a regulatory change (i.e., effective in 1988) to restrict the harvest to only those bulls having spike or forked antlers on at least one side. Presumably, older bulls will be protected and some young bulls will survive to be recruited into the older age classes. This should enhance the reproductive performance of the population and ultimately increase the number of harvestable moose. After a few years a limited harvest of older bulls may be permitted.

CONCLUSIONS AND RECOMMENDATIONS

Although the Unuk and Chickamin River moose populations were introduced many years ago, they are at low levels and unattractive to all but a very few hunters. The Unuk River population has supported a small annual harvest; six bulls were killed in 1988. Harvest reports indicate 25 hunters participated. No changes in regulations are recommended at this time.

The harvest objective for the Stikine River (i.e., 40 moose) was accomplished; however, the means (i.e., standard aerial survey techniques) of determining the posthunting population objective (i.e., 450) may not be effective for this drainage. The moose demography survey technique developed by Gasaway et al. (1987) also may not be applicable because of the large amount of closed-canopy habitat. Use of indirect indicators may be a more practical method of determining the population size. For instance, ascertaining moose/hour or densities in open-canopy and/or treeless habitat may be an effective method, in the absence of a detailed radiotelemetry study; e.g., Craighead (1984).

Harvest figures and calf productivity indicated that the Stikine River population is about 450 moose. This population is probably not capable of sustaining a harvest of 50+ bulls. The extremely low survival of calves born in 1988 suggests a need for regulatory restrictions to prevent a shortage of breeding bulls in 1990. We recommend the institution of a registration hunt to begin in 1990 that will limit the harvest of bulls to those having a spike, fork, or 50-inch antler spread and the reduction of the open season to 1-15 October. Although these changes will protect many bulls in the initial year, it will still provide hunting opportunities. The temporarily decreased harvests should increase over time, as older bulls increase calf production.

The Thomas Bay population objective of providing for a harvest of 15 moose was accomplished; however, no progress was made in determining the carrying capacity. We doubt that such a project is attainable with existing staff and funding levels. Plans for habitat improvement are being developed in conjunction with the USFS. We recommend the same harvest strategy as for the Stikine River.

Public responses indicate little interest in moose in Unit 2. Moose have been identified in Unit 3 as desirable for viewing purposes (Flynn and Paul 1989). The hunting seasons should remain closed in Units 2 and 3. We should seek public comment on opening a bull-only season to provide hunting opportunity and additional population data.

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Table 1. Annual sex and/or age composition surveys of moose in Subunit 1B, 1981-1988.

Year/ month	Bulls: 100 cows	Calves: 100 cows	Calves: 100 adults	Total moose	Survey time
Stikine River					
81/03	NA	NA	37	56	unknown
82/03	NA	NA	37	37	unknown
82/11	3	23	22	39	3:48
82/12	NA	NA	27	113	2:48
83/08	14	21	19	38	1:54
84	No survey				
85	No survey				
86	No survey				
87/08	24	48	29	45	3:00
89/02	25	11	7	77	4:22[a]
Thomas Bay					
80/12	NA	NA	46	19	unknown
81/12	NA	NA	25	20	2:00
82/01	NA	NA	33	8	2:00
82/01	NA	NA	9	14	1:00
82/03	NA	NA	13	21	4:30
82/12	NA	NA	0	22	3:03
83/01	NA	NA	0	7	1:00
84	No survey				
85	No survey				
86/09	100	33	17	7	1:10
87	No survey				
88/12	17	46	39	39	4:36[a]

[a] Helicopter

Table 2. Annual reported harvest of moose in Subunits 1A and Unit 1B, 1984-88.

	Subunit 1A total	Subunit 1B total
1984	7	53
1985	0	51
1986	0	65
1987	2	69
1988	6	84

Subunit 1A

	Chickamin River				Unuk River				Total
	M	F	NS	Total	M	F	NS	Total	
1988	0	0	0	0	6	0	0	6	6

Subunit 1B

	Stikine River				Thomas Bay				Total
	M	F	NS	Total	M	F	NS	Total	
1988	57	0	0	57	25	0	2	27	84

[a] Nonsport harvest; i.e., illegal, accident, etc.

Table 3. Residency and hunting success for moose hunters in Subunit 1B, 1985-1988.

	Successful					Unsuccessful				
	Local res.[a]	Non-loc. res.	Non-res.	Unk.	Total	Local res.[a]	Non-loc. res.	Non-res.	Unk.	Total
Stikine River										
1985	23	6	0	2	31	159	51	1	4	215
1986	28	9	1	3	41	150	46	2	1	199
1987	37	7	1	2	47	127	49	0	5	181
1988	41	16	0	0	57	167	74	4	3	248
Thomas Bay										
1985	12	1	0	0	13	85	16	0	0	101
1986	13	1	0	0	15	116	22	1	0	139
1987	21	0	1	0	22	79	7	2	0	88
1988	27	0	0	0	27	87	5	1	0	93

[a] Local residents are those hunters living in Wrangell (Stikine River) and Petersburg (Thomas Bay).

Table 4. Permit data for moose registration hunt number No. 955, Thomas Bay, 1984-1988.

	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Total hunters
1984	130	39	79	12	91
1985	154	40	101	13	114
1986	201	47	139	15	154
1987	159	49	88	22	110
1988	170	50	93	27	120

Table 5. Successful hunter transport methods in Subunit 1B, 1985-1988.

Year	Air-plane	Horse	Boat	Unknown
Stikine River				
1985	3	0	27	1
1986	2	1	31	0
1987	3	0	41	0
1988	3	0	53	1
Thomas Bay				
1985	1	0	12	0
1986	3	0	11	1
1987	1	0	21	0
1988	4	0	23	0

STUDY AREA

GAME MANAGEMENT UNIT: 1C (6,500 mi^2)

GEOGRAPHICAL DESCRIPTION: Southeast Alaska mainland from Cape Fanshaw to Eldred Rock

BACKGROUND

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

Swarth (1922) stated that a moose was killed at the mouth of the Stikine ". . .some years. . ." prior to 1919. If moose appeared at the same time on the Taku River, presumably they first occurred in the lower part of the river near the turn of the century. In 1960, 38 moose were observed in the Taku River area by ADF&G biologists, and 27 moose were harvested there. Moose also occurred on the Whiting and Speel Rivers south of the Taku; however, they may have orginated from either the Taku or Whiting herds or from some other source. Moose populations are found in Port Houghton and at Cape Fanshaw as well, and they are probably an extension of the Thomas Bay herd in Subunit 1B.

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

POPULATION OBJECTIVES

To 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.

To maintain a posthunting population of 90 moose, an annual harvest of eight, and a hunter success rate of 80% in the Berner's Bay area by 1994.

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

METHODS

Aerial sex and age composition surveys were scheduled for early winter; however, the absence of snow prevented surveys until early January 1989. The Berners Bay and Taku River moose populations were surveyed, but as Tables 1 and 2 indicate, accurate sex and age information was not obtained. Hunters voluntarily provided incisors from moose harvested in Berners Bay and elsewhere in Subunit 1C. Data collected from registration permits included length of hunt, hunter residency, harvest date and location, and transport means.

RESULTS AND DISCUSSION

Population Status and Trend

The carrying capacity for the Berners Bay herd (i.e., 100 moose) has been maintained with selective harvests that have adjusted the bull:cow ratio. Although the Taku River herd may be decreasing, moose moving down river from Canada may supplement it. While population dynamics are not well understood in the Chilkat Range herd, moose numbers are probably stable.

Population Size:

In Berners Bay the number of moose observed in the fall surveys has remained low since 1984 (Table 1). While a total of 68 were counted in 1988, the estimated population is 90-100 moose.

Survey data are incomplete for other portions of Subunit 1C (Table 2). No surveys were conducted in the Chilkat Range in 1988 because of poor survey conditions. If moose sightability in the eastern portion of Subunit 1C were similar to the Haines and Yakutat areas, the Taku River to Cape Fanshaw population probably numbers about 150. Moose from Canada may supplement the Taku herd, but the harvests in Canada have apparently increased in recent years. The Endicott River portion of the Chilkat Range may support about 50 moose, and the entire Chilkat Range may support another 150. Moose from this area emigrated to the willow communities of Adams Inlet (Glacier Bay).

Population Composition:

Because 1988 surveys in Berners Bay were conducted after antler drop began, accurate bull:cow ratios were not obtained (Table 1); however, the calf proportion of the Berners Bay herd increased in 1988 to 18%. The total counts that have remained low since 1985 might be partly due in 1988 to the use of a Heliocourier for the flight instead of a Supercub.

Although the total Taku River sample was very small (Table 2), calves accounted for 25%. Again, the bull:cow ratio was unreliable because of the timing of the survey. The transient nature of this moose herd probably encourages wide fluctuations in its composition. Although the small sample size of the 1988 survey precludes an in-depth analysis of herd dynamics, data suggest excellent recruitment.

No surveys were conducted in the Chilkat Range.

Mortality

Season and Bag Limits:

The open season for resident hunters in the Berners Bay drainages is 15 September to 15 October The bag limit is 1 bull by drawing permit only; up to 5 permits will be issued. The open season for all hunters in Subunit 1C, except the Berners Bay drainages, is 15 September to 15 October; the bag limit is 1 bull by registration permit only.

Human-induced Mortality:

From 1984 to 1988 the bag limit in Berners Bay (drawing permit hunt No. 901) has been limited to 5-15 moose (Table 3). The ratio of male:female moose in the quota has been based on aerial survey data. Because few moose were observed in the 1986 survey and no survey was conducted in 1987, the 1988 quota remained at 5 bulls. Four of 5 permittees were successful in 1988. The incidence of poaching in Berners Bay is very low, because of the proximity to Juneau and the frequency of visitors there.

Moose hunting in the remainder of Subunit 1C is managed by a permit system (registration permit No. 959), and there is no harvest quota. The known harvest for the Taku River has ranged from 13 to 26 moose since 1984, and that for the Chilkat Range has ranged from six to 11 (Table 3). The total harvest of 28 moose for the remainder of Subunit 1C in 1988 was the second highest occurring since 1984.

Some portion of the Taku River moose harvest reported by Alaska hunters may occur in British Columbia; however, the magnitude of this harvest is unknown. Illegal harvests likely occur on the Taku River by Canadian hunters in Alaska as well, as it undoubtedly does on the Endicott River drainage and other sites in the Chilkat Range.

Hunter Residency and Success. Local residents harvest the majority of moose in Subunit 1C (29 of 32 moose [91%] in 1988) because (1) residents from Southcentral and Interior Alaska have better opportunities for moose hunting closer to home, (2) Subunit 1C hunting areas are not readily accessible via highway vehicle, and (3) only Alaska residents can apply for the Berners Bay hunt (Table 4). Fewer permittees hunted in 1988 than in any of the previous 3 years (Table 5); 23% of those who hunted were successful, the highest since 1984.

Permit Hunts. Annually, between 200 and 600 applications have been submitted for Berners Bay drawing permits over the previous 5 years; e.g., 363 in 1988. The proximity to Juneau explains the popularity of this hunt.

Since the registration permit format was instigated in Hunt Area No. 959, over 200 permits have been issued annually (Table 5). The number of applicants actually hunting has ranged from 106 to 205, attesting to the popularity of moose hunting in the Juneau area. In 1988, 215 permits were issued and 138 applicants hunted. Reporting compliance has remained high.

Harvest Chronology. Similar to the preceding 4 years, much of the 1988 harvest was bagged in the first week of the season (Table 6). In 1988, 44% of the harvest occurred in the first week of the season. The vagaries of weather have a great deal to do with harvest chronology, because prolonged periods of rain can discourage hunters from going afield and winds can prevent access to hunting areas.

Transport Methods. Boats have provided the lion's share of transportation for moose hunters in Subunit 1C (Table 7), because hunting areas are removed from highway access points, seasons are closed prior to the onset of snow, and aircraft landing sites are limited. In 1988, 75% of the successful hunters in Subunit 1C used boats for access.

Natural Mortality:

Although no natural mortality was documented during the reporting period, the extended cold winter and deep snow of early 1989 undoubtedly exacerbated poor nutrition and enhanced wolf predation.

CONCLUSIONS AND RECOMMENDATIONS

Winter surveys suggested low-but-stable and reduced moose populations in Berners Bay and the Taku River, respectively. A continuation of the registration permit system should accommodate population objectives, despite survey biases. In Berners Bay the harvest quota of 5 bulls should remain in effect.

Throughout Subunit 1C jaws of harvested moose should be collected and analyzed. Once population and carrying capacity estimates are made for the Taku and Endicott River populations, consideration should be given to the establishment of harvest quotas in those hunt areas.

Population objectives for each of the 3 herds are probably being met; however, the population estimate for the Chilkat Range remains speculative. Harvest and other parameters of the hunt vary annually, but the averages appear to be at or slightly below the objective levels. The harvest in Berners Bay could probably be increased, but we are not proposing such a change because recent survey data are not available.

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Table 1. Berners Bay historical moose survey data (Subunit 1C), 1984-1988.

Year	No. bulls	No. cows	No. calves	Unk sex/age	Total sample	No. MM: 100 FF	Calves/ 100 FF	% calves	Count time	Moose/ hour
1984	22	60	19	0	101	37	32	19	2.2	46
1985	20	44	6	0	70	46	14	9	2.3	30
1986	15	46	7	0	68	33	15	10	1.6	41
1987	No survey									
1988[a]	3	53	12	0	68	6	23	18	2.2	3

[a] Early winter survey; sex and age ratios unreliable.

Table 2. Historical moose survey data in the remainder[a] of Subunit 1C, 1983-1988.

Year	No. bulls	No. cows	No. calves	Unk sex/age	Total sample	No. MM: 100 FF	Calves/ 100 FF	% calves	Count time	Moose/ hour
1984	No survey									
1985	No survey									
1986[b]	3	10	6	0	19	30	60	32	1.5	13
1986[c]	2	42	1	0	45	5	2	2	1.8	25
1987	No survey									
1988[b]	No survey									
1988[c]	2[d]	16	4	0	22	13	25	18	1.6	14

[a] excluding Berners Bay
[b] Chilkat Range
[c] Taku
[d] Early winter survey; sex and age ratios unreliable

Table 3. Annual harvest by hunt area in Subunit 1C, 1984-1988.

	Reported				Estimated		
Year	Berners Bay	Taku	Chilkat Range	Total	Unreported	Illegal	Total
1984	13	18	6	37	0	1	38
1985	13	26	7	46	0	0	46
1986	5	15	10	3	0	0	30
1987	5	13	6	24	0	0	24
1988	4	17	11	32	0	0	32

Table 4. Hunter residency and success in Subunit 1C, 1984-88.

Year	Successful				Unsuccessful			
	Local Res. [a]	Nonlocal Res.	Nonres.	Total	Res.	Res.	Nonres.	Total
1984	39	0	0	39	102	6	3	111
1985	42	3	1	33	145	16	1	162
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

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

Table 5. Harvest data by permit hunt in Subunit 1C, 1984-88.

Hunt No.	Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows	Total
901	1984	15	0	1	14	1	13	14
	1985	14	0	0	13	8	5	13
	1986	7	0	2	5	5	0	5
	1987	5	0	0	5	5	0	5
	1988	5	0	1	4	4	0	4
959	1984	217	79	110	25	25	0	25
	1985	245	51	161	33	33	0	33
	1986	241	69	145	26	26	0	26
	1987	222	69	185	20	20	0	20
	1988	215	76	110	28	28	0	28
1988 totals for both hunts		220	76	111	32	32	0	32

Table 6. Harvest chronology in Subunit 1C, 1984-88.

Year	15-21 Sept	22-28 Sept	5 Oct-29 Sept	6-15 Oct
1984	13	6	8	12
1985	19	7	4	16
1986	15	4	5	7
1987	13	4	3	5
1988	14	8	2	8

Table 7. Successful hunter transport methods in Subunit 1C, 1984-88.

Year	Airplane	Boat	3- or 4-wheeler	snow machine	ORV	Highway vehicle
1984	5	34	0	0	0	0
1985	7	37	0	0	0	0
1986	9	20	0	0	0	1
1987	1	24	0	0	0	0
1988	8	24	0	0	0	0

STUDY AREA

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

GEOGRAPHICAL DESCRIPTION: That portion of the southeast Alaska mainland lying north of the latitude of Eldred Rock, excluding Sullivan Island and the drainages of Berners Bay

BACKGROUND

In Subunit 1D most moose inhabit the Chilkat River watershed and the Chilkat Peninsula. There is an estimated 200-250 mi^2 of moose summer range, 110-120 mi^2 of winter range, and 80 mi^2 of preferred winter range. Smaller parcels of moose habitat are located in the Chilkoot, Katzehin, and Warm Pass Valleys, and along the western shore of Lynn Canal.

Moose populations peaked in the Chilkat Valley in the mid-1960's, when as many as 700 may have been present. A sharp decline, possibly attributable to overutilization of range in the moose population occurred by the early 1970's (i.e., 400-500). Census data collected during the mid-1980's suggested that moose numbers had declined to approximately 400 in the Chilkat River drainage. The most recent surveys indicate a slightly increasing moose population.

Residents of Subunit 1D have expressed concern over the decrease in moose hunting opportunities. In 1986 the ADF&G staff worked closely with the area residents and fish and game advisory committees to formulate a comprehensive moose management plan for the area. This plan is in the process of being updated. Suggested revisions reflect current survey data and harvest trends. Harvest objectives identified in the original plan were based on projected calf survival rates that have not been realized; therefore, these were reduced in the draft of the revised plan. The draft plan for the years 1990 to 1994 will be presented to the public for comments in the fall of 1989.

POPULATION OBJECTIVES

To maintain a population of 450 moose, a posthunting bull:cow ratio of 25:100, a sustained annual harvest of 30, and a hunter success rate of 12%.

METHODS

An aerial survey of the moose population was conducted on 30 December 1988. The area surveyed included the Chilkat Valley from Murphy Flats to the vicinity of Turtle Rock, the Klehini, Kelsall, and Tahkin River valleys to the limit of moose tracks, and the Hidden Valley area of the Chilkoot River drainage. Harvest data was gained from registration permit returns for the 1988 fall hunt. Successful hunters were asked to retain the front portion of the lower jaw to allow age determination by cementum annuli examination.

RESULTS AND DISCUSSION

Population Status and Trend

Moose densities declined sharply in the late 1960's and early 1970's. The rate of decrease moderated somewhat over the next decade. Between 1978 and 1987 the population fluctuated around a median of approximately 400 moose. The aerial survey conducted in late December 1988 yielded the highest total population and moose per hour of survey time counts in more than 8 years. The calf:adult ratio was still depressed, as it has been since 1984. Calf survivals were apparently low. This survey was conducted under excellent conditions. Despite the encouraging results of the 1988 survey, it is probable that moose numbers are increasing only slightly.

Population Size and Composition:

Poor flying and surveying conditions in the fall of 1988 resulted in delaying aerial sex and age composition counts until late December. Because an unknown percentage of the bulls had shed their antlers by then, sex ratios were not determined. There were good-to-excellent survey conditions and ample snow cover.

A total of 252 moose were observed in 4.4 hours of survey time, for an average of 57 moose per hour (Table 1). While the majority of moose in Subunit 1D inhabit the Chilkat Valley and associated drainages, lesser numbers can be found on the Chilkat Peninsula and along the lower reaches of the Katzehin River; these areas were not surveyed. Based on aerial surveys in this area, a sighting of 50% has frequently been used to estimate moose numbers. I am reluctant to use that conversion factor for the 1988 because of the perceived high observation rate at the time of surveying. Until additional data supporting an increase in the moose population are acquired, there are approximately 400 moose in Subunit 1D.

Composition estimates are restricted to calf:adult ratios because of the late-winter timing of the survey. Of 252 animals sighted, 31 (12%) were calves. Similar to the 11% observed in 1987-88 (Table 1) and slightly below the previous 5-year average (1984-87) of 14%.

Mortality

Season and Bag Limit:

The open season for subsistence hunters only in Subunit 1D is 1 to 10 September. The bag limit is 1 bull by registration permit only; 15 bulls may be harvested by residents of Subunit 1D only.

Human-induced Mortality:

This was the 2nd year in which the harvest quota of 15 bulls was in effect. Compliance with a request for early reporting of harvests was again excellent; however, the quota was still exceeded (i.e., 18 bulls). Although the hunt was closed by noon of the 1st day, posthunting interviews with successful hunters suggested that the quota had been reached prior to 1,000 hours.

Ages were determined for 17 harvested moose (Table 2). The mean age was 2.8 years, down slightly from the 3.2 average in 1987, but similar to the 5-year mean of 2.9.

Hunter Residency and Success. Of 259 registrants for the 1987 moose hunt, 247 (95%), nine (4%), and three (1%) were Haines, Klukwan, and Skagway residents, respectively. Of the hunters obtaining permits, 207 (80%) indicated that they had participated in the hunt. Eighteen hunters (9%) were successful.

Transport Methods. The majority of successful hunters, 88%, reported using boats to reach hunting areas. Highway vehicles (6%) and off-road vehicles (6%) were also used.

Natural Mortality:

Discussions with area sportsmen suggested that the brown bear population has increased in recent years, and predation may be partly responsible for the poor recruitment rates observed. Data in support of this contention is not available. Deteriorating range conditions (Hundertmark et al. 1983) may also play a role in low calf production and survival.

Habitat

Nearly all of the moose range lies within the state forest, and it 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 have occurred during the reporting period in the Chilkat Valley above Wells Bridge and in the upper reaches of the Kelsall River. Use of either of these areas by moose will be sporadic, primarily in the summer. Although Hundertmark et al. (1983) determined that moose made extensive use of coniferous forest habitat during both summer and winter, these harvest areas do not contain important winter range. While some benefits may be accrued for moose through increased browse plant production in logged areas, the extent of deciduous reproduction in clear-cuts located in the upper reaches of the Valley has not yet been determined.

CONCLUSIONS AND RECOMMENDATIONS

Calf survival and recruitment are primary areas of concern for the Subunit 1D moose population. Population objectives identified in the 1986 Subunit 1D Moose Management Plan have been revised. Because of continued low recruitment, a sustainable annual harvest of 45 bulls was felt to be unrealistic in the near term. The revised objective of an annual surplus of 30 bulls will only be met if calf survivals increase.

The extent of predation on moose calves by brown and black bears is not known. Radio-collaring of moose calves in the spring to determine rates and causes of mortality have been considered and rejected because of costs and habitat conditions that would make capture of calves by helicopter impractical. Supplemental feeding of predators during critical calving periods has proven effective in relieving predation pressures until calves are old enough to successfully avoid predators. Such a method that may be feasible for use in the Chilkat Valley is under consideration.

A thorough investigation of relationships between moose habitat and logging in the Chilkat Valley is needed. Mechanical crushing, chaining, and firing (i.e., methods to rejuvenate browse) should be considered in areas where timber harvests are impractical or undesirable. Inexpensive removal of decadent alder and cottonwood stands could be accomplished by volunteers. Small-scale removals could be monitored to determine browse production and use by moose prior to more expensive efforts.

Because sex composition data for this moose population has not been gathered for 3 years, progress toward meeting established management goals is not clear. Every effort should be made to collect such data in 1989. Until management goals are met, harvests will likely remain restrictive. Hunters have continued to express their displeasure over the 1-day season that offers little in the way of a quality hunting experience. Changes to the hunting regulations for Subunit 1D will be considered by the Board of Game. Proposals that could slow the pace of the hunt, such as a spike-fork antler restrictions, are under consideration by the Department. While annual harvest objectives will not be reached sooner under such conditions, the number of hunters afield and hunter-days of effort would rise appreciably.

LITERATURE CITED

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Table 1. Moose survey data in Subunit 1D, 1984-1989.

Year	Bulls	Cows	Calves	Unknown sex/age	Total	No. MM: 100 FF	No. calves :100 FF	Percent calves	Moose /hour
1984[a]	--	---	11	77	88	--	--	13	23
1884	15	135	37	0	187	11	27	20	36
1985	23	155	29	0	207	15	19	14	38
1986	33	93	13	0	139	36	14	9	40
1987[a]	--	---	29	174	203	--	--	14	53
1988[a]	--	---	21	165	186	--	--	11	53
1989[a]	--	---	31	221	252	--	--	12	57

[a] Late-winter survey; sex and age composition not available.

Table 2. Moose harvest by age class in Subunit 1D, 1983-88.

	Age Class											
Year	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5+[a]	*n*	Mean	Known harvest
1983	1	3	7	10	6	0	1	2	0	1	31	3.7	31
1984	2	15	12	2	2	1	0	0	0	0	34	2.2	34
1985	0	7	4	1	0	1	0	0	0	0	13	2.3	13
1986[b]	--	--	--	--	--	--	--	--	--	--	--	---	0
1987	0	3	6	7	3	1	0	0	0	0	20	3.2	22
1988	0	6	5	3	1	1	1	0	0	0	17	2.8	18

[a] Includes animals 9.5 years and older.
[b] No open season.

Table 3. Hunter residency and success in Subunit 1D, 1984-88.

Year	Successful				Unsuccessful			
	Local res.[b]	Nonlocal res.	Nonres.	Total	Local res.	Nonlocal res.	Nonres.	Total
1984	24	10	1	35	298	12	4	314
1985	14	0	0	14	29	0	0	29
1986[a]	--	--	--	--	--	--	--	--
1987	22	0	0	22	208	0	0	208
1988	18	0	0	18	185	0	0	185

[a] No open season in 1986.
[b] Local residents are those persons living in Unit 1D.

Table 4. Harvest data for permit hunt No. 959 in Subunit 1D, 1984-88.

Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows	Total
1984	555	206	314	35	35	0	35
1985	43	0	29	14	14	0	14
1986[a]	--	--	--	--	--	--	--
1987	294	64	208	22	22	0	22
1988	259	52	185	18	18	0	18

[a] No open season in 1986.

Table 5. Harvest chronology in Subunit 1D, 1984-88.

	September			
Year	1-7	8-15	16-23	24-30
1984[a]	--	8	20	7
1985[b]	--	4	14	--
1986[c]	--	--	--	--
1987[d]	22	--	--	--
1988[d]	18	--	--	--

[a] Season opened September 15 and closed September 27.
[b] Season opened September 15 and closed September 21.
[c] No open season in 1986.
[d] One day season, September 1.

Table 6. Successful hunter transport methods (%) in Subunit 1D, 1984-89.

Year	Airplane	Boat	Orv	Highway vehicle
1984	14	49	9	29
1985	0	50	0	50
1986[a]	--	--	--	--
1987	14	55	5	27
1988	0	88	6	6

[a] No open season.

STUDY AREA

GAME MANAGEMENT UNIT: 5 (6,235 mi^2)

GEOGRAPHICAL DESCRIPTION: Cape Fairweather to Icy Bay, eastern Gulf Coast

BACKGROUND

The moose population in Unit 5 peaked in the early 1960's; population estimates exceeded 2,000. The population began declining in the mid-60's. Poor reproductive success and the severe winters of 1971-72 and 1972-73 depressed the moose population, and hunting seasons were closed between 1974 and 1977. Since that time, moose hunting has been regulated by registration permits. The three herds occupy Unit 5: the Yakutat Forelands, Malaspina Forelands, and the Nunatak Bench Herds.

POPULATION OBJECTIVES

To maintain a posthunting population of 1,000 moose, an annual harvest of 47, and a hunter success rate of 28% in the Yakutat Forelands Herd.

To maintain a posthunting population of 50 moose, and annual harvest of 5, and a hunter success rate of 50% in the Nunatak Bench Herd.

To maintain a posthunting population of 250 moose, an annual harvest of 25, and a hunter success rate of 50% in the Malaspina Forelands Herd.

METHODS

Winter aerial surveys to determine sex and age composition were conducted in Subunit 5A from 5 to 7 December 1988. Sufficient snowfall for good survey conditions came late in the fall, and the Subunit 5A and Subunit 5B surveys were completed after antler drop. Moose incisors surrendered by successful hunters were ground and aged by examination of cementum annuli. Data collected from registration permit reports included the number of days hunted, hunter residency, harvest date and location, and transport type.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

Population surveys have not been recently conducted in Unit 5. It is unknown whether the Nunatak Bench herd in Subunit 5A has re-formed following the retreat of the Hubbard Glacier and the subsidence of the waters of Russell Fiord in 1986. Since the hunting closures in the mid-70's, the moose population in Subunit 5A has been slowly rebuilding; now it may be at or near carrying capacity. Some evidence has suggested the population in Subunit 5B may have declined over recent years.

In Subunit 5A (excluding the Nunatak Bench) a total of 515 moose were counted in December 1988 (Table 1) under good-to-excellent survey conditions. The count was the highest since the population crash in the early 1970's. Furthermore, total survey time and the moose-per-hour value were the lowest and highest, respectively, of the last 5 years (Table 2). The area between the Alsek and Doame Rivers was not surveyed because of poor weather conditions; this area accounted for 24% of the moose observed in the fall of 1985.

The cause of the 60% increase in the number of moose observed in 1987 is unknown; good survey conditions increased sightability. Many comments were received from members of the public who perceived more moose than usual along the west side of the Alsek River. Although this increase may have been the result of moose movement from the upper Alsek during the previous winter, snow data from 1987-88 does not suggest accumulations deep enough to instigate such large-scale movements. A more likely explanation is that the recent series of mild winters has allowed for higher survival rates; however, the percentage of calves (i.e., 17%) observed during the 1988 survey does not appear to support this hypothesis.

The Nunatak Bench herd in Subunit 5A was not surveyed because of poor weather. Prior to the 1986 flooding of the Nunatak Bench herd's winter range when Hubbard Glacier blocked Russell Fiord, there were an estimated 50 moose in the herd. Numbers were undoubtedly reduced during the flooding. Water levels have now receded in the fiord, and moose may have moved back into this area.

No surveys were conducted in Subunit 5B in 1988. Only a portion of Subunit 5B has been surveyed since 1982, and the last two were done after most antlers had dropped. I estimate the population in Subunit 5B was approximately 250 moose.

Population Composition:

Composition counts in December showed bull:cow and calf:cow ratios of 27:100 and 25:100, respectively, in Subunit 5A (Table 1). Except for 1986, these ratios are consistent with previous surveys. A bias in the survey in 1986 may have caused a lower bull:cow ratio and a higher calf:cow ratio than was actually present. The 1988 survey showed 17% calves, lower than the previous 5-year average (21%), but favorably comparable with two out of three winter surveys conducted in the preceding 5 years (Table 2). No composition counts were conducted in Subunit 5B or the Nunatak Bench area in Subunit 5A.

Mortality

Season and Bag Limit:

The open season for subsistence hunters in Subunit 5A is 15 October to 15 November; the open season for all hunters in Subunit 5A is 22 October to 15 November. There is no open season for Nanutak Bench. The bag limit is 1 bull by registration permit only; 50 bulls may be taken. The season will be closed in that portion west of the Dangerous River when 25 bulls have been taken in that area. The open season for all hunters in Subunit 5B is 1 September to 15 November. The bag limit is 1 bull by registration permit only; 25 bulls may be taken.

Human-induced Mortality:

Since 1982 the Yakutat and Malaspina Forelands hunts have been managed for quotas of 50 and 25 bull moose, respectively. 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 70 moose since 1984 (Table 3).

In 1988, 47 moose were harvested in 9 days in Subunit 5A, and the area west of the Dangerous River was closed after only 7-1/2 days of hunting and a harvest of 23 bulls. Because of the short nature of the hunt, nonresident and nonlocal hunters were essentially excluded from participation. The rapid attainment of the quota may be indicative of high moose numbers on the forelands. About 50% of moose observed during surveys were located west of the Dangerous River (Table 1); assuming animal distribution was similar during the hunting season, this could help explain the rapid harvest. Furthermore, from 1 to 13 October, 22 inches of rain had fallen. I estimated that alder, cottonwood, and willow were about 80% bare of leaves because of rain and wind, leaving moose in deciduous thickets highly visible to hunters.

No poachers were apprehended during the year, but there was a rumor of at least 1 moose taken illegally (Table 3). The illegal harvest is very low in Subunit 5A, because of active law enforcement and the closed nature of small communities. In

Subunit 5B poaching may be fairly high because of the remote nature of the area.

Hunter Residency and Success. The 1984-1988 average annual moose harvest for local residents within Unit 5 was 34, ranging from 29 to 44 (Table 4). The 1988 harvest of 44 (76% of the total take) by this group was higher because of local subsistence hunters having 1 week to hunt prior to the opening of the general season.

Local residents also took higher percentages of the harvest in 1985 and 1987. In 1985 the hunt was under a "Tier II" format (i.e., 200 permits to qualifying local subsistence hunters), and in 1987 hunting in the 1st week was restricted to local subsistence hunters.

Nonlocal residents harvested an average of 23 moose annually between 1984 and 1988, but only 12 (21%) in 1988 (Table 5). Nonresidents took an average of 3 moose annually during the 5-year period.

Permit Hunts. In 1988 only local hunters could hunt during the 1st week of the season in the Yakutat Forelands (Hunt Area No. 961) in Subunit 5A. The 1st week traditionally accounts for a majority of the total harvest. In 1988 a low number of permits were issued (i.e., 206) compared with those issued in previous years when the "Tier II" format had not been in effect (mean = 267).

In 1985 Hunt Area No. 961 was a "Tier II" subsistence hunt and the number of permits issued was low (Table 5). A 200-permit ceiling was established, but the hunt was undersubscribed. Many nonlocals did not apply, mistakenly thinking they would not qualify.

There were 58 permits issued for the Malaspina Forelands (Hunt Area No. 962) in Subunit 5B, close to the 1984-1988 mean of 62 (Table 5). A fewer number of "did-not-hunts" were recorded in 1988 than in 1985 and 1987.

Division of Commercial Fisheries and Fish and Wildlife Protection Division staff assisted with issuing permits and monitoring hunts. Few permittees responded late in 1988 because of enforcement activities and growing familiarity with registration permit hunts.

Harvest Chronology. The early season moose harvest in Unit 5 was relatively low. The hunting season in Subunit 5B was open from 1 September to 15 November (Table 6), and seven of the 11 moose harvested (64%) were taken by 15 October.

Most of the Subunit 5A harvest occurred in the 1st week of the season (i.e., October 15-21). In 1988, 16 of 47 (34%) and 37 (79%) moose were harvested on opening day and by the end of the 1st week, respectively. The season was closed by Emergency Order

9 days after opening. No season has been open in the Nunatak Bench area (Hunt Area No. 960) since 1986.

Transport Methods. Most hunters used aircraft for access (Table 7). Of successful hunters, 20 of 47 (43%) in 5A and 9 of 11 (82%) in 5B utilized planes. Aircraft have been the most popular means of access during the last 5 years, ranging from 41% to 65% (mean = 54%). Boat access was less important in 1988, accounting for only 12% of all successful hunters. Associated with this decrease was an increase in 3- and 4-wheelers. Off-road vehicles have been used in Yakutat for many years, and more hunters seem to be using them for access. Indeed, vehicle ruts are now common in meadows in Subunit 5A.

Natural Mortality:

Reports of natural mortality during 1988-89 were higher than those in recent years. Because of an extended cold spell following heavy snows in January, snow remained on the ground longer than usual; there were between 45 and 60 inches of snow on the ground for 27 days. This factor may have resulted in increased mortality.

Habitat Assessment and Enhancement

While no quantitative data were collected, observations of winter browse across the Yakutat Forelands suggested that moose were near carrying capacity. Moderately to heavily browsed willow and large-trunked cottonwood were common. Subjective evaluation suggests that feltleaf willows (*Salix alaxensis*) have been browsed at a disproportionate rate in relation to its occurrence.

The U.S. Forest Service (USFS) made little progress on a study of moose browse response to mechanical treatment. Previously considered study areas were discarded for a location south of the Harlequin Lake recreational cabin. The emphasis of the project changed by the end of the reporting period, and the Forest Service now plans to remove spruce in an attempt to forestall plant succession. While it is true that spruce/hemlock is the climax habitat throughout much of the forelands, such an approach will not address the apparent reduction of browse vitality. Hopefully, both aspects of this matter will be addressed in future work.

Game Board Actions and Emergency Orders

The hunting season in Subunit 5B was closed by Emergency Order on 23 October, because of the imminent possibility of exceeding the quota. On 22 October the season was closed west of the Dangerous River. The last time the season was closed early in Unit 5A was in 1984; i.e., 13 November.

CONCLUSIONS AND RECOMMENDATIONS

A drawing-permit cow hunt would have been proposed for 1988 if moose regulations had been subject to consideration by the Board of Game. Provided 1989 sex and age surveys indicate no significant changes from 1988 surveys, such a proposal should be made for 1990.

A winter habitat utilization study should be instigated in Subunit 5A. The role of climax habitats are not well understood for this moose population. Other important information could be gained as well; e.g., more accurate population estimate, calving locations, pregnancy rates, and accurate herd composition. A minimum of 40 moose should be telemetered for the study.

Fall sex and age composition counts are needed for Subunit 5B and the Nunatak Bench in Subunit 5A. Weather constraints have prevented adequate counts in these areas.

Cooperation with the USFS in a browse treatment study should be continued. Treatment of willow and cottonwood stands and removal of young spruce stands should be included in the study.

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Table 1. Moose sex and age composition in Subunit 5A, fall, 1988.

Date	Location	Bulls	Cows W/O	Cows W/1	Cows W/2	Lone calves	Bulls/ 100 cows	Calves/ 100 cows	Total moose	Calf % in herd	Count time/hr	Moose/ hour
Dec. 5 1988	Above FH-10	1	1	3	0	0	25	75	8	38	.9	9
Dec. 5 1988	Dangerous Italio Rivers	13	67	9	1	0	17	14	101	12	2.2	46
Dec. 6 1988	Alsek-Italio Rivers	35	89	13	3	0	33	18	159	14	2.7	59
Dec. 6/July 1988	Dangerous Situk Rivers (below highway)	40	96	28	7	3	31	34	216	21	4.9	44
Dec. 7 1988	Situk River-FH-10	2	16	5	1	0	9	32	31	17	.8	39
Total Alsek River FH-10		91	269	58	12	3	27	25	515	17	11.5	45

Table 2. Moose survey data in the Yakutat Forelands, Subunit 5A, 1984-1988

Year	No. bulls	No. cows	No. calves	Unk sex/ age	Total sample	MM/100 FF	Calves 100 FF	% calves	Count time	Moose/ hour
1983/84 F[a]	No survey									
1983/84 W	0	83	299	382	0	0	22	12.0	0	32
1984/85 F	90	229	60	0	379	39	26	16	12.1	31
1984/85 W		26	113	139	0	0	19	5.9	24	
1985/86 F	50	168	41	0	259	30	24	16	11.0	24
1985/86 W	No survey									
1986/87 F	34	166	60	0	260	20	36	23	11.3	23
1986/87 W	No survey									
1987/88 F	No survey									
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
1988/89 W	No survey									

[a] F = fall count; W = winter count

Table 2B. Moose survey data in the Malaspina Forelands, Subunit 5B, 1984-1988

Year	No. bulls	No. cows	No. calves	Unk sex/ age	Total sample	MM/100 FF	Calves 100 FF	% calves	Count time	Moose/ hour
1983/84 W[a]	0	0	21	45	66	0	0	32	1.8	37
1984/85	No survey									
1985/86	No survey									
1986/87	No survey									
1987/88 W	0	0	14	55	69	0	0	20	2.8	25
1988/89	No survey									

[a] W = winter count

Table 3. Annual harvest for 1984-88 and subunit harvest for 1988 in Unit 5.

Year	Reported	Estimated total harvest
1984	70	70
1985	59	61
1986	63	63
1987	46	46
1988	58	59
Subunit		
A	47	48
B	11	11

Table 4. Hunter residency and success in Unit 5, 1984-88.

Year	Successful				Unsuccessful			
	Local res.[a]	Nonlocal res.	Nonres.	Total	Local res.[a]	Nonlocal res.	Nonres.	Total
1984	29	36	5	70	153	72	16	241
1985	35	21	0	59	90	38	5	133
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

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

Table 5. Harvest data by permit hunt in Unit 5, 1984-88.

Hunt no.	Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows
960[d]	1984	20	6	8	6	3	3
	1985	6	3	1	2	2	0
	1986	5[a]	5	0	0	0	0
	1987	0[b]	0	0	0	0	0
	1988	0[b]	0	0	0	0	0
961[d]	1984	287	57	181	49	49	0
	1985	146	26	76	44	44	0
	1986	271[c]	73	144	54	54	0
	1987	242	43	161	38	38	0
	1988	206	48	108	47	47	0
962[d]	1984	54	4	35	15	15	0
	1985	94	32	49	13	13	0
	1986	42[c]	0	33	9	9	0
	1987	60	36	16	8	8	0
	1988	58	18	29	11	11	0
1988 totals all hunts		264	66	137	58	58	0

[a] Season closed prior to hunting effort.
[b] Season closed.
[c] 5A & B permits combined; all did-not-hunts coded to 961.
[d] Hunt 960 is Nunatak Bench; 961 is Yakutat Forelands; 962 is Malaspina Forelands.

Table 6. Harvest chronology in Unit 5, 1984-88.

Year	Sept 1-15	Sept 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16 Feb 15
1984	4	4	17	33	6	6
1985	1	1	20	30	5	2
1986	0	4	23	36	0	0[a]
1987	1	2	4	37	2	0[a]
1988	1	4	19	34	0	0[a]

[a] Nunatak Bench hunt closed.

Table 7. Successful hunter transport methods in Unit 5, 1984-88.

Year	Airplane (%)	Boat (%)	3- or 4-wheeler (%)	Orv (%)	Highway vehicle (%)
1984	43 (62)	16 (23)	3 (4)	3 (4)	5 (7)
1985	30 (51)	13 (22)	5 (8)	0 (4)	5 (7)
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)

STUDY AREA

GAME MANAGEMENT UNIT: 6 (10,140 mi^2)

GEOGRAPHICAL DESCRIPTION: Prince William Sound and North Gulf Coast

BACKGROUND

Griese (1989) summarized the historical status of indigenous moose as well as the dispersal of the moose population that had been introduced to the Copper River Delta. Moose from the Malaspina Glacier forelands may have reached eastern Subunit 6A near Icy Bay in the 1960's. The total number of moose harvested from the introduced population reached 2,375 through 1987.

Five-year population objectives were established in 1987 for the major moose populations. These population objectives called for higher population densities than had been set in the 1976 management plans (Rausch 1977).

POPULATION OBJECTIVES

To maintain observed moose densities between 1.8 and 2.0 moose/mi^2 in the fall and posthunting bull:cow ratios of 30:100.

METHODS

Upon receiving adequate snow cover, aerial trend and composition surveys were conducted during late November or early January; A PA-18 Supercub was used at search intensities of 1.4-2.2 minutes/mi^2. Surveys were conducted mostly under excellent conditions; although Subunit 6A east of Suckling Hills was surveyed under fair-to-good conditions because of incomplete snow cover. Sex and age composition was determined and recorded by group and uniform coding unit (UCU).

Population estimates were based on the number of moose observed, percentage of wintering habitat surveyed, and quality of survey conditions. Population estimates increased by increments based on survey quality. "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.

Moose harvests were monitored by 2 separate methods. Hunters participating in drawing or registration permit hunts were required to report effort and were sent up to 2 reminder letters. Hunters participating in general moose hunts were sent single reminder letters, if they failed to return their original hunt report. Hunter success and effort were recorded by UCU. The lower front teeth of moose were collected from successful permit hunters. Moose ages were determined by counting cementum lines of teeth (Gasaway et al 1978).

RESULTS AND DISCUSSION

Population Status and Trend

The n umber of moose in Unit 6 was at a record-high level. Estimates of individual moose populations (Table 1) represented individual record-high numbers. Observed winter densities of 1.6-3.5 moose/mi.^{2} in individual populations also reflected record-high populations (Table 2).

All moose populations in Unit 6 were increasing. While Subunit 6D has never been surveyed, anecdotal observations suggested a small population of moose growing slowly. Uniformly good calf survivals throughout the unit (Table 2) were primarily responsible for the recent increase; however, reduced hunter harvest was probably equally important.

Population Size:

There are an estimated 1,490-1,650 moose in Unit 6 (Table 1). The largest pouplation (i.e., 500 moose) occupied Subunit 6A east of Suckling Hills.

Population Composition:

Aerial sex and age composition surveys of the population indicated ratios of 10-35 antlered males: 100 antlerless adults and 28-39 calves: 100 antlerless adults (Table 2). Although the sex and age composition in Subunit 6A west of Suckling Hills and in Subunit 6C accurately reflected the composition of those populations, the January surveys in Subunit 6A east of Suckling Hills and in Subunit 6B were misleading because antler drop inflated the antlerless adult segments of the populations. Ratios in the later populations were considered minimum.

Mortality

Season and Bag Limit:

The open season for resident and nonresident hunters in Subunit 6A west of Cape Suckling is 1 September to 15 October. The open season for resident and nonresident hunters in the remainder of Subunit 6A is 20 August to 31 December. The bag limit for Subunit 6A is 1 moose. The open seasonf or Alaska residents only in Subunits 6B and 6C is 1-30 September. The bag limit in Subunit 6B is 1 bull by drawing permit only (10 permits). The bag limit in subunit 6C is 1 moose by drawing permit only; up to 20 permits each for antlered and antlerless moose will be issued.

The open season for resident and nonresident hunters in Subunit 6D is 1-30 September; the bag limit is 1 bull.

Human-induced Mortality:

The reported moose harvest during the fall of 1988 reached 107, the lowest in 5 years (Table 3). The reduced harvest occurred primarily because of reduced bag limits on the road system and reduced effort by local hunters in Subunit 6A (Table 4). A substantial decline in hunting opportunities has also occurred in the last 5 years in Subunits 6B and 6C (Table 5); the combined harvest in these subunits declined from 83 moose in 1984 to only 39 in 1988.

The reported harvest of 107 moose was composed of 66% males and 34% females (Table 2). The female harvest was limited in Subunits 6B and 6C because of low recruitment during 1987 (Griese 1989). The average age of 41 males was 2.3 years (range = 0.3-6.3), and the average age of 18 females was 2.7 years (range = 0.3-10.3).

The illegal and unreported harvest was estimated at 23 moose, primarily from Subunit 6A (Table 3). An estimated 73% of successful hunters participating in the general hunt in eastern Subunit 6A were successful.

<u>Hunter Residency and Success</u>. The reported harvest by Alaska residents represented 81% of the 1988 harvest and 86% of reporting hunters (Table 4). Nonresidents have increased their participation slightly over the past 5 years. Hunter success was 41% for the 258 reporting hunters in Unit 6 (Table 4); i.e., 56% in Subunit 6A, 32% in 6B, 100% in 6C, and 15% in 6D.

<u>Permit Hunts</u>. Two drawing-permit hunts were conducted in Subunits 6B and 6C, offering 10 bull permits and 10 antlerless moose permits (Table 5). Hunter success was 95%, which was typical for this type of hunt; i.e., Cordova road system.

Registration hunts were conducted in Subunits 6A and 6B; 286 total permits were issued (Table 5), and 60 moose were harvested. Registration hunts were monitored and stopped when maximum allowable harvest levels had been reached.

<u>Harvest Chronology</u>. Seventy-four percent of the reported harvest in Unit 6 occurred during September (Table 6). An additional 17% were taken during October. Permit hunts limited hunting effort to September in Subunits 6B and 6C. The previous 4-year harvest trend has favored September and early October. For the last 2 years hunting in western Subunit 6A has been restricted by mid-October to encourage harvest of antlerless moose or increase the harvests east of Suckling Hills. While increases occurred, they were not substantial.

Transport Methods. The reported transport method used by Unit 6 hunters changed little over the last 5 years. Boaters, primarily airboaters, were slightly dominant again because of renewed opportunity in the registration permit hunt in Subunit 6B. The use of highway vehicles remained low because road-accessible permit hunts were restricted.

Natural Mortality:

Six moose carcasses were located in Subunits 6B and 6C during the reporting period. While one 3-year-old bull could have been the result of hunting mortality, the remaining five (ranging in age from 1.0 to 17.5) appeared to have died of natural causes; i.e., accidental drowning through ice, wolf predation, and unknown causes (J. McCracken, pers. commun.). No winter starvation was noted.

Game Board Actions and Emergency Orders

Hunting regulations for moose have changed almost annually in recent years, in response to varying levels of production and mortality. Because hunter interest and demand increased substantially for moose in Subunits 6C and 6B while recruitment rates for moose populations were declining, the Board of Game required drawing permits for Subunit 6C beginning in 1984. The number of drawing permits for Subunit 6C went from 36 to 40 (sexes combined) and then down to 20 in 1987 because of low recruitment. In Subunit 6B the popular registration permit hunt was limited to a drawing for 15 bull permits in 1986, also because of low recruitment and high demand. That registration permit hunt was once again conducted in 1988.

The rapidly expanding moose populations in Subunit 6A caused the Board to adopt more liberal regulations to entice hunters. The moose population in Subunit 6A east of Suckling Hills was hunted less than the western portion. The Board of Game varied their season lengths in 1987. Eastern Subunit 6A opened 20 August and closed 31 December for either-sex moose, while western Subunit 6A opened 1 September and closed October 15 for either-sex moose. The intent was to entice hunters into the lightly hunted eastern portion. The Board adopted a registration permit hunt for western Subunit 6A during the 1988 season to more closely monitor the harvest of bulls during the shorter season.

Beginning in 1985 the Board awarded a subsistence priority to residents of Alaska. The Tier II system used in 1985 effectively awarded all drawing permits to residents of Unit 6. Since 1986 only Alaska residents have been allowed to apply for drawing permits in Subunits 6B and 6C. In 1988 the Board extended that priority to the registration permit hunt in Subunit 6B.

CONCLUSIONS AND RECOMMENDATIONS

The population objectives in Unit 6 were attained. Winter density estimates for all subunits except 6C were at or above the objectives. The excessive density in Subunit 6A east of Suckling Hills (3.5 moose/mi^2) may cause damage to winter range. Sex composition of the moose herds fell short of the objective (i.e., 30 males:100 females), although subunit 6A west of Suckling Hills exhibited 35 males:100 females during a November survey. Subunit 6C exhibited 24 males:100 females during a November survey. January surveys conducted in the remaining populations produced greatly inflated antlerless moose segments, invalidating ratios.

The strategy of directing moose hunters to moose herds in Subunit 6A by restricting hunting opportunity to the west were ineffective. The registration permit hunt in western Subunit 6A provided an opportunity to attain composition objectives; however, further hunting effort seemed to stop when antlered moose were no longer legal to harvest. Neither hunting pressure in eastern Subunit 6A nor antlerless moose harvest in all of Subunit 6A increased appreciably following this strategy. I recommend that the season and bag limit in Subunit 6A be liberalized.

The increasing density of moose in Subunit 6B justifies efforts to stabilize the adult segment of the population. I recommend a continuation of the registration and drawing-permit hunts that allow harvests of 30 antlered and 20 antlerless moose, respectively.

Subunit 6C exhibited a density slightly less than the objective and an increasing trend. Since the observability of the moose population in Subunit 6C is greatest of all the Unit 6 populations, efforts should be made to attain composition objectives and maintain those ratios. I recommend that drawing-permit hunts for up to 20 antlered moose and up to 20 antlerless moose be conducted in 1989. Harvest of additional antlerless moose would be warranted, if population levels reach observed density objectives.

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Table 1. Moose population status, by subunit, as determined from aerial surveys in Unit 6, January 1989.

	6A (east)	6A (west)	6B	6C	6D	6A-D
Moose observed	369	398	296	231	--	1294
Estimated population	465-515	440-480	310-345	255-280	20-30	1490-1650
% calves	20%	22%	23%	20%	--	$\underline{x}$ = 22%

Table 2. Moose composition counts by subunit Unit 6, 1984-88

Subunit	Year	Males: 100 females	Calves: 100 females	Calf % of herd	Adults	n	Moose /hr	Density
6A East								
	1984	--	--	--	--	--	--	--
	1985	34	28	17	286	346	99	3.3
	1986	--	--	--	--	--	--	--
	1987[a]	12	26	19	244	301	97	2.8
	1988[b]	10	28	20	294	369	62	3.5
6A West								
	1984	--	--	--	--	--	--	--
	1985	19	18	13	243	279	66	1.7
	1986[b]	14	44	28	183	254	71	1.4
	1987[a]	10	26	19	172	213	46	1.1
	1988	35	39	22	309	398	53	2.2
6A Subtotal								
	1984	--	--	--	--	--	--	--
	1985	27	23	15	529	625	81	2.4
	1986[b]	14	44	28	183	254	71	1.4
	1987[a]	11	26	19	416	514	66	1.8
	1988[b]	22	33	21	603	767	57	2.7
6B								
	1984	64	32	16	151	180	43	1.1
	1985	33	8	6	159	169	39	0.9
	1986[c]	--	--	13	132	152	39	0.9
	1987[a]	40	20	12	205	234	50	1.3
	1988[b]	11	32	23	229	296	76	1.8
6C								
	1984	26	36	22	132	170	59	1.2
	1985[a]	19	37	24	139	194	51	1.4
	1986	--	--	--	--	--	--	--
	1987[a]	24	18	13	103	118	37	1.3[4]
	1988	24	32	20	182	231	57	1.6

Table 2. Continued.

Subunit	Year	Males: 100 females	Calves: 100 females	Calf % of herd	Adults	n	Moose /hr.	Density
6D - No data								
Total								
	1984	44	34	19	283	350	49	1.1
	1985[a]	26	23	15	836	988	63	1.7
	1986[c]	--	--	22	315	406	54	1.2
	1987[a]	20	24	16	724	866	55	1.5
	1988[b]	19	33	22	1014	1294	60	2.2

[a] All or part of area surveyed in December, cow segment inflated
[b] All or part of area surveyed in January, cow segment greatly inflated
[c] All or part of area surveyed in March, ratios are not meaningful
[d] Portion of area resurveyed under improved survey conditions to provide more comparable density estimate

Table 3. Moose harvest and accidental death by subunit in Unit 6, 1984-88.

		Reported			Estimated			Accidental		
Year	Subunit	M	F	Total	Unreported	Illegal	Total	Road	Other	Total
1984	6A (East)	16	1	17	2	3	22	0	0	22
	6A (West)	42	21	63	3	2	68	0	0	68
	Subtotal 6A	58	22	80	5	5	90	0	0	90
	6B	22	28	50	5	1	56	0	0	56
	6C	19	12	33	0	1	34	1	0	35
	6D	0	0	0	0	1	1	0	0	1
	Total	99	62	163	10	8	181	1	0	182
1985	6A (East)	17	10	27	4	3	34	0	0	34
	6A (West)	33	15	48	7	3	58	0	0	58
	Subtotal 6A	50	25	75	11	6	92	0	0	92
	6B	36	0	36	2	1	39	0	0	39
	6C	19	18	37	0	2	39	1	0	40
	6D	0	0	0	0	0	0	0	0	0
	Total	105	43	148	13	9	170	1	0	171
1986	6A (East)	22	13	35	4	3	42	0	0	42
	6A (West)	33	34	67	6	2	75	0	0	75
	Subtotal 6A	55	47	102	10	5	117	0	0	117
	6B	9	0	9	0	1	10	0	0	10
	6C	21	16	37	0	1	38	0	0	38
	6D	0	0	0	0	0	0	0	0	0
	Total	85	63	148	10	7	165	0	0	165
1987	6A (East)	25	14	39	6	3	48	0	0	48
	6A (West)	28	14	42	7	1	50	0	0	50
	Subtotal 6A	53	28	81	13	4	98	0	0	98
	6B	9	0	9	0	0	9	0	0	9
	6C	14	11	25	0	2	27	1	0	28
	6D	2	0	2	0	2	4	0	0	4
	Total	78	39	117	13	8	138	1	0	139

Table 3. Continued.

Year	Subunit	Reported			Estimated			Accidental		Total
		M	F	Total	Unreported	Illegal	Total	Road	Other	
1988	6A (East)	18	8	26	10	4	40	0	0	40
	6A (West)	19	20	39	3	1	43	0	0	43
	Subtotal 6A	37	28	65	13	5	83	0	0	83
	6B	22	8	30	0	1	31	0	0	31
	6C	9	0	9	0	2	11	1	1[a]	13
	6D	3	0	3	1	1	5	0	0	5
	Total	71	36	107	14	9	130	1	1	132

[a] Caught in trapper's snare.

Table 4. Moose hunter residency and success in Unit 6, 1984-88.

Year	Subunit	Successful				Unsuccessful		
		Local Res	Nonlocal Res	Nonres	Total	Resident	Nonres	Total
1984	6A (East)	2	9	6	17	--[a]	--[a]	--[a]
	6A (West)	40	5	19	63	--[a]	--[a]	--[a]
	Subtotal 6A	42	14	25	80	--[a]	--[a]	--[a]
	6B	33	5	1	49	--[a]	--[a]	--[a]
	6C	32	1	0	33	1	0	1
	6D	0	0	0	0	11	0	11
	Total	107	20	26	162	12	0	12
1985	6A (East)	5	12	11	28	15	1	16
	6A (West)	31	6	11	48	27	0	27
	Subtotal 6A	36	18	22	76	42	1	43
	6B	29	7	1	37	99	0	99
	6C	37	0	0	37	1	0	1
	6D	0	0	0	0	8	0	8
	Total	102	25	23	150	150	1	151
1986	6A (East)	9	12	10	34	13	2	17
	6A (West)	53	4	6	66	18	6	25
	Subtotal 6A	62	16	16	100	31	8	42
	6B	9	0	--[2]	9	6	--[b]	6
	6C	34	3	--[2]	37	1	--[b]	1
	6D	0	0	0	0	11	0	11
	Total	105	19	16	146	49	8	60
1987	6A (East)	6	12	21	39	13	7	20
	6A (West)	30	6	6	42	19	5	24
	Subtotal 6A	36	18	27	81	32	12	44
	6B	7	2	--[2]	9	3	--[b]	3
	6C	24	1	--[2]	25	3	--[b]	3
	6D	1	0	0	2	6	0	11
	Total	68	21	27	117	44	12	61

Table 4. Moose hunter residency and success in Unit 6, 1984-88.

		Successful				Unsuccessful		
Year	Subunit	Local Res	Nonlocal Res	Nonres	Total	Resident	Nonres	Total
1988	6A (East)	4	8	10	26	17	11	28
	6A (West)	27	6	6	39	18	4	22
	Subtotal 6A	31	14	16	65	35	15	50
	6B	28	2	--[2]	30	84	--[b]	84
	6C	8	1	--[2]	9	0	--[b]	0
	6D	3	0	0	3	17	0	17
	Total	70	17	16	107	136	15	151

[a] Unsuccessful hunters not required to report in Subunit 6A in 1984
[b] Nonresidents were ineligible for permits

Table 5. Moose harvest by permit hunt in Unit 6, 1984-88.

Hunt No.	Subunit	Year	Legal moose	Permits issued[a]	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows	Total
965	6A	1984	Either sex	R-393	?[b]	?[b]	81	59	22	81
	6A(West)	1988	Either sex	R-123	63	21	39	19	20	39
966	6B	1984	Either sex	R-371	?[b]	?[b]	50	22	28	50
		1985	Bull	R-249	74[c]	92[c]	37	36	0	37
		1986	Bull	D-15	0	6	9	9	0	9
		1987	Bull	D-15	3	3	9	9	0	9
		1988	Antlerless	D-10	0	1	9	1	8	9
964	6B	1988	Antlered	R-163	59	83	21	21	0	21
967	6C	1984	Either sex	D-36	2	1	33	19	12	33
		1985	Bull	T-20	1	1	18	18	0	18
		1986	Bull	D-20	0	0	20	20	0	20
		1987	Bull	D-15	1	1	13	13	0	13
		1988	Bull	D-10	1	0	9	9	0	9
968	6C	1985	Cow	T-21	0	1	19	0	19	19
		1986	Cow	D-20	2	1	17	1	16	17
		1987	Cow	D-15	1	2	12	1	10	12
		1988	Cow	D-0	--	--	--	--	--	--

[a] R = registration; D = drawing; T = "Tier II".
[b] Hunters who did not hunt or were unsuccessful were not required to report.
[c] Hunters who did not hunt or were unsuccessful were not required to report, however 2 letters inquiring of their effort resulted in all but 46 permittees reporting.

Table 6. Moose harvest chronology in Unit 6, 1984-88.

Year	Subunit	Aug 20-31	Sept 1-15	Sept 16-30	Oct 1-15	Oct 16-31	Nov 1-30	Dec 1-31
1984	6A (East)	--	5	4	6	1	0	0
	6A (West)	--	16	25	15	4	2	2
	Subtotal 6A	--	21	29	21	5	2	2
	6B	--	49	1[a]	--	--	--	--
	6C	--	10	22	--	--	--	--
	6D	--	0	0	--	--	--	--
	Total	--	80	52	21	5	2	2
1985	6A (East)	0	5	6	9	2	3	2
	6A (West)	0	4	17	19	3	4	0
	Subtotal 6A	0	9	23	28	5	7	2
	6B	--	24	12	--	--	--	--
	6C	--	21	12	4	--	--	--
	6D	--	0	0	--	--	--	--
	Total	0	54	47	32	5	7	2
1986	6A (East)	1	13	12	3	4	2	0
	6A (West)	1	19	24	7	9	4	0
	Subtotal 6A	2	32	36	10	13	6	0
	6B	--	7	2	--	--	--	--
	6C	--	22	15	--	--	--	--
	6D	--	0	0	--	--	--	--
	Total	2	61	53	10	13	6	0
1987	6A (East)	4	6	5	10	6	5	3
	6A (West)	--	14	11	14	1[b]	--	--
	Subtotal 6A	4	20	16	24	7	5	3
	6B	--	6	3	--	--	--	--
	6C	--	16	9	--	--	--	--
	6D	--	1	1	--	--	--	--
	Total	4	43	29	24	7	5	3

Table 6. Continued.

Year	Subunit	Aug 20-31	Sept 1-15	Sept 16-30	Oct 1-15	Oct 16-31	Nov 1-30	Dec. 1-31
1988	6A (East)	2	4	0	1	12	3	2
	6A (West)	--	3	29	5[c]	0	2	0
	Subtotal 6A	2	7	29	6	12	5	2
	6B	--	25	5[d]	--	--	--	--
	6C	--	6	3	--	--	--	--
	6D	--	1	2	--	--	--	--
	Total	2	39	39	6	12	5	2

[a] Either sex season closed by emergency order on September 17.
[b] Either sex season ended October 15, moose reported taken after season.
[c] Antlered moose season closed by emergency order on October 4
[d] Antlered moose season closed by emergency order on September 16

Table 7. Successful moose hunter transport methods by subunit in Unit 6, 1984-88.

Year	Subunit	Airplane	Horse	Boat or airboat	3- or 4-wheeler	ORV	Highway vehicle
1984	6A (East)	14	0	3	0	0	0
	6A (West)	31	0	31	1	0	0
	Subtotal 6A	45	0	34	1	0	0
	6B	8	0	40	0	0	2
	6C	0	0	7	0	0	26
	6D	0	0	0	0	0	0
	Total	53	0	81	1	0	28
1985	6A (East)	18	1	5	2	0	0
	6A (West)	20	1	21	0	1	0
	Subtotal 6A	38	2	26	2	1	0
	6B	7	0	24	0	0	5
	6C	0	0	9	1	0	27
	6D	0	0	0	0	0	0
	Total	45	2	59	3	1	32
1986	6A (East)	21	0	5	5	1	2
	6A (West)	17	0	39	2	2	0
	Subtotal 6A	38	0	44	7	3	2
	6B	0	0	8	0	0	1
	6C	1	0	8	1	0	28
	6D	0	0	0	0	0	0
	Total	39	0	60	8	3	31
1987	6A (East)	29	0	2	7	0	0
	6A (West)	14	0	24	0	1	0
	Subtotal 6A	43	0	26	7	1	0
	6B	1	0	7	0	0	1
	6C	0	0	11	0	1	13
	6D	2	0	0	0	0	0
	Total	46	0	44	7	2	14

Table 7. Successful moose hunter transport methods by subunit in Unit 6 , 1984-88.

Year	Subunit	Airplane	Horse	Boat or airboat	3- or 4-wheeler	ORV	Highway vehicle
1988	6A (East)	18	0	2	2	0	1
	6A (West)	14	0	22	3	0	0
	Subtotal 6A	32	0	24	5	0	1
	6B	1	0	17	0	0	3
	6C	0	0	4	0	0	5
	6D	1	0	1	0	0	1
	Total	34	0	46	5	0	10

STUDY AREA

GAME MANAGEMENT UNIT: 7 (4,423 mi^2)

GEOGRAPHICAL DESCRIPTION: East Kenai Peninsula

BACKGROUND

Moose populations in Unit 7 irrupted most recently during the 1960's after wildfires established widespread areas of early seral vegetation and natural predators were reduced to low levels. A steep population decline followed in the early 1970's after a series of severe winters. Moose populations have subsequently flucuated at relatively low levels as forest habitats matured and wolf and bear populations recovered. Since 1980 bark beetle has infested approximately 36,000 acres of spruce forest (USDA Forest Service 1988). An additional 9,000 acres of forests and shrublands within the Chugach National Forest have been treated with prescribed fire in recent years. Reduction of old-growth forests should benefit these moose populations by enhancing the nutritional quality and availability of winter food plants.

POPULATION OBJECTIVES

To maintain a viable population occupying available habitat and a minimal sex ratio of 15 bulls:100 cows.

METHODS

Population trend and sex-age composition were assessed by aerial surveys using a PA-18 Super Cub in standardized count areas during October and November. Since 1980, surveys were made only during years of extensive snow cover and high moose sightability (i.e. 1980, 1981, 1982, and 1987). Annual moose harvest data were collected through the statewide harvest ticket system.

RESULTS AND DISCUSSION

Population Status and Trend

Moose numbers have gradually declined in Unit 7 during this decade; however, they still remain moderately abundant in suitable intermontane habitats.

Population Composition:

During the fall 1988 surveys, 484 moose were counted and classified, including 118 bulls, 258 cows, and 108 calves.

Sample ratios were 46 bulls:100 cows, 42 claves:100 cows, and 22% calves.

Mortality

Season and Bag Limit:

Hunting is prohibited in that portion of Unit 7 drained by Resurrection Creek downstream from Rimrock and Highland Creeks including Palmer Creek. The open season for residents only in the Placer River drainage and that portion of Placer Creek outside the Portage Glacier area is from 1 to 30 September; the bag limit is 1 bull by drawing permit only, and 20 permits for antlered moose will be issued to Alaska residents only. The open season for resident and nonresident hunters in the remainder of Unit 7 is from 1 to 20 September; the bag limit is 1 bull with a spike or fork antler on at least 1 side or with at least a 50-inch spread or at least 3 brow tines on 1 side.

Human-induced Mortality:

In 1988, 308 hunters reported killing 50 moose (49 bulls, 1 unspecified), compared to 295 hunters who killed 36 bulls in 1987. The frequency of harvested bull antler spreads was 11 bulls <30.0 inches; 5 bulls 30.0-39.0 inches; 7 bulls 40.0-49.0 inches; 10 bulls $\geq$50.0 inches; and 17 unspecified bulls. Twenty-six moose (52%) were taken during 1-10 September, 22 (44%) were taken during 11-20 September, and the harvest dates for two were unknown (04%).

Hunter success was 16% in 1988 versus 12% in 1987. The relative frequencies of hunter transport types were as follows: highway vehicles > boats > horses > airplanes > off-road vehicles.

Hunter Residency. Moose hunters in Unit 7 consisted of 204 (66%) local residents, 83 (27%) other residents, 14 (5%) nonresidents, and 7 (2%) unspecifieds.

Game Board Actions and Emergency Orders

To correct for declining proportions of bulls in the Unit 7 and other Kenai Peninsula moose seasons, the Board of Game adopted a spike-fork/50-inch regulation beginning in the 1987 season. Only moose with either a spike or a fork antler on at least one side or with at least 3 brow tines on one side or an antler spread of at least 50 inches are legal game during the 1-20 September open season.

CONCLUSIONS AND RECOMMENDATIONS

Harvest size, hunter success, and population composition data show a substantial increase in the Unit 7 abundance of bull moose. The sex ratio population objective was met.

LITERATURE CITED

USDA Forest Service. 1988. Forest pest management report: Forest insect and pest conditions in Alaska - 1988. Report R10-88C-1. Juneau. 16pp.

PREPARED BY:	SUBMITTED BY:
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Table 1. A summary of annual numbers of hunters, success rates, and bull moose harvests in Unit 7, Kenai Peninsula, 1983-1988.

Year	Number hunters	Percent success	Harvest total
1983[a]	271	21	58
1984[a]	365	21	77
1985[a]	409	22	92
1986[a]	409	14	58
1987[b]	295	12	36
1988[b]	308	16	50

[a] Season dates 1-10 September.

[b] Season dates 1-20 September.

STUDY AREA

GAME MANAGEMENT UNIT: 9 (44,500 mi^2)

GEOGRAPHICAL DESCRIPTION: Alaska Peninsula

BACKGROUND

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

POPULATION OBJECTIVES

To maintain existing densities in areas with moderate (0.5-1.5 moose/mi^2 or high (1.5-2.5 moose/mi^2 densities.

To increase low-density populations (where habitat conditions are not limiting) to 0.5 moose/mi^2 by 1995.

To 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

Fall sex and age composition aerial surveys were scheduled throughout Subunits 9B, 9C, and 9E. Harvests were monitored within the Naknek River drainage registration permit hunt held in December. Moose censuses were planned for the areas that depended on cooperative funding from National Park Service and/or U.S. Fish and Wildlife Service, west of Lake Clark or Aniakchak and Meshik.

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 populations in most of Unit 9 have stabilized or are declining at a much slower rate than had occurred earlier (i.e., 15-20 years ago). Very low moose densities and unreliable snow conditions in Subunit 9A precluded efficient surveys for monitoring trends in population size or composition. Although 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 ± 16% moose (90% confidence level) in the 1,314-mi^2 study area. Extrapolation of this census to the remainder of Subunit 9E provided a rough estimate of approximately 2,500 moose. The area of Subunit 9C outside of Katmai National Park had approximately 500-600 moose. There may be approximately 2,000 moose in Subunit 9B. A cooperative census (NPS or USFWS) planned for the area west of Lake Clark should help to refine this estimate. 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 1983. Decline in bull:cow ratios in Subunits 9B and 9C have apparently been halted. Bull harvests in Subunit 9E have increased to a lesser extent, but the bull:cow ratio has apparently not yet been affected. In recent years calf:cow ratios have been lower in the Katmai and Subunit 9E trend areas, possibly because of higher bear densities there than further north. However, 1987 surveys in all subunits showed little difference in calf:cow ratios (18-23 claves:100 cows). 1988 surveys showed marked improvements in calf survival in all areas, except west of Lake Clark (Table 1).

Mortality

Season and Bag Limit:

The open season for all hunters in Subunits 9A and 9B, except that portion draining into Lake Clark, is 10-20 September; the bag limit is 1 bull. The open season for nonresident hunters in Subunit 9B is 5-20 September. The open seasons for subsistence and resident hunters in portions of Subunit 9B draining into Lake Clark drainage and the remainder of Subunit 9B are 5-20 and 10-20 September, respectively, and 1-31 December. The bag limit in the Lake Clark drainage is 1 moose; however, antlerless moose may be taken from 16-31 December. The bag limit for the remainder of Subunit 9B is 1 bull. The open seasons for subsistence hunters in Subunit 9C, Naknek River drainage, are 5-20 September and 1-31 December. The open season for resident and nonresident hunters there is 10-20 September. The bag limit for the Naknek River drainage is 1 moose; however, antlerless moose may be taken by registration permit only. The open seasons for subsistence, resident, and nonresident hunters in the remainder of Subunit 9C are 5-20 September and 1-31 December, 10-20 September and 1-31 December, and 10-20 September, respectively. The bag limit for subsistence hunters in the remainder of Subunit 9C is 1 moose; however, antlerless moose may be taken only in December. Other hunters are limited to 1 bull. There is no open season in Subunit 9D. The open seasons for subsistence hunters in Subunit 9E are 10-20 September and 1-15 December; the season for resident and nonresident hunters is 10-20 September. The bag limit is 1 antlered moose; however, moose taken from 10-20 September must have an antler spread of at least 50 inches or have at least 3 brow tines on at least 1 antler.

Human-induced Mortality:

In 1988 a total of 237 moose, including 16 cows and 218 bulls, were reported killed by hunters. The 1988 harvest represented a 24% decline from that for 1987; it was also the first time since 1982 that the harvest did not increase (Table 2). The unreported subsistence harvest in Unit 9 was more stable at slightly over 100 per year.

Hunter Residency and Success. The number of nonresident hunters tripled from 1983 to 1987, while the number of residents remained relatively stable (Table 4). The number of hunters from all categories declined slightly in 1988; however, some subsistence hunters did not get moose harvest tickets and consequently were not represented in the local resident category. Hunter success varied by residency. Since 1983 the success rates for local residents of Unit 9, other residents, and nonresidents have averaged 33%, 39%, and 56%, respectively. The success rates showed no specific trends for any of the residency categories during 1983-87, but they were substantially below the average success rate (74%) for all hunters reported from 1967 to 1973. Hunter success in 1988 was 44%. This slight decline was probably due to the shortened season in Subunit 9B.

Permit Hunt No. 972. Board action in 1987 restricted the December Naknek River drainage registration hunt to subsistence users only. This action slightly reduced the number of permits issued, but it did not significantly affect the results (Table 3). As in past years, weather and travel conditions affected harvest more than any other factors. An abundance of caribou along the King Salmon road system in 1988 may also have diverted some hunters from pursuing moose. An upper harvest limit of approximately 12 cows had been established, and the harvest was monitored to ensure this level was not exceeded.

Harvest Chronology. Because of increased harvest and dropping bull:cow ratios in Subunit 9B, the 1988 fall season was reduced for all hunters. Only subsistence hunters could participate from 5-9 September, and all moose hunting ended on 20 September. The shortening of the season and the new legislative restrictions on "outfitters" were effective in reducing the bull harvest, compared with that for the previous year (Table 2). Harvest levels in December have remained low (Table 5), but some subsistence harvests undoubtedly were unreported.

Transportation Methods. Aircraft continued to be the most common method of transportation in Unit 9 (Table 6). Because of good snow cover in much of Subunit 9B during the December seasons in 1987 and 1988, snowmachines were used more frequently than in previous years.

Natural Mortality:

Although calf survival was much improved in 1988, it was still apparent that bear predation of neonatal moose is the 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 record-low temperatures during January, winter mortality did not appear to be significant. Except in the northwestern portion of Subunit 9B, snow levels throughout the Alaska Peninsula were light.

Game Board Actions and Emergency Orders

The fall moose harvest in Unit 9 increased substantially from those in 1984 to 1987 because of more nonresident hunters. Several restrictions on the hunting seasons in Unit 9 have been implemented in the past 5 years, in response to increasing hunting pressures. Antlerless moose hunting was eliminated in Subunit 9E (1983), and the December season was shortened to 15 days (1984) and restricted to subsistence users only (1987). The fall season was shortened by 5 days for subsistence users and by 10 days for all other hunters in Subunit 9C (1987). The December season in the Naknek River drainage was restricted to subsistence hunters only in 1987. In 1984 the antlerless moose season was shortened by 16 days for the Lake Clark drainage and closed for the remainder of Subunit 9B.

At the 1987 Board of Game meeting, the Department proposed that the September season in Subunits 9A and 9E be aligned with that of Subunit 9C. The justification for this proposal was to reduce bull harvests in Subunit 9B and minimize inadvertent shifting of hunting pressure within Unit 9 by having nonsubsistence fall seasons run concurrently in all subunits. The Board adopted this recommended change for the 1988 season. A recent Alaska Supreme Court decision declaring the exclusive or joint-use guiding area system unconstitutional opened the potential for a significant increase in guided moose hunters. However, federal land managers have agreed to limit the number of commercial-use permits to only those operators previously licensed. Because much of the better moose habitat is within National Wildlife Refuges or National Parks/Preserves and because of the restrictions on unguided commercial hunting services imposed by House Bill 112, no further hunting restrictions were recommended.

CONCLUSIONS AND RECOMMENDATIONS

Hunting regulations have been restricted in several subunits to eliminate antlerless moose hunting in areas with the lowest calf:cow ratios. Additionally, fall seasons have recently been shortened in the northern 3 subunits to maintain bull:cow ratios at prescribed levels.

Brown bear predation on neonatal moose is 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. The Department has placed a priority on managing bears, and any drastic reduction in numbers likely would be opposed by a large segment of the public.

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Table 1. Moose composition counts and population estimates in Unit 9, 1983-88.

Subunit	Year	Males: 100 females	Calf: 100 females	Calf %	Adults	n	Moose /hr	Estimated population density
9B (Lake Clark)	1984	54	30	16	410	491	63	1.1/mi^2
	1987	31	23	15	302	356	39	0.8/mi^2
	1988	36	22	14	520	604	61	1.4/mi^2
9B (Iliamna)	1984	67	20	11	180	202	27	0.4/mi^2
	1986	103	42	17	77	93	28	0.3/mi^2
	1988	39	61	30	71	102	28	0.3/mi^2
9C	1983	46	33	18	334	409	45	0.6/mi^2
	1984	42	25	15	502	591	60	0.9/mi^2
	1986	34	27	17	432	518	64	0.8/mi^2
	1987	36	18	12	577	653	62	1.0/mi^2
	1988	38	32	19	555	684	66	1.1/mi^2
9E	1983	40	14	9	617	677	42	0.5/mi^2
	1986	43	11	6	216	230	30	0.5/mi^2
	1987	47	18	11	225	274	40	0.5/mi^2
	1988	52	33	18	225	274	40	0.5/mi^2

Table 2. Annual moose harvest in Unit 9, 1983-88

Subunit	Year	Reported M	Reported F	Total	Estimated unreported/illegal	Total
9A	1983	8	0	8	2	10
	1984	14	0	14	3	17
	1985	10	0	10	2	12
	1986	19	01	19	3	22
	1987	10	0	10	2	12
	1988	6	0	6	2	8
9B	1983	43	11	54	75	129
	1984	46	2	48	75	123
	1985	74	1	75	75	150
	1986	65	3	72	75	147
	1987	118	6	124	75	199
	1988	71	6	77	75	152
9C	1983	34	4	38	5	43
	1984	40	6	46	5	51
	1985	63	9	72	5	77
	1986	57	10	67	5	72
	1987	47	9	56	5	61
	1988	42	10	52	5	57
9E	1983	73	0	73	75	98
	1984	75	0	75	25	100
	1985	87	0	87	25	112
	1986	81	0	81	25	106
	1987	110	0	110	25	135
	1988	96	0	96	25	121

Table 3. Moose harvest data for permit hunt no. 972 in Subunit 9C (Naknek Drainage), 1983-88.

Year	Permits issued	Did not hunt[a]	Unsuccessful hunters	Successful hunters	Bulls	Cows	Total
1983	81	22	55	8	4	4	8
1984	75	21	44	11	6	5	11
1985	69	15	35	15	7	8	15
1986	78	18	45	13	3	10	13
1987	61	10	33	16	8	8	16
1988	47	10	22	15	7	8	15

[a] Does not include data from unreturned permits

Table 4. Moose hunter residency and success in Unit 9, 1983-88.

	Successful				Unsuccessful			
Year	Local resident	Nonlocal resident	Nonresident	Total[a]	Local resident	Nonlocal resident	Nonresident	Total[a]
1983	31	90	48	173	93	96	40	236
1984	31	73	75	186	68	127	35	239
1985	44	83	103	242	68	128	78	283
1986	39	74	112	240	80	116	104	308
1987	47	89	152	300	97	135	102	345
1988	41	80	111	237	60	164	114	305

[a] Totals include hunters of unknown residency.

Table 5. Moose harvest chronology percent by time period in Unit 9, 1983-88.

Subunit	Year	September				December	
		5-9	10-14	15-20	21-25	1-15	16-31
9A	1984	38	31	8	23	0	0
	1985	10	60	30	0	0	0
	1986	25	25	44	6	0	0
	1987	33	11	44	11	0	0
	1988	17	66	17	0	0	0
9B	1984	19	2	23	23	27	6
	1985	19	14	26	29	4	7
	1986	18	19	24	27	0	12
	1987	19	21	29	20	1	10
	1988	8	35	41	0	0	14
9C	1984	20	17	22	13	15	13
	1985	23	11	31	25	7	3
	1986	23	23	16	16	16	6
	1987	9	27	25	0	9	29
	1988	4	37	20	24	17	
9E	1984	1	56	37	0	6	0
	1985	1	56	40	0	2	0
	1986	0	53	42	0	5	0
	1987	3	56	40	0	1	0
	1988	4	56	42	0	0	

Table 6. Successful moose hunter percent by transportation methods in Unit 9, 1983-88

Year	Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Vehicle
1983	66	0	19	0	2	6	6
1984	72	0	15	3	3	2	4
1985	69	0	21	7	1	0	2
1986	70	0	17	7	1	2	3
1987	70	0	15	6	6	0	2
1988	64	0	22	4	6	2	2

STUDY AREA

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

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

BACKGROUND

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

Moose harvests in Unit 11 averaged approximately 164 (123-242) per year from 1963 until 1974. Either-sex bag limits were in effect until 1974, and up to 40% of the harvest were cows. During this period, hunting seasons were long, and they were split to provide for fall and winter hunting. The moose harvest peaked, as did the total number of hunters and hunter success rate, in the early 1970's. In response to declining moose numbers, the 1974 fall moose season was shortened, the winter season was closed, and the harvesting of cows was prohibited. Current seasons were established in 1975, and harvests have averaged 43 bulls per year since.

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

POPULATION OBJECTIVES

To maintain the existing moose population with a posthunting sex ratio of no less than 15 adult bulls:100 cows.

METHODS

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

Large portions of Unit 11 are classified as limited suppression zones, where wildfire would be allowed to burn. Plant growth, composition, and utilization have been monitored periodically in a large burn that has the highest moose population in the unit. Other methods of addressing moose habitat issues included monitoring land use patterns and evaluating and responding to any proposals that affect moose habitat.

RESULTS AND DISCUSSION

Population Status and Trend

The number of moose observed in Count Area (CA) 11 (i.e., western slopes of Mount Drum) increased between 1979 and 1987 but declined slightly in 1988 (Table 1). The number of moose observed per hour during the fall surveys increased from 12 to 52 during this period, suggesting a dramatic population increase in the vicinity of CA 11. Moose counts were not conducted elsewhere in Unit 11, and inferences about population status and trends there must be drawn from general field observation and reports from the public. Very limited information pertaining to the lower Chitina River Valley indicated moose numbers have not increased; the population was stable or declining. In the northern portion of the unit the moose population was stable.

Population Size:

An accurate population estimate is not available for Unit 11 because moose have never been censused there. Moose numbers observed during fall composition counts in CA 11 resulted in a density estimate of 0.7 moose/mi^2 in 1988. 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 were surveyed. The lowest densities were in the Chitina River Valley, and the highest were in CA 11. If actual moose densities approached the estimates obtained during the 1986 stratification flights, the unit moose population numbered between 1,000 and 2,000.

Population Composition:

A bull:cow ratio of 56:100 was observed in CA 11 in 1988, representing a 20% decline from the previous year's ratio of 70 bulls:100 cows and 30% below the 1985 ratio of 80 bulls:100 cows. The cause of the decline is unknown; however, it was not the result of hunter harvests. Relatively few bulls are taken in this portion of Unit 11. Although bull:cow ratios have declined, the overall number of bulls counted was higher than that observed during the early 1980's. Fifty large bulls:100 cows were observed, compared with only 6 yearling bulls:100 cows. This adult bull:cow ratio met the population objectives (i.e., 15 adult bulls:100 cows).

The observed calf:cow ratio was 22:100 in 1988, similar to the 1987 figure of 20:100 and below the 6-year (1981-86) average of 25 calves:100 cows. Although improved slightly, calf production or survival was still poor.

Distribution and Movement:

Data from past fall composition and winter stratification surveys, field observations, and reports from the public indicated that the densest concentration of moose in Unit 11 occurred along the western slopes of Mount Drum. The Chitina River Valley had the lowest density of moose in the unit, and the upper reaches of the Copper River in the northern portion of the unit had intermediate moose densities.

Fall rutting and postrutting concentrations occur in upland habitats as high as elevations of 4,000 feet. 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 levels for the year. Some moose from the western slopes Unit 11 move westerly across the Copper River to winter in eastern Unit 13.

Mortality

Seasons and Bag Limit:

The open season for subsistence, resident, and nonresident hunters is 1-20 September. The bag limit is 1 bull.

Human-induced Mortality:

Hunters reported killing 48 bull moose in 1988 (Table 2). This harvest was somewhat lower than the previous year's take of 58 but equal to the 5-year (1983-87) mean of 48 bulls. Hunting pressure in 1988 was the lowest since 1981; only 157 hunters reported, compared with 183 in 1988. Hunting pressure over the past 5 years (1983-87) has averaged 197 hunters per year.

The mean antler spread reported for bulls harvested during 1988 was 41 inches, well below the 5-year (1983-87) mean of 45 inches. More than 50% of the harvest in 1988 were bulls with antler spreads of 40 inches or more. This data suggested that (1) hunting pressure in Unit 11 was not heavy enough to crop bulls before they reached maturity and (2) there were enough mature bulls available for breeding purposes.

Illegal and unreported harvests of both bulls and cows have been documented in Unit 11 and, in some years, may be as much as 20% of the reported harvest. Recent poaching activity has been greatest in the northern portion of Unit 11 along the Nabesna Road. A tremendous increase in the human population around Slana over the past 5 years has led to increased poaching, and enforcement efforts in the are have been increased.

Hunter Residency and Success. Local residents, nonlocal residents, and nonresidents accounted for 36%, 48%, and 8% of the harvest in 1988, respectively (Table 3). Residency of hunters in 1988 was similar to that reported in prior years. Hunter success rates are influenced by National Park Service (NPS) regulations (i.e., allow only local residents to hunt in those portions of the unit designated as park). Because nonlocal residents and nonresidents can hunt only on preserve lands, they are excluded from much of the unit.

The overall hunter success rate in 1988 was 31%, similar to the 30% for 1987 and slightly higher than the 5-year (1983-87) mean of 25%. Successful hunters averaged 6.5 days afield in 1988, while unsuccessful hunters averaged 6.4 days.

Harvest Chronology. More moose were taken during the latter part of the season in 1988 than in prior years (Table 4). While hunting pressures were heavy early in the season, especially opening weekend, it dropped off as the season progressed. If hunting pressure were greater late in the season, the harvests would probably increase. Bull moose were more vulnerable the last week of the season because their movements increased as the rut approached. Moreover, they were more visible to hunters because leaf fall had occurred by mid-September.

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

Natural Mortality:

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

Habitat Assessment and Enhancement

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

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

Game Board Actions and Emergency Orders

The hunting regulations for moose in Unit 11 have remained unchanged since 1975. Separate subsistence seasons have not been established, because bull harvests are not limited by permits or antler restrictions and everyone may participate in the hunt.

CONCLUSIONS AND RECOMMENDATIONS

Data from CA 11 suggested an increase in moose numbers along the western slopes of Mount Drum over the past 5 years. That area burned in the 1981, and browse is more abundant than in unburned areas. Whether the increase in available browse resulted in increased moose production or just attracted more moose into the count area is not known. The number of moose numbers in the remainder of the unit, especially the Chitina Valley, is either stable or decreasing slowly.

Hunting pressures and annual harvests have been relatively low and fairly stable, although hunting pressures declined slightly. Restrictive regulations by the NPS limiting hunter participation and transportation in much of the unit are important contributing factors to the limited harvests.

I recommend maintaining the existing season and bag limit. The harvest of bulls appears to be sustainable, because bull:cow ratios were high and the total number of bulls observed has increased. In addition, the mean antler spread of bulls in the harvest was relatively wide, indicating a large proportion of the bull population was made up of adult animals. Because of the low moose density and calf recruitment in the unit, any substantial increase in the bull harvest would be expected to cause a decline in the bull:cow ratio. Cow hunts should be avoided as long as low moose densities persist.

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

LITERATURE CITED

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Table 1. Moose composition counts in Unit 11, 1984-88.

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour	Density moose/mi^2
1984	75	9	17	9	114	125	31	0.4
1985	80	22	12	6	140	149	40	0.5
1986	78	12	14	7	155	167	41	0.6
1987	70	6	20	11	192	215	55	0.7
1988	56	6	22	12	170	194	52	0.7

Table 2. Annual moose harvest in Unit 11, 1984-88.

	Reported			Estimated			
Year	M	F	Total[a]	Unreported	Illegal	Total	Total
1984	41	0	41	5	5	10	51
1985	46	0	46	5	5	10	56
1986	48	0	49	5	5	10	59
1987	58	0	58	5	5	10	68
1988	48	0	48	5	5	10	58

[a] Includes unknown sex.

Table 3. Moose hunter residency and success in Unit 11, 1984-88.

Year	Successful				Unsuccessful			
	Local resident	Nonlocal resident	resident	Total[a]	Local resident	Nonlocal resident	resident	Total[a]
1984	17	18	4	39	75	104	3	182
1985	17	28	2	47	56	69	1	126
1986	20	23	2	45	69	39	1	109
1987	24	23	5	58	60	58	6	125
1988	17	23	4	48	46	54	5	109

[a] Includes unspecified residency.

Table 4. Moose harvest chronology percent by time period in Unit 11, 1984-88.

Year	Season dates	Week of Season			
		1st	2nd	3rd	4th
1984	1-20 Sept.	13	22	27	38
1985	1-20 Sept.	41	25	34	--
1986	1-20 Sept.	27	31	38	4
1987	1-20 Sept.	24	29	42	5
1988	1-20 Sept.	7	16	44	33

Table 5. Successful moose hunter transport methods (%) in Unit 11, 1984-88.

Year	Airplane	Horse	boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown
1984	29	7	0	10	0	22	22	10
1985	25	4	0	9	2	32	13	5
1986	45	12	0	4	0	10	21	8
1987	36	10	3	5	0	16	16	4
1988	17	2	2	10	0	29	27	13

STUDY AREA

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

GEOGRAPHICAL DESCRIPTION: Upper Tanana and White River drainages

BACKGROUND

Moose were probably 2 to 3 times more numerous in this area in the mid-1960's than they are today. Moose numbers declined rapidly from 1966 through about 1976, as they did in surrounding areas. Heavy predation by wolves and grizzly bears, several severe winters, and heavy localized antlerless moose harvests all contributed to the population decline. Antlerless harvests were stopped after 1974, and the Nabesna Road moose season was closed entirely from 1974 through 1981. In 1986 the Little Tok River drainage was closed to moose hunting because of low rates of yearling recruitment and a deteriorating bull:cow ratio.

Wolf control in adjacent Subunit 20D (1980) and in extreme northern Unit 12 (1981-83) benefited moose in 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, heavy wolf harvests in adjacent Unit 13 have benefited moose that annually migrate into the Tok 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.

POPULATION OBJECTIVES

To 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.

To increase the overall hunter success rate to at least 35% without reducing participation from current levels (400 hunters/year) by the year 2000.

To maintain a posthunting sex ratio of at least 40 bulls:100 cows.

To maintain the present population of moose (1,200-1,500).

To 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 the 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 Tetlin and Tok River drainages.

To increase the (1) moose population from an estimated 400 to 800 moose by the year 2000, (2) proportion of males in the population to 40 bulls:100 cows along the north slope of the Alaska Range (adult bulls >5 years should compose no less than 20% of all bulls >17 months posthunting), and (3) browse production on at least 100 acres/year for at least 10 years in known winter range in Northwestern Unit 12 (Robertson River, upper Tanana Valley).

To increase the (1) moose population from an estimated 1,200-1,300 to 2,200-2,500 by the year 2000 and (2) proportion of males in the upper Chisana River area to 40 bulls:100 cows and increase the proportion of adult bulls >5 years in that population to at least 20% of all bulls >17 months in Eastern Unit 12 (Cheslina River to U.S.-Canada Border).

METHODS

Sex and age composition was estimated in November and December using aerial-contour surveys. All moose observed were classified as large bulls (antlers >50 inches), medium bulls (antlers larger than yearlings but <50 inches), small bulls (spike, cerviform, or palmate-antlered yearling bulls >17 months), cows without calves, cows with 1 calf, cows with 2 calves, lone calves, or unidentified moose. Bulls classified as yearlings are actually about 17 months old. Medium-sized bulls generally are 2-4 years old, and large bulls are usually older than 4 years. The same areas are surveyed annually in a comparable manner.

Moose were censused in March 1989 in the main Tanana River and Tok River valleys using techniques described by Gasaway et al. (1986). Funding was provided by the U.S. Air Force (USAF).

Moose harvests were estimated from harvest reports. Overwinter browse use by moose was determined by standard ADF&G transect surveys funded by the USAF. Habitat improvement was accomplished by mechanical crushing of decadent willow stands with crawler tractors; it was funded and conducted by the Tetlin Native Corporation. Except for maintaining restrictive and liberal hunting regulations for moose and grizzly bears, respectively, no action was taken in 1988 to increase moose numbers.

RESULTS AND DISCUSSION

Population Status and Trend

As a result of past land-and-shoot wolf harvests, previous wolf control efforts, recent high grizzly bear harvests in Unit 13, and increasing grizzly bear harvests in the Tanana Valley, moose numbers have increased modestly in the Tok, Robertson, and portions of the Tanana River drainages. This increase is based upon moose/hour observations during aerial surveys. Moose numbers were increasing slowly and were stable in eastern and southern portions of Unit 12, respectively. Further increase in moose abundance is not expected, because wolf numbers have approached precontrol levels and the loss of 1 month of the trapping season and the prohibition against land-and-shoot taking of wolves has reduced wolf harvests appreciably.

Population Size:

Based upon data collected during moose contour surveys and area-specific population estimation surveys, 2,500-3,500 moose currently seasonally inhabit Unit 12. With an estimated 6,000 mi^2 (15,500 km^2) of actual habitat in the unit, overall density probably ranges from 0.42 to 0.58 moose/mi^2 (160 to 226/1,000 km^2), a low density compared with those existing in the mid-1960's and what current habitat conditions could support.

In March 1989 a population survey was conducted in a 1,204-mi^2 (3,118 km^2) area of northwestern Unit 12. This area was found to support about 790 moose (CI = $\pm$ 17.9%, $\underline{P} \leq 0.10$) for a mean density of approximately 0.53 moose/mi^2 (253/1,000 km^2). Moose wintering in the Tok River drainage existed at a mean density of about 1.07 moose/mi^2 (462/1,000 km^2), whereas densities were lowest in the Tanana Valley near Tok and Tanacross; i.e., 0.19 moose/mi^2 (100/1,000 km^2). Many of the moose wintering in the Tok River drainage were migrants from Unit 13 and not available to Unit 12 hunters during the September hunting season.

Population Composition:

Contour surveys were flown in and near Unit 12 during the period 20 October to 2 December 1988 to obtain moose sex and age composition data. We flew 28.4 hours in PA-18 Super Cubs and classified 1,133 moose; i.e., a rate of 40 moose/hour of survey (Table 1). All areas were surveyed, except for the Tetlin and Nabesna Road areas. The U.S. Fish and Wildlife Service, Tetlin National Wildlife Refuge staff conducted the Cheslina-Kalukna, Nabesna River-Chisana River, and Chisana River-Border surveys and I conducted the remainder. The cost of most moose surveys in Unit 12 was absorbed by the Tok Moose Study (OTH-B Backscatter Radar) budget.

Survey conditions were not as good in western Unit 12 as they had been in recent years. Ground fog and turbulence delayed the surveys. Early heavy snow accumulations precipitated early movement of mostly cow moose toward lower-elevation winter ranges, limiting the comparability of 1988 ratios with those of recent years. Nevertheless, the sex ratio was acceptable in most areas, and survival of calves to 17 and 5 months in 1987 and 1988, respectively, appeared to be the highest in many years.

The sex ratio in the Little Tok River (27 bulls:100 cows) failed to improve as expected; however, recruitment in the area has continued to improve following the increased harvest of wolves from the area in the winter of 1986-87.

I noticed problems with the age structure of bulls in the North Slope Alaska Range and Dry Tok Creek survey areas. During the Alaska Range survey, no large bulls (antlers ≥50 inches) were observed, and in the Dry Tok Creek area only 3 large bulls were found.

Distribution and Movements:

Moose occur throughout Unit 12 below an elevation of about 4,000 feet. Densities are generally the greatest in northwestern Unit 12 and moderate and lowest in the central and southeastern portions, respectively.

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. According to longtime residents of Unit 12, the Tok River valley used to support a large population of resident moose, but cow harvests in the late 1960's and early 1970's noticeably reduced this population.

Very few resident moose exist on the Northway-Tetlin Flats (ADF&G files). A few resident moose may be found in the vicinity of Tok and Tanacross. Year-round poaching of moose of both sexes has contributed to the decline of resident moose in lowland areas near human settlements, and it is probably helping keep current densities low.

<u>Mortality</u>

Season and Bag Limits:

There is no open season 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. Moose hunting is permitted elsewhere in the unit under the following seasons and bag limits. In the portion drained by the Tanana, Nabesna, and Chisana Rivers east of the Tetlin Indian Reservation boundary and north of the winter trail from Pickeral Lake to the Canadian border, the subsistence season is from 1 to 20 September. The open season for residents and nonresidents is from 10 to 15 September. The bag limit for all hunters is 1 bull.

In the portion east of the Nabesna River and south of the winter trail running southeast from Pickeral Lake to the Canadian border, the open season for all hunters is 1 to 30 September; the bag limit is 1 bull with antler spread of at least 50 inches or with at least 3 brow tines on at least one of the antlers.

In the remainder of Unit 12, the subsistence season is 1 to 30 September, and the open season for residents and nonresidents is 1 to 15 September. The bag limit for all hunters is 1 bull.

Human-induced Mortality:

The total reported harvest of bull moose in Unit 12 during the fall of 1987 (81) was similar to the 5-year mean (83) (Table 2). Reported harvests represented approximately 2-3% of the estimated population. Actual estimated harvests (about 135 moose) represented approximately 4-5% of the population. Recent reported harvests have been only one-half of the mean (i.e., 167 moose/year) during the period from 1963 to 1974. Out-of-season poaching may be as high as 40 moose of either sex, and the harvest of moose for Native funeral potlatches may account for 15 to 20 more; the requirement for reporting the taking of potlatch moose has been ignored (C. Thorsrud, Fish and Wildlife Protection, pers. commun.). Only 4 or 5 moose are normally killed in highway accidents each year. Therefore, total human-induced mortality could be as high as 145 moose/year, or about 4-6% of the population.

The Tok River drainage received the greatest harvest (27 bulls), followed by the White River drainage (12), the Chisana and Tanana drainages (10 each), the Tetlin drainage (8), and the Robertson River (4). Three successful hunters did not report a specific harvest location. The mean number of moose hunters who reported hunting in Unit 12 during the past 5 years was 372; only 296 hunters reported hunting in 1988. The loss of 5-10 days of the season for all hunters, except local subsistence hunters, and low moose densities may well be deterring some nonlocal hunters from hunting in Unit 12.

Hunters reported antler spread measurements for 76 bull moose, resulting in a mean of 42.5 inches (SD = 12.43). Twelve bulls (16%) had antler spreads of less than 30 inches and were judged to be yearlings. The 36 (47%) bulls having antler spreads from 30.0 to 49.99 inches were mostly 2- to 4-year-olds. The 28 bulls (37%) having antler spreads of >50 inches were considered mature adults. Seven of 8 bulls taken in the Tanana River area had antler widths <39.99 inches, indicating most were young moose. If harvests of these young animals could be reduced (i.e., spike-fork or 50-inch antler restriction for a few years), the sex ratio in this population and age structure of bulls could be improved.

<u>Hunter Residency and Success</u>. Residents of Unit 12 accounted for 130 of the hunters who reported, compared with 177 hunters who were listed as residents of Unit 12 in 1986. Twenty-five of 296 hunters who reported hunting in Unit 12 in 1988 did not provide

residency information. Comparable 1987 data were not available because of a computer problem.

The hunter success rate for moose hunters in Unit 12 in 1988 was 27%, compared with a 5-year mean of 23% (Table 2). During the period 1969 through 1971 the mean success rate was 39%; therefore, hunting success has declined by 41%, even though the number of hunters in 1988 was 25% lower. The success rate was lower than the management objective of 35%. Local hunters reported taking 27 bulls for a success rate of 21%, 12% lower than that enjoyed by nonlocal hunters. Successful hunters spent an average of 6.8 days afield, and unsuccessful hunters spent 8.2 days.

Harvest Chronology. Twenty-five moose (32%) were taken during the week ending 6 September, 29 (37%) the week ending 13 September, 21 (27%) the week ending 20 September, two (3%) the week ending 27 September, and two (3%) the week ending 4 October. The date of harvest was unknown for 2 bulls. More moose were taken earlier in the season in 1988 than in 1987.

Transport Methods. Highway vehicles were used by most hunters (n = 105, 43%), followed by boats (n = 33, 13%), three- or four-wheelers (n = 30, 12%), aircraft and ORV's (n = 28 each, 11%), and horses (n = 21, 9%). Methods of transport were unknown for 51 hunters. Most moose were taken by hunters using highway vehicles (n = 20, 27%), followed by ORV's (n = 18, 24%), horses (n = 13, 18%), aircraft (n = 9, 12%), boats (n = 8, 11%), and three- or four-wheelers (n = 6, 8%).

Hunters using ORV's were the most successful (64%), followed by hunters using horses (62%), aircraft (32%), boats (24%), three- or four-wheelers (20%), and highway vehicles (19%). Most local subsistence hunters used highway vehicles, boats, and three- or four-wheelers; however, these are the least effective means of transportation for hunting moose because of crowded hunting conditions along the highway system and the major rivers. I believe the reason hunters using three- or four-wheelers are not more successful is because most actually hunt on their machines rather than using them to reach a hunting area. The same may be true for hunters using highway vehicles to "road hunt."

Most competition between subsistence and nonlocal hunters occurred along highways and major rivers. Despite the animosity directed at hunters that used aircraft for access, airborne hunters accessed areas normally out of reach for most local subsistence hunters, and true competition was minimal.

Natural Mortality:

Research conducted cooperatively by the ADF&G and the USFWS on and near the Tetlin National Wildlife Refuge during the period 1985 to 1988 has shown that predation is the major mortality factor affecting moose in Unit 12 (ADF&G files). In contrast to other studies, wolf predation was found to be the greatest source of moose calf mortality on the Northway-Tetlin Flats. Wolf predation also appeared to be the greatest source of adult moose mortality. The noticeable increases in yearling recruitment and the overall moose population following wolf control during the period 1980 to 1983 in the Robertson River drainage and elsewhere in northern Unit 12 also supported the idea that wolf predation is an important limiting factor on moose populations in Unit 12.

The extremely low survival of calves to 5 months of age in the Little Tok River drainage was more indicative of bear predation than wolf predation; however, improved calf survival to 5 and 17 months of age during the past 2 years following increased wolf harvests in that drainage indicated wolf predation was also an important mortality factor. Calf survival and yearling recruitment have generally been the highest in the Tanana Valley near Tok and Tanacross, where numbers of both grizzly bears and wolves were lower because of hunting, trapping, and other human activities.

Results of an intensive moose population study (i.e., funded by the USAF in preparation for construction of an OTH-B Backscatter Radar site) near Tok will be more thoroughly presented in a separate publication. Natural mortality rates and causes will be discussed; however, both wolf and bear predation are important mortality factors. Research and management activities indicated that natural moose mortality must be reduced if moderate rates of moose population growth and/or increases in useful productivity for human use are to be realized.

Habitat Assessment and Enhancement

Only 5,000-6,000 mi^2 in Unit 12 are considered to be moose habitat. The remainder of Unit 12 is characterized by rugged, glaciated mountains (above elevations of 4,000 feet) unsuitable for moose. Furthermore, 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. Had fires been allowed to reach greater size in the past, a much greater proportion of Unit 12 would now be covered with early to midsuccessional deciduous vegetation types. Much good moose habitat is currently limited to subalpine brush fields in the Alaska Range and Mentasta, Nutzotin, and North Wrangell Mountains or to riparian areas along the Tanana, Chisana, Nabesna, Tok, and White Rivers. Measured browse use during the above-normal snowfall winter of 1988-89 was slightly greater in all areas surveyed during the USAF Backscatter Radar moose investigations than in the spring of 1988. Habitat is not limiting moose population growth throughout most of Unit 12.

Over 1,300 acres of old-age decadent willows have been intentionally disturbed since 1982 to stimulate crown-sprouting of new leaders. Approximately two-thirds of the area crushed by crawler tractors in April 1988 were in the Tok River drainage; the remainder (about 380 acres) was in the Tanana drainage north of Tok. This work, which has produced an estimated 2 million pounds of additional browse each year for wintering moose, has been undertaken to provide future browse supplies for the moderate density, increasing moose populations in the Tok and Tanana River drainages. The Tetlin Native Corporation crushed over 300 additional acres in April 1989, in accordance with recommendations made by the ADF&G. In eastern Unit 12, the USFWS has continued to conduct prescribed fires that will ultimately benefit moose on the Tetlin National Wildlife Refuge.

Additionally, the Alaska Department of Natural Resources, Division of Forestry, has cooperated with the ADF&G to develop logging projects in the lower Tok and upper Tanana River drainages within the Tanana State Forest that maximize benefits for moose. In the next few years more habitat enhancement may occur as partial mitigation for a proposed USAF Backscatter Radar site. Preliminary plans are being formulated for a series of low-cost prescribed fires in the upper Tok and Robertson River drainages to enhance early winter and mild winter habitat at higher elevations. Habitat management objectives have been achieved in Unit 12 for several years.

Game Board Actions and Emergency Orders

At the November 1987 meeting, the Board of Game prohibited land-and-shoot harvesting of wolves in Unit 12 and reduced the wolf trapping season by 1 month. These actions reduced the annual wolf harvests in the winter of 1988-89, further frustrating efforts to increase numbers and/or productivity of moose. In the long term these Board actions are expected to adversely impact wolves as well, if moose populations fail to increase.

At the March 1988 meeting, the Board granted additional subsistence hunting privileges to local hunters by reducing the 15-day resident and nonresident moose season in eastern Unit 12 to 5 days; however, no increase in reported harvest by local hunters was noted. Complaints were received from guides operating at the extreme southern boundary of this area, because their clients' moose hunting opportunities had been reduced.

CONCLUSIONS AND RECOMMENDATIONS

Moose were far less numerous in Unit 12 than they were in the mid- to late 1960's; both annual harvests and hunter success were about half of what they had been. Habitat is not limiting moose population growth, but predation is. Wolves have been identified as the most important moose predator in the Northway-Tetlin Flats, but low rates of calf survival to 5 months in the Little Tok River drainage and elsewhere suggest that bear predation may also be important. Out-of-season harvesting of either-sex moose near communities and transportation routes may also be a factor limiting moose population growth.

Most management objectives for moose in Unit 12 are not being met. There are not enough moose to meet the hunters' demand for them, particularly in accessible areas used by local hunters.

A temporary spike-fork regulation would improve the age structure of bulls in the North Slope Alaska Range and Dry Tok Creek survey areas, provided that such a regulation is also applied to Unit 13, where most bulls in the Dry Tok rutting population are harvested. The relatively severe winter of 1988-89 in Unit 13 is expected to reduce survival of calves born in 1988. This could cause further deterioration of the sex ratio in the Dry Tok Creek area unless steps are taken to reduce bull harvests in northeastern Unit 13.

I recommend that steps be taken to increase moose density in northwestern Unit 12. Increased moose density and productivity are prerequisites to attaining strategic use goals.

The Board should reapprove the harvesting of wolves by the land-and-shoot method. Issuance of public aerial shooting permits for the taking of wolves should be considered. Liberal bear hunting regulations should be retained. Moose hunting regulations should remain conservative. Efforts should be made to refine and evaluate nonlethal methods for reducing bear and wolf predation on moose in this area, including diversionary feeding of predators during and following the May-June calving period and the use of birth control substances and procedures to reduce wolf fertility. Enforcement and education efforts should be increased to reduce or eliminate harvesting of cow moose in the main Tanana River valley. Increased subsistence use of the Fortymile Caribou Herd should be encouraged to reduce dependence upon moose in northwestern Unit 12.

LITERATURE CITED

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Table 1. Moose sex and age ratios in Unit 12, 1984-88.

Year	Males: 100 females	Yrlg males: 100 females	Yrlg male % in herd	Calves:100 cows ≥2 yrs	Calf % in herd	Twins:100 cows w/ calf	Moose/ hour	Total moose
1984	46	9	5	26	14	6	34	1,271
1985	47	9	5	26	14	8	36	1,342
1986	41	10	6	24	13	6	36	1,312
1987[a]	55	11	6	27	13	9	37	897
1988	64	18	9	40	17	6	40	1,133

[a] Tok and Dry Tok surveys were not completed, but normally yield a sample of 400+ moose.

Table 2. Reported and estimated moose harvest, number of hunters, and hunter success in Unit 12, 1984-88.

Year	Reported harvest M	F	Unk	Total	Estimated harvest Potlatch[a]	Poaching[b]	Total harvest	Total reporting hunters	Success[c] (%)
1984	84	0	0	84	15-20	30-40	129-144	415	20
1985	66	0	0	66	15-20	30-40	111-126	412	16
1986	105	0	0	105	15-20	30-40	150-165	403	26
1987	79	0	1	80	15-20	30-40	125-140	333	24
1988	79	0	2	81	15-20	30-40	125-140	296	27
Mean	83	0	1	83	-- --	-- --	128-143	372	23

[a] Unreported take for Native funeral potlatches.

[b] Out-of-season harvests other than those legally provided for Native funeral potlatches.

[c] Among reporting hunters.

STUDY AREA

GAME MANAGEMENT UNIT: 13 (23,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Nelchina and Upper Susitna Rivers

BACKGROUND

Although moose densities in Unit 13 were low during the early 1900's, they started to increase during the 1940's. Moose were abundant throughout the 1950's and early 1960's, the population peaking in the mid 1960's. Moose numbers declined during the late 1960's and early 1970's, because of severe winters, increased predation, and large human harvests of both bulls and cows. The low point in the population probably occurred in 1975, when 41 moose per hour and 15 bulls:100 cows were observed during fall surveys. Moose numbers have been increasing since 1976.

Unit 13 historically has been one of the most important moose-producing areas in Alaska. Annual moose harvests were large, averaging over 1,200 bulls and 200 cows, during the late 1960's and early 1970's. Hunting seasons were long, with both fall and winter hunts. As moose numbers began to decline, harvests were reduced by eliminating the cow seasons in 1971 and winter seasons in 1972 and reducing fall bull seasons to 20 days in 1975. Harvests in the late 1970's 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 one having an antler spread of at least 36 inches or with 3 brow tines on at least one antler. Under this regulation the bull harvest declined 34% in the first year (i.e., 848 to 557), although it has increased since then and is now near historically high levels. In a portion of the unit (Subunit 13A west) the bag limit was again changed in 1985 to allow the taking of only bulls with spike or forked antlers, and in 1987 limited permit hunts for any bull were also established in this area.

POPULATION OBJECTIVES

To maintain the existing moose population with a posthunting sex ratio of no less than 15 adult bulls:100 cows.

METHODS

Aerial surveys were conducted during the fall to determine sex and age composition and population trends on count areas located throughout the unit. Censuses have been conducted periodically in different portions of the unit to obtain population estimates. Harvests were monitored by requiring permit and harvest ticket reports from all hunters. Natural mortalities were monitored by field observations and by reports from the public. Habitat conditions have been periodically monitored by examination of browse utilization on transects located in different portions of the unit. Although no active habitat manipulation was conducted, Unit 13 is included in the Copper River Fire Management Plan in which large portions of the unit are included in a limited suppression category, where wildfire would be allowed to burn once ignition occurs. In addition, staff evaluated and responded to land use proposals that could affect moose habitat.

RESULTS AND DISCUSSION

Population Status and Trend

The total number of moose counted during the fall 1988 moose sex and age composition counts declined slightly from the prior year's figures (Table 1). Between 1984 and 1988 the number of moose observed in composition counts increased by 5%. The number of moose observed per hour for all count areas declined by 8% in 1988, after increasing at an average rate of about 5% per year over the prior 4 years. This decline was partially due to the inclusion in 1988 of 2 count areas in Subunit 13E having very low moose densities to the regular count areas, thus reducing the number of moose observed per hour. On a subunit basis the only variation in moose survey results from 1987 was in Subunit 13A, where there was an appreciable decline in total moose counted and moose per hour. It is unlikely that mortality increased in this area over the past year, and the differences between the 1988 and 1989 counts are probably the result of changes in distribution of moose within the subunit. Portions of count units where large numbers of moose were observed in 1988 had substantially fewer animals during the 1989 counts.

Population Size:

A census conducted over a 1,877-mi^2 area in the western portion of Subunit 13A during November 1987 produced an estimate of 5,913 (90% CI = ±725) moose, or about 3.1 moose/mi^2, somewhat higher than the density estimates obtained within the better moose habitat types in other subunits during fall composition surveys (Table 2).

Population Composition:

Composition data collected during fall sex and age composition surveys are presented in Tables 1 and 2. The bull:cow ratio increased in 1988, exceeding the 5-year mean of 29:100. The calf:cow ratio also increased, approximating the 5-year mean of 28:100. There were 19 large (i.e., older than 1 year of age) bulls:100 cows observed unitwide, thus exceeding the minimum management objective of 15:100.

Table 2 lists the 1988 composition survey data by subunit. Bull:cow ratios were similar in Subunits 13B, 13C, and 13E.

Since 1984, the bull:cow ratio in Subunit 13A has increased 124% (17:100 to 38:100). Large bulls currently compose 73% of the bull population, compared with only 16% in 1984. This increase was directly attributable to the spike-fork regulation, under which only a portion of the yearling bulls are harvestable and large bulls are protected.

Calf production and/or survival varies somewhat between subunits with Subunits 13B and 13E generally having higher calf:cow ratios than Subunits 13A and 13C. Calf:cow ratios throughout the unit fluctuate annually, but overall trends were not evident. Calf production or survival remained low in Subunit 13D, averaging only 14 calves:100 cows over the past 5 years.

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 Flats, and the Tulsona Creek burn.

Mortality

Seasons and Bag Limits:

The open season for resident and nonresident hunters in Unit 13 is 1-20 September. The bag limit in that portion of Subunit 13A west of Lake Louise road, Lake Louise, Lake Susitna, and Tyone River is 1 moose; bulls must have spike-fork antler; however, 200 drawing permits will be issued for bull moose with any size antlers. Cows may be taken by drawing permit only; 25 permits will be issued to Alaska residents only. The taking of cows accompanied by calves is prohibited. The bag limit for the remainder of Unit 13 is 1 bull with 36-inch antlers; however, in Subunit 13E, one cow may be taken by drawing permit only; 12 permits will be issued to Alaska residents only. The taking of cows accompanied by calves is prohibited.

Human-induced Mortality:

In 1988 the reported harvest in Unit 13 was 1,259 moose for the sport and subsistence seasons (Table 3). The 1988 harvest was 31% above that for the previous year (959) and 35% more than the 5-year (1983-87) mean harvest (933). A total of 4,329 hunters reported in Unit 13 during 1988, up 3% from 1987 and 14% above the 5-year (1983-87) mean of 3,788 hunters.

The general sport season harvest (Table 4) in 1988 (963) was substantially above that (24%) for the previous year (774) but similar to the harvest for 1986 (961). In contrast, the 3,568 sport hunters reporting in 1988 was virtually identical to the 3,556 hunters reporting in 1987, but it was less than the 3,695 hunters reporting in 1986. The average reported antler spread for all bulls taken in the sport hunt was 43 inches, similar to the average spread observed since implementation of the 36-inch antler regulation.

Included under the general sport harvest are moose taken in the western half of Subunit 13A, where a spike-fork regulation has been in effect since 1985, limiting the harvest to a portion of the yearling bull population and thereby protecting larger bulls. Harvests for 1985, 1986, 1987, and 1988 were 70, 117, 71, and 91 spike-fork antlered bulls, respectively.

Some illegal and unreported harvests of bulls and cows have been documented in Unit 13, but there is little information on which to base estimates of the numbers involved. Road kills occur during periods of deep snow, and they increased in 1988 because of above-average snow conditions. Overall, few moose were lost in accidents in Unit 13, compared with other units having more extensive road or railroad systems.

Permit Hunts. Registration Hunt No. 913W is a subsistence hunt in which any antlered bull may be taken. Only residents of Unit 13 are eligible, and only 1 permit is issued per household in Glennallen and Cantwell throughout the season. In 1988, 797 permits were issued, 30 more than in 1987 but 282 fewer than 1986, when no limits had been placed on the number of permits per household (Table 4). The harvest in 1988 was 193 moose, 24% above the previous year's take; it was the largest subsistence harvest reported to date. Hunter success was 33% in 1988, compared with 28% in 1987 and 22% in 1986. With such a high hunter success rate, the harvest would have been appreciably larger had the Board not limited the number of permits issued per household in 1987. The mean antler spread of subsistence-killed bulls was 33 inches, down 12% from the 1987 mean of 37 inches. Sixty-five percent of the bulls harvested had antler spreads of less than 36 inches; they would not have been legal under the 36-inch minimum regulation for the sport hunt.

Drawing permit Hunt No. 912 is for antlered bulls of any size, and the hunt area is located in Subunit 13A West, south of the Black River. There are no residency restrictions, and anyone may apply. This hunt was established in 1987 (previously Hunt No. 914) to allow for a controlled harvest of large bulls in the spike-fork area. In 1988, 100 permits were issued; hunters harvested 51 bulls, compared with 29 in 1987. The mean antler spread was 43 inches; 83% of the bulls had antler spreads of 35 inches or greater.

Drawing permit Hunt No. 914 (established in 1988) is also for antlered bulls of any size in Subunit 13A West, but hunters are restricted to the area north of the Black River. This portion of Subunit 13A is also in the spike-fork area, but it has received little hunting pressure since 1985, because access is difficult and hunters have not expended the effort and expense necessary to hunt in this area. One hundred permits were issued, but only 56 permittees reported hunting. The reported harvest was 26 bulls; 84% of the bulls had antler spreads of 35 inches or more ($\bar{X}$ = 45 in).

Four drawing-permit hunts for cow moose were established in Unit 13 in 1988. Two hunts (Nos. 915W and 917W) were for unit residents only, while anyone could apply for hunt Nos. 916 and 918. Hunt Nos. 915W and 916 were located in Subunit 13A West, while hunts 917W and 918 were located in that portion of Subunit 13E situated between the Susitna River and Brushkana Creek. Harvest data for these hunts are presented in Table 4. Overall, the cow hunts were popular; 1,312 applications were received for the 76 available permits. Permittees harvested 18 and 8 cows in Subunits 13A and 13E, respectively.

Hunter Residency and Success. Unit 13 residents, nonlocal residents, and nonresidents accounted for 21%, 65%, and 9% of the unit moose harvest in 1988, respectively. Residency was not reported for 5% of the successful hunters (Table 5). Between 1983 and 1985, unit residents averaged 124 moose per year. Between 1986 and 1988 the harvest by locals increased by 85% to an average of 230 moose per year; most were taken in the subsistence hunt. Harvests by nonlocal residents and nonresidents increased 26% and 84%, respectively, in the last 5 years.

The overall hunter success rate was 29% in 1988, up substantially from the 23% experienced in 1987 and the 5-year (1983-87) mean of 25%. The highest reported success rates were for hunt Nos. 916 and 913 (i.e., drawing permit) in which 65% and 56% of the permittees that hunted were successful. Subsistence hunters had a success rate of 33%, while sport hunters averaged 27%. Successful moose hunters spent an average of 5.7 days hunting, compared with 6.1 days for all unsuccessful hunters. Successful subsistence hunters averaged 4.9 days, compared with 6.0 days required for sport hunters. Successful cow moose hunters spent the least amount of time in the field, averaging only 2.2 days in Subunit 13E and 4.0 days in Subunit 13A.

Harvest Chronology. More moose are usually taken during the first part of the season (Table 6), because hunting pressure is usually greater then. However, in 1988 the majority of the harvest occurred in the second half of the season. Subsistence hunters have taken advantage of the early subsistence opening. In 1987 and 1988 they took 50% and 35%, respectively, of the subsistence harvest before the sport hunt had opened.

Transport Methods. Off-road vehicles continued to be the transportation method most used by successful hunters. Highway vehicles, aircraft, and 3- and 4-wheelers were also popular transport methods (Table 7). Highway vehicles were important to subsistence hunters; 40% of successful permittees reporting their use, compared with 24% using ORV's and 10% each for aircraft and 3- and 4-wheelers. Highway vehicles were also the most used transportation method in all the cow moose hunts.

Antler Growth vs. Age of Harvest. Between 1983 and 1986 teeth were collected from 295 bulls harvested in Unit 13 with known antler measurements. Table 8 presents the percentage of bulls in each antler class by age group. These data suggested that 31% of the 2-year-olds and 84% of the 3-year-olds were legal under the 36-inch regulation. Approximately half the 4-year-olds and 80% of the 5-year-olds had 50+ inch antlers.

Natural Mortality:

Predation on moose by brown bears and wolves directly influences overall moose abundance in Unit 13; however, brown bear and wolf harvests have been relatively large over the past few years, and predation during this period, while influencing abundance, was not considered to be limiting the moose population. Bear and wolf harvests declined during the reporting period, but the effects of the reduced harvest of these predators on moose numbers are unknown.

Mortality attributable to deep snow conditions increased during the winter of 1988-89. Snowfall was at or above normal throughout the unit; the eastern portion of the unit, especially Subunit 13C, had snowpacks as much as 80% above normal. Overall, snow accumulations were the deepest in 10 years. Heavy snows started by mid-October, over a month earlier than normal. Dead moose calves were observed by January. Although calves were the most susceptible to deep snows, some adult mortality attributed to starvation was observed during aerial surveys in late February, March, and April.

Habitat Assessment and Enhancement

Wildfires occurred throughout much of Unit 13 prior to 1950, when fire suppression activities were initiated. Since then little total acreage has burned. The overall effect of fire suppression has been to reduce the amount of several habitat types available to moose and reduce the carrying capacity for moose in portions of the unit. Currently, climax upland and riparian willow communities are the most important habitat types for moose in the unit. Browse evaluation in these habitat types conducted from 1983 to 1986 suggested that browse species were able to withstand the level of use occurring at that time. If the moose population increases, additional browse evaluation will be necessary to monitor the effects of increased utilization on preferred plant species.

Unit 13 has numerous areas where habitat improvement could produce more favorable browse conditions for moose. Because of the size and remoteness of much of the unit, wildfire is the only feasible tool for extensive habitat improvement projects. To promote wildfire, the Copper River Fire Management Plan allows for wildfire to burn in remote portions of the unit, rather than to undergo initial suppression. In addition, the use of prescribed burns to create moose habitat may be considered; however, the unit's climate of cool, wet summers will severely limit this method in all but the very dry years. Mechanical treatment of habitat, such as crushing, has been considered as an alternative to burning in sites where moose are known to concentrate. This method is expensive and would be limited to small areas near the road system where access for equipment is available. Possible enhancement sites include riparian willow stands on the Copper River between Gakona and Slana in Subunit 13C.

Game Board Actions and Emergency Orders

In 1985 the Board established a hunt for only spike/fork-antlered bulls in Subunit 13A West to increase the number of large bulls in the subunit. Because this regulation was successful in increasing the number of large bulls, the Board established drawing-permit hunts in 1987 and 1988 to allow some large bulls to be harvested. These hunts were approved by the Board during their spring 1989 meeting, and in addition, the Board voted to allow subsistence hunters (913W) to take any size bull in Subunit 13A West for the first time.

Also during the 1989 spring Board meeting, cow moose seasons were reauthorized in Subunits 13A West and Subunit 13E; 50 drawing permits were available in each subunit. One half of the permits in each area were reserved for unit residents. These cow moose drawing hunts were subsequently cancelled by the Department in late April, in response to increased winter mortality. In November 1987 the Board made land-and-shoot wolf hunting and trapping illegal in Unit 13, effective for the 1988-89 season. This action resulted in reduced wolf harvests during the reporting period. Few wolves were taken from the more remote portions of the unit, where access by snowmachine is difficult.

CONCLUSIONS AND RECOMMENDATIONS

Based on slight declines in total moose and moose per hour counted during fall 1988 surveys, it appears that moose numbers in Unit 13 have showed little change. Moose were generally increasing during the prior 10-year period, because of a series of mild winters, reduced predation, and restricted human harvests. Surveys suggested moose numbers in more favorable habitats are approaching the level observed during the late 1960's, before the large decline in numbers occurred.

Close monitoring of moose population trends will be needed over the next few years because factors that can influence moose abundance have changed. The winter of 1988-89 was relatively severe, increasing moose mortality, especially calves. The impact of the winter will not be known until the fall 1989 moose surveys have been completed; however, a decline in moose numbers is expected, especially in Subunits 13C and 13B where snowpack was the deepest. Predation rates on moose may also have changed. Both the wolf and brown bear harvests declined in 1988. The impacts of reduced human harvests of these two predators on moose numbers in Unit 13 are unknown. The moose population is expected to decline if predation increases and winters become more severe. I recommend close monitoring of moose numbers to detect changes in population trend. I also recommend not holding cow hunts until the magnitude of increased winter mortality has been determined.

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Table 1. Moose composition counts in Unit 13, 1984-88.

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour	Density moose mi^2 (range)
1984	25	13	28	18	5344	6549	65	1.5 (.7-2.3)
1985	32	15	29	18	5432	6614	67	1.6 (.6-2.9)
1986	27	12	30	19	5323	6582	70	1.6 (.5-3.1)
1987	28	12	26	17	5723	6892	78	2.0 (.6-2.9)
1988	31	12	28	18	5629	6846	72	1.8 (.5-3.0)

Table 2. Moose composition counts in Unit 13, 1988.

Subunit	Males: 100 females	Yearling males:100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour	Density moose mi^2 (range)
13A	38	10	25	15	1368	1617	60	1.7
13B	27	14	31	19	2718	3370	81	2.2
13C	26	15	25	17	598	718	110	3.0
13D	74	11	16	8	176	192	40	0.5
13E	27	10	35	22	439	561	88	1.3

Table 3. Annual moose harvest and accidental death in Unit 13, 1984-88.

Year	Reported			Estimated			Accidental			Grand total
	M	F	Total[a]	Unreported	Illegal	Total	Road	Train	Total	
1984	830	3	839	25	10	35	30	--	30	904
1985	812	4	823	25	10	35	30	--	30	888
1986	1120	3	1140	25	10	35	30	--	30	1205
1987	948	2	959	25	10	35	30	--	30	1024
1988	1216	28	1259	25	10	35	50	--	--	1344

[a] Includes unknown sex.

Table 4. Moose harvest data by hunt in Unit 13, 1984-88.

Hunt No.	Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows	Total
Sport								
	1984	--	--	2,528	816	813	3	816
	1985	--	--	2,634	792	788	4	792
	1986	--	--	2,734	961	958	3	961
	1987	--	--	2,782	774	773	1	774
	1988	--	--	2,605	963	955	2	963
912	1987	99	19	51	29	29	0	29
	1988	100	16	31	51	51	0	51
914	1988	100	56	18	26	26	0	26
916	1988	25	4	7	3	0	13	13
918	1988	12	3	4	5	0	5	5
Subsistence								
913W	1984	100	18	59	23	23	0	23
	1985	200	50	119	31	31	0	31
	1986	1079	277	623	179	179	0	179
	1987	767	277	410	156	155	1	156
	1988	797	195	389	193	184	0	193
915W	1988	25	5	9	5	0	5	5
917W	1988	14	4	7	3	0	3	3
1988 Totals All Hunts				3,070	1,259	1,216	28	1,259

Table 5. Moose hunter residency and success for all hunts in Unit 13, 1984-88.

Year	Successful				Unsuccessful			
	Local resident	Nonlocal resident	Non-resident	Total[a]	Local Resident	Nonlocal resident	Non-resident	Total[a]
1984	116	650	65	839	397	2115	51	2587
1985	135	598	60	823	598	2034	48	2753
1986	230	813	81	1140	936	2299	67	3355
1987	199	633	77	959	651	2323	89	3243
1988	263	821	113	1259	665	2138	104	3070

[a] Includes unspecified residency.

Table 6. Moose harvest chronology percentages by time period for all hunts in Unit 13, 1984-88.

Year	Season dates	Week of Season				
		1st	2nd	3rd	4th	5th
1984	1-20 Sept.	12	38	32	18	
1985	1-20 Sept.	43	31	26	--	
1986	1-20 Sept.	41	30	29	--	
1987	25 Aug.-20 Sept.	6	36	24	30	4
1988	25 Aug.-20 Sept.	2	13	36	30	19

Table 7. Successful moose hunter percent by transport method for all hunts in Unit 13, 1984-88.

Year	Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown
1984	26	3	7	7	0	35	16	6
1985	18	3	8	11	0	36	18	6
1986	18	4	9	12	0	28	22	7
1987	16	5	7	15	0	32	19	6
1988	19	4	6	14	0	32	19	6

Table 8. Percentage distribution of antler spread categories by age class from Unit 13 moose harvest[a], 1983-1986.

Age (years)	Spike/fork	Antler Spread (inches)					
		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] $\underline{n} = 295$

STUDY AREA

GAME MANAGEMENT UNIT: 14A (2,701 mi^2)

GEOGRAPHICAL DESCRIPTION: Matanuska Valley

BACKGROUND

Moose numbers in the Matanuska Valley were relatively low in the early 1900's. During the period 1940 to 1969 moose increased dramatically in response to 2 principal factors: (1) intensive predator control by the federal government prior to statehood (1959) and (2) clearing of land for agriculture that resulted in a substantial increase in winter range (i.e., after abandonment of farms and/or growth of browse along roads and the edges of cleared areas).

Moose numbers peaked in the late 1960's and then abruptly declined in the early 1970's, following several hard winters and large harvests. From 1966 to 1970 the mean annual harvest was 390 moose, predominantly bulls. By 1970 the bull:cow ratio had declined to 9 bulls:100 cows and Department staff recommended a larger harvest of cows; previously, limited cow seasons had been held only in 1966 and 1969. In 1971 an early and late cow season (i.e., 20 days each in September and November) were authorized, resulting in nearly a 3-fold increase in the harvest: 1,018 moose, including 479 cows. Cow seasons were eliminated during the next 5 years (1972-1977), and the mean annual harvest of bulls declined to 251 (range = 167-346). These actions, as well as mild winters, allowed the moose population to increase. Cow seasons were reinstated in 1978. While moose numbers were increasing during this period, so was hunting pressure. In 1980 there was a 65% increase in hunters (i.e., 1,053 to 1,735), followed by a 35% increase in 1981 and another 5-10% increase during the next 3 years, stabilizing at about 2,300-2,400 hunters annually after 1983. Harvests generally exhibited a rising trend after 1978; the annual means during this period were 297 bulls (range = 201-358) and 82 cows (range = 53-129).

During the early 1980's, a construction boom in the Matanuska-Susitna Valley reduced the quantity and/or availability of moose browse on winter range. Because of continuing development and resulting loss of moose habitat, maintenance and improvement of winter range have become ongoing management concerns. Additionally, a substantial increase in human population in the Matanuska-Susitna Valley in the early 1980's resulted in higher winter moose mortality from highway vehicles and a higher incidence of illegal harvest. The increasing annual mortality (of which hunting was only a part) and a winter of prolonged deep snow in 1984-85 may have stabilized or caused a slight reduction in moose numbers. Since 1985 it appears the population has remained stable or increased slightly.

POPULATION OBJECTIVES

To maintain the existing moose population with a posthunting sex ratio of no less than 20 bulls:100 cows.

METHODS

Aerial sex and age composition surveys were conducted in early winter to determine population composition and trend in select count areas. In November 1988 a complete population census of the subunit was conducted by stratified sampling. A stratified census was also conducted in the Matanuska Valley Moose Range (MVMR) in March 1989. During both censuses, sex and age composition was recorded. Harvests were monitored by requiring (1) harvest reports from hunters who took bulls in the subunit and (2) drawing-permit reports from successful antlerless moose hunters.

RESULTS AND DISCUSSION

Population Status and Trend

Because traditional count areas have lacked adequate snow cover in some years, aerial moose surveys have been conducted sporadically. Even in years in which counts were done, variable snow conditions resulted in different densities of moose on fall and winter ranges that, in turn, resulted in variations in the composition and observed numbers of moose. Lack of consistency in survey data made accurate interpretation of the status of the moose population during the past 5 years difficult; however, moose numbers were stable or slightly increasing between 1982 and 1984. The prolonged winter with deep snow in 1984-85 and high mortality from trains and highway vehicles probably reduced the population. Since then the moose population has probably increased slightly, because of mild winters and relatively high calf production and survival.

Population Size:

An early-winter census in November 1988 resulted in a population estimate of 4,600 moose ± 700 (3,900-5,300). Subunit 14A was subdivided into 120 sample units, and the census resulted in the following sample unit classifications and moose densities: 4 super high, 1.05 moose/mi^2; 13 high, 1.15 moose/mi^2; 46 medium, 1.25 moose/mi^2; and 57 low, 1.3 moose/mi^2. In addition to the early winter census, a mid- to late-winter census of the MVMR was conducted on 28 February and 1 March. The MVMR census covered 184.3 mi^2 in the Matanuska River drainage. This area was divided into 16 sample units, and all were censused. The resultant population estimate was 892 ± 120 (709-949) moose. Sample unit classifications and moose densities were as follows: 6 high, 6.2 moose/mi^2; 4 medium, 2.2 moose/mi^2; and 6 low, 0.8 moose/mi^2.

Population Composition:

Prior to the 1988 early-winter census, fall composition surveys had been conducted in only three of the last 6 years (Table 1). These data indicated that bull:cow ratios had fluctuated between 16:100 and 25:100. These ratios probably did not accurately represent changes in composition of the moose population, because variable snow depth and other related environmental conditions affected moose density and composition in the survey count areas. The lowest bull:cow ratio of 16:100 cows (1986) was recorded in a year with light snow cover, when only 873 moose were observed, compared with 1,600 to 2,000 moose in other years. Also, the count areas were predominantly in winter range along valley bottoms. A large number of bulls remained in the higher alpine areas, biasing the observed sex ratio. Data from the 1987 fall composition count (Table 1) was an accurate representation of moose composition in the population because surveys covered large geographic areas and the sample size was large. Results from the 1988 early winter census were similar to the 1987 fall composition counts. Census results were 26.7 bulls:100 cows and 55 calves:100 cows. Calves composed 30.3% of the population (see Table 1 for yearly comparisons).

Subunit 14A continues to exhibit high calf production and survival. The percentage of calves in the moose population during December in 3 different survey years (1982, 1986, 1987) was 25-27%. In February 1988 when the MVMR population was censused, calves composed 21% of the population, also indicating that survival of calves through late winter was quite high.

Mortality

Season and Bag Limit:

The open season for resident and nonresident hunters is 1-20 September. The bag limit is 1 moose; however, antlerless moose may be taken by drawing permit only. Up to 400 permits will be issued.

Human-induced Mortality:

The combined reported harvest of the general season and permit hunts for 1988 was 612 moose: 454 bulls, 150 cows, and 8 unspecifieds (Table 2). The annual harvest was 10% higher (46 moose) than the previous reporting period (1987-88). The bull harvest increased 7% from that of the previous year; the cow harvest increased by 10%. The 6-year trend showed a relatively stable cow harvest (range = 123-150) and an increasing bull harvest (343 to 454).

In addition to the reported harvest, Subunit 14A also had relatively high moose mortalities from other human causes, including unreported or illegal harvests and collisions with highway vehicles or trains. In the past 6 years, the mean mortality from all these causes was 170 moose. From 1983 to 1988 the total annual moose mortality from all human causes, including hunting, ranged from 529 to 820 moose (Table 2). Annual mortality from human causes has increased during the past 6 years.

Hunter Residency and Success. In 1988, 456 of 2,563 hunters (18%) were successful. Over the past 6 years the annual number of hunters participating in the general (bulls-only) hunt has remained relatively constant near the mean of 2,319 and hunter success rates have followed a similar stable trend, ranging from a low of 16.5% in 1983 to a high of only 18.8% in 1987.

The number of moose taken by local residents (i.e., Subunits 14A and 14B), compared with that by nonlocal residents, has changed over the past 6 years. In 1983 and 1984 nonlocal residents killed more moose than local residents. In the past 4 years, local residents have killed more moose than nonlocal residents. The annual harvest by nonlocal residents during the past 6 years fluctuated between 139 and 203 (mean = 180); whereas, the harvest by local residents increased in the past 6 years from 179 to 231 (mean = 197).

The number of nonresidents who hunt in Subunit 14A has been consistently low. In the past 6 years, the mean annual number of nonresident hunters was 21, harvesting an average of only 6 moose annually (Table 3).

Permit Hunts. Four-hundred antlerless moose permits have been issued annually in Subunit 14A since 1982. The number of moose harvested by permit holders has been relatively consistent during this period. In 1988 hunters took 156 moose: 13 males and 143 females. This was the largest permit hunt harvest in the past 6 years (mean 137). The previous high and low harvests were 143 and 119 moose in 1983 and 1986, respectively (Table 4). The number of hunters who did not hunt (mean 59) and the number of unsuccessful hunters (mean 204), have remained fairly consistent from year to year. The greatest variability has occurred in the number of applicants for this hunt, ranging from 5,642 (1983) to 10,864 (1988). In 1985 there were only 1,277 applicants, but in that year only qualified subsistence hunters were eligible.

Harvest Chronology. Reported dates of harvest for the past 6 years show that 38-58% of the annual harvest occurred in the first week of the hunting season (Table 5). In 1986 and 1987 harvests were larger than normal during the last week of the season; the reasons for this are unknown. The harvest in 1988 followed the more typical pattern for Subunit 14A.

Transport Methods. Highway and off-road-vehicles (ORV's) have been the predominant means of transportation among successful moose hunters, because of good road and trail access in most of the subunit. These methods have accounted for over 50% of the moose harvest in the past 6 years (Table 6). The major trend in transportation methods used by successful hunters has been the dramatic increase in the use of 3- and 4-wheelers. In 1984 only 20 moose were reported killed using this method. By 1988 use of 3- and 4-wheelers by successful hunters had climbed to 78, surpassing ORV's and becoming the second-most-popular transportation method next to highway vehicles. Other transportation methods used to take moose in 1988, listed in descending order of importance, were boats (56), aircraft (23), and horses (22).

Game Board Actions and Emergency Orders

Alaska statutes require the Board of Game to reauthorize antlerless moose seasons annually. In 1982 the number of antlerless permits was increased from 150 to 400. In 1986 the antlerless season was shortened to 6-20 September, and then in 1987 it was lengthened back to 1-20 September. The Board of Game has not made any other changes to the moose hunting regulations since 1982.

CONCLUSIONS AND RECOMMENDATIONS

Aerial composition counts conducted in years with good snow cover indicated that the population objective of at least 20 bulls:100 cows has been achieved and maintained. Until recently, the major shortcoming in moose management data for Subunit 14A has been the lack of an accurate population estimate. The completion of the early and late-winter censuses has provided the number of moose in the subunit and a more precise method of evaluating the impact of hunter harvest and other annual mortality. The posthunting population estimate in November was 4,600 moose ($\pm$ 700), and the March census in the MVMR indicated short yearling recruitment was 21%. Even with some natural mortality in late spring, annual recruitment in "average" winters can be expected to be 18-20% of the population. With 4,600 moose in the population, recruitment can be expected to be 828-920 moose annually. Mortality from all human causes in 1988 was 810 moose. Natural mortality in Subunit 14A is low during most years. Therefore, it appears that annual mortality from all causes does not exceed or is very close to annual recruitment. The moose population in Subunit 14A is probably stable under the present management regulations. No changes is season and bag limits are recommended at this time.

PREPARED BY:	SUBMITTED BY:
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Wildlife Biologist III	Management Coordinator

Table 1. Moose composition counts in Subunit 14A, 1982-1988.

Year	Males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose/ hr	Population estimate
1982	19.9	40.3	25.1	1,533	2,055	58.9	3,000-4,000
1983[a]	--	--	--	--	--	--	--
1984[a]	--	--	--	--	--	--	--
1985[a]	--	--	--	--	--	--	--
1986	16.4	38.8	25.0	647	863	61.2(est)	3,000-4,000
1987	25.6	47.3	27.3	1,225	1,686	n/a	3,000-4,000
1988[b]	26.7	55.1	30.3	3,206	4,600	n/a	3,900-5,300

[a] No surveys flown.
[b] These data are from a November 1988 census of all of Subunit 14A.

Table 2. Annual moose harvest and accidental death in Subunit 14A, 1983-88.

Year	Reported			Estimated			Accidental[d]			Grand total
	M	F	Total[a]	Unreported[b]	Illegal[c]	Total	Road	Train	Total	
1983	343	148	534	27	30	57	94	8	102	693
1984	311	139	460	23	37	60	51	33	84	604
1985	324	123	457	23	21	44	24	4	28	529
1986	401	134	555	28	26	54	112	22	134	743
1987	425	137	566	28	30	58	151	45	196	820
1988	454	150	612	31	18	49	129	20	149	810
Mean	377	139	531	27	27	54	94	22	116	700

[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. Moose hunter[a] residency and success in Subunit 14A, 1983-88.

Year	Successful					Unsuccessful					
	Local[b] resident	Nonlocal resident	Nonres	Unk	Total	Local[c] resident	Nonlocal resident	Nonres	Unk	Total	Total hunters
1983	179	202	5	5	391	1,930	unk	14	33	1,977	2,368
1984	154	163	4		321	1,898	unk	11	14	1,923	2,244
1985	172	139	9	10	330	1,558	unk	15	58	1,652	1,982
1986	223	203	6	4	436	1,969	45	10	20	2,044	2,480
1987	221	185	9	13	428	1,733	46	18	49	1,846	2,274
1988	231	192	5	17	456	1,950	53	20	84	2,107	2,563
Mean	197	180	6	8	393	1,839	48	15	43	1,924	2,319

[a] Does not include hunters participating in drawing permit hunts.
[b] Includes only residents of Subunits 14(A) and 14(B).
[c] Includes all Alaskan residents from 1983-1985, and all Unit 14 residents in 1986-1988.

Table 4. Moose harvest data by permit hunt[a] in Subunit 14A, 1983-88.

Year	# Applicants	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Males	Females	Total
1983	5,642	400	57	200	143	8	135	143
1985	6,643	400	77	184	139	7	132	139
1985	1,277[b]	400	55	218	127	6	121	127
1986	7,491	400	61	220	119	3	116	119
1987	6,631	400	51	211	138	10	127	138
1988	10,864	400	52	192	156	13	143	156
Mean	6,425	400	59	204	137	8	129	137

[a] Permit hunts 919 and 920 combined.
[b] Only qualified subsistence hunters (Tier II) were eligible to apply.

Table 5. Moose harvest chronology[a] in Subunit 14A, 1983-88.

Year	Before season opened	Weeks of season 1st	(%)	2nd	3rd	4th	After season closed	Unknown	Total
1983	2	214	(54)	69	46	-	2	58	391
1984	4	187	(58)	61	45	-	8	16	321
1985	4	180	(55)	56	77	-	0	13	330
1986	6	167	(38)	97	131	-	7	28	436
1987	7	184	(43)	92	130	-	2	13	428
1988	6	236	(52)	103	91	-	8	12	456

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

Table 6. Successful moose hunter transport methods[a] in Subunit 14A, 1983-88.

Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Orv	Vehicle	Unk	Total all methods
1983	22	16	47	0[b]	1	85	198	22	391
1984	18	6	44	20	0	61	145	27	321
1985	28	13	42	43	0	37	148	19	330
1986	27	14	56	71	1	56	173	38	436
1987	25	14	59	70	0	45	173	43	428
1988	23	22	56	78	1	56	190	30	456
Mean	23	14	51	47	<1	57	171	30	394

[a] Does not include transport data from drawing permit hunts.
[b] In 1983 use of 3- or 4-wheelers was reported as ORV use.

STUDY AREA

GAME MANAGEMENT UNIT: 14B (2,079 mi^2)

GEOGRAPHICAL DESCRIPTION: Western Talkeetna Mountains (Willow to Talkeetna)

BACKGROUND

Moose populations in the lower Susitna Valley and western Talkeetna Mountains were relatively low in the early 1900's; however, they increased substantially from 1940 to 1969 in response to (1) intensive predator control efforts by the federal government prior to statehood and (2) increased winter range because of cleared land for agriculture and highways, abandoned farms, and/or growth of browse occurring along roads and edges of cleared areas. Because access within Subunit 14B was limited and harvests were relatively low, moose populations continued to increase through the 1960's, probably peaking in the latter part of the decade.

The mean annual harvest of 144 moose between 1966 and 1970 was predominantly bulls. During this period, limited cow seasons were held in 1966 and 1969, resulting in a harvest of 25 and 46 cows, respectively. Bull:cow ratios were low in some heavily hunted areas, and because harvests in remote areas of Subunit 14B were well below sustained yield, a harvest of up to 350 cows was authorized in 1971. This regulation resulted in a 4-fold increase in the annual harvest (from 82 to 372), of which 243 were cows. Snowfall during the winters of 1970 and 1971 was near the record levels, resulting in a very high winter mortality, particularly among calves. Two back-to-back hard winters with high moose mortality and the record harvest of moose resulted in an abrupt decline in the population.

Between 1972 and 1977 limited (i.e., by permit only) cow seasons were held only 2 times, and in 1974 the winter bull season (1-20 November) was eliminated. From 1972 to 1977, the mean annual harvest of bulls and cows combined was only 51. Restricted hunting seasons and a series of relatively mild winters allowed the moose population in Subunit 14B to gradually increase. Cow seasons were reinstated in 1978, when 100 permits were authorized during the 1-20 September season. In 1979 a late-winter antlerless season (15 Dec-15 Feb.) was also authorized (50 permits). Concurrent with the change in these regulations, or perhaps because of them, an increase in hunting pressure occurred. From 1978 to 1982, the number of hunters increased from 368 to 997, a 2.7-fold increase in 4 years. Moose harvests also increased from 115 in 1979 to 248 in 1982 (mean = 168).

Access to most of Subunit 14B was difficult, particularly the Talkeetna Mountains, and remote moose populations were lightly hunted. In 1982 a general cow season (10 to 20 September) was authorized east of the powerline intertie, and in 1983 the entire subunit was opened to either-sex hunting from 1 to 30 September. These liberalizations, together with the fact that Subunit 14B was one of the few areas along the road system that remained open to moose hunting after 20 September, produced a significant increase in the number of hunters and a corresponding increase in the annual harvest. Because of large harvests and a severe winter in 1984-85, the winter hunt was eliminated and the area and the open season for cows was reduced in 1985. However, large hunter harvests continued, and with additional relatively high mortality from trains and highway vehicles, moose numbers declined in portions of Subunit 14B. The cow season was closed in 1988.

A construction boom in the Matanuska-Susitna Valleys in the early 1980's affected some moose habitat in Subunit 14B. Some development is continuing, adding to moose management problems. Increased emphasis on agriculture, timber harvest, grazing, and land development has the potential to adversely impact moose populations because of large-scale loss of habitat and increased human access. Increases in human population and hunters have contributed to complexities in moose management.

POPULATION OBJECTIVES

To maintain the existing moose population with a posthunting sex ratio of no less than 30 bulls:100 cows.

METHODS

In years when snow conditions were adequate, aerial sex and age composition surveys were conducted annually during early winter in select count areas to determine population composition and trends. In 1987 a complete population census was conducted in early December by stratified sampling. Sex and age composition was recorded during the census. Harvests of bulls and cows were monitored by requiring harvest reports from any person who hunted in the subunit.

RESULTS AND DISCUSSION

Population Status and Trend

Although aerial surveys have been conducted for many years, estimates of the moose population prior to 1983 are not available. Based on counts of about 1,800 moose in 1983 and 1984, observers believed at least 2,500 to 3,000 moose were present at that time; however, the moose population may have numbered as high as 4,000-4,500. A prolonged winter with deep snow in 1984-85, a large hunter harvest (534), and relatively high mortality from trains and highway vehicles (261) caused a significant reduction in moose numbers by the end of the winter. From 1985 to 1987 annual mortality approximated annual recruitment and the population remained stable or decreased slightly. After the closing of the cow season in 1988, the population may have increased slightly.

Population Size:

A population census in Subunit 14B was conducted between 5 and 8 December 1987. This stratified census of 88 sample units resulted in a population estimate of 2,900 ± 450 moose. Average density throughout the subunit was 2.7 moose/mi^2. Moose densities in the southern half of Subunit 14B were considerably higher than those in the northern half.

In addition to the 1987 census, a late-winter census on 15 and 16 March 1989 was conducted in a portion of the Kashwitna Forest Management Unit. Twelve sample units ranging in size from 6.7 to 14.7 mi^2 were censused in a 135-mi^2 area west of Willow Mountain and between Willow Creek and the Kashwitna River. Survey conditions during the census were generally poor. Although the area had a uniform snow cover, the last recorded snowfall had been 2 weeks prior to the census. Tree stumps, fallen trees, rocks, and other large debris showed through the snow cover as dark brown spots. Under these conditions, moose were extremely difficult to observe, even if they were lying out in the open. Many moose tracks and other sign were evident in all of the sample units; some tracks were new, but most were old. In the 12 sample units censused, 114 moose (100 adults and 14 calves) were observed. The population estimate (applying a sightability correction factor of 2.99) was 342 moose ± 152. Based on this estimate, average moose density throughout the area was 2.5 moose/mi^2; calves composed 12% of the population.

Population Composition:

Fall composition surveys were not conducted in 1988; they have been done only 3 times in the past 7 years. Results from the 1987 census provided the most recent composition data; the bull:cow ratio was 36.8:100. Previous composition data indicated bull:cow ratios ranging from 34:100 to 43:100 (Table 1).

Calves observed in Subunit 14B during fall composition surveys have constituted 14.9-18.2% of the surveyed sample (Table 1). In 1987 17.4% of the population were calves (28 calves:100 cows); the small sample from the 1989 Kashwitna Forest census indicated 12% calves in the herd in early March. Compared with other areas in Alaska, this proportion of calves would be classified as fair to good, but it is still lower than that in Subunit 14A where winters are milder and predation is lower. Yearling recruitment in Subunit 14B has probably ranged between 10-15% of the population in most years.

Mortality

Season and Bag Limit:

The open season for resident and nonresident hunters in Subunit 14B is 1-30 September; the bag limit is 1 bull.

Human-induced Mortality:

In 1988 the reported harvest was 140 moose (i.e., 134 bulls, 2 cows, and 42 unspecified) representing a decrease of 60% (207 moose) from the 1987 harvest (Table 2). This dramatic decrease was due primarily to the closure of the cow season in all of Subunit 14B, resulting in a substantial reduction in hunting effort as well as in legally harvestable moose.

In addition to the reported harvest, moose in Subunit 14B also experienced relatively high mortality from other human causes. In 1988, 127 moose were killed by vehicles and trains, and an estimated 13 were killed by illegal and/or unreported means. Total moose mortality in 1988 from all human causes, including hunting, was 280 moose. From 1983 to 1988 the total mortality from all causes ranged from 258 to 862 moose (Table 2). Changes in hunting regulations, as well as variable winter snow conditions, contributed to the wide range in annual mortality. In winters with deep snow, mortality from highway vehicles and trains averaged 3 to 5 times higher than in years with light snow.

Hunter Residency and Success. In 1988 local (i.e., Subunits 14A and 14B) residents took 45% of the harvest (63 moose), nonlocal residents took 48% (67 moose), nonresidents took 1% (7 moose), and hunters of unknown residency took 6% (8 moose). Because of the cow season closure, hunting pressure was the lowest for the past 6 years. Only 1,039 people hunted moose in 1988, compared with a high of 2,524 in 1984 (Table 3). Even though the number of hunters has fluctuated widely in the past decade, the proportion of the harvest taken by hunters of different residency categories has remained relatively constant from year to year. In the past 6 years, local residents have taken an average of 37% of the harvest, compared with 58% by nonlocal residents. The proportion of the harvest by local residents has been increasing slightly, while that by nonlocals has been declining (Table 3). Harvests by nonresidents have been consistently low; in the past 6 years they have never taken more than 4% of the reported harvest.

Harvest Chronology. The chronology of the harvest in 1988 was similar to 1987, although it was substantially lower. In 1988, 35% of the harvest (49 moose) was taken during the first week of the hunting season, compared with 14% and 17% during weeks two and three, respectively. The harvest increased to 29% (41 moose) during the last week of the season (Table 4). A large harvest occurred in the last week of the season, because Subunit 14B was one of the few areas on the road system that remained open to moose hunting after 20 September. The extended September hunting resulted in the attraction of late-season hunters, despite the fact that the cow season had been closed. Similar hunting regulations in Subunit 14B were in effect in 1984 and 1987, and the chronology of the harvest in those years also showed a secondary peak during the final week of the season (Table 4).

Transport Methods. In 1988 successful hunters used the following transportation methods to take moose (Table 5): 3- or 4-wheelers, 27 (19%); highway vehicles, 34 (24%); ORV's, 37 (26%); airplanes, 25 (18%); boats, 10 (7%); horses, 2 (1%); and unspecified, 5 (4%). Access into Subunit 14B is primarily off the Parks Highway or Hatcher Pass Road, and highway vehicles have been the principal means of transportation to gain access to the hunting area. In the early 1980's, access to most of the remote areas in Subunit 14B was limited; therefore, most moose were killed by hunters who had gained access from the highway system using highway vehicles or specialized ORV's. With the improvement in 3- and 4-wheeler technology, use of these vehicles increased, especially as new and better trails were pioneered into the back country.

Game Board Actions and Emergency Orders

From 1978 to 1982 the Board began liberalizing cow seasons because of low harvests and concern that moose might be nearing winter range carrying capacity. Permit hunts for antlerless moose were conducted in the fall and late winter. After 4 years of consecutive cow seasons, some concern was expressed about the "excessive" harvest along the highway system. In 1982 the Board modified the hunts for antlerless moose by providing that (1) west of the powerline intertie, cows could only be taken by drawing permit (100 permits), and (2) east of the intertie cows could be taken in an 11-day general cow season (10-20 September) during the middle of the regular bull season (1-30 September).

In 1983 the Board established an either-sex, 30-day season throughout the unit. The late-winter antlerless season was also retained. These regulations remained in effect through 1984. In 1985 concern over high moose mortality from a severe winter and generally high harvests from the 2 previous years resulted in some restrictions to hunting. The late-winter antlerless season and the cow season west of the powerline were eliminated. The Board set a bag limit of 1 moose east of the powerline intertie and 1 bull in the remainder of Subunit 14B; also, the hunting season was shortened to 1-20 September throughout the subunit. In 1987 the hunting season was lengthened from 1-20 September to 1-30 September, and the either-sex bag limit east of the powerline intertie was retained. In 1988, the Board eliminated all cow hunting seasons, but it retained the 1-30 September bull season.

CONCLUSIONS AND RECOMMENDATIONS

Composition counts conducted in years with good snow cover and the results from the 1987 stratified census indicated the population objective of 30 bulls:100 cows has been achieved and maintained. Completing the population census in Subunit 14B was a major milestone in the moose management program. As information from future censuses becomes available, trends in the moose population will be easier to determine. The 1987 census provided a "precise" estimate of the number of moose in Subunit 14B that had been previously unavailable. After an evaluation of the effects of hunting and other causes of mortality was made, staff recommended elimination of the cow season because annual mortality in some areas exceeded annual recruitment. Elimination of the cow season significantly reduced harvests, and it should allow the population to increase, if heavy mortality from railroad and highway kills or severe winters do not occur. No changes in season length or bag limits are recommended at this time.

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SUBMITTED BY:

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Table 1. Moose composition counts in Subunit 14B, 1982-1988.

Year	Males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hr	Population estimate
1982	43.0	29.1	16.9	934	1,124	47.8	--
1983	33.8	23.4	14.9	1,556	1,828	47.5	2,500-3,000
1984	34.7	33.7	18.2	1,449	1,771	55.2	2,500-3,000
1985[a]	--	--	--	--	--	--	--
1986[a]	--	--	--	--	--	--	--
1987[b]	36.8	28.4	17.4	906	1,097	n/a	2,900 ± 362
1988[a]	--	--	--	--	--	--	--

[a] No surveys conducted.
[b] These data were derived from a population census conducted in December 1987.

Table 2. Annual moose harvest and accidental death in Subunit 14B, 1983-88.

Year	Reported			Estimated			Accidental[d]			Grand total
	M	F	Total[a]	Unreported[b]	Illegal[c]	Total	Road	Train	Total	
1983	219	228	464	23	20	43	39	21	60	567
1984	258	271	534	27	40	67	77	184	261	862
1985	126	88	216	11	22	33	5	4	9	258
1986	131	104	243	12	7	19	28	37	65	327
1987	227	118	347	17	25	42	43	173	216	625
1988	134	2	140	7	6	13	40	87	127	280
Mean	182	134	324	16	30	36	39	84	123	487

[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. Moose hunter residency and success in Subunit 14B, 1983-88.

	Successful							Unsuccessful					
Year	Local[a] resident	(%)	Nonlocal resident	(%)	Nonres	Unk	Total	Local[b] resident	Nonlocal resident	Nonres	Unk	Total	Total hunters
1983	136	(32)	278	(65)	9	3	426	1,832	unk	23	23	1,878	2,304
1984	167	(37)	309	(63)	8	6	490	1,992	unk	22	20	2,034	2,524
1985	87	(40)	119	(55)	6	4	216	1,025	unk	17	24	1,066	1,282
1986	98	(40)	131	(53)	10	4	243	932	35	11	13	991	1,234
1987	133	(38)	182	(52)	8	24	347	1,312	50	23	54	1,439	1,786
1988	63	(45)	67	(48)	2	8	140	797	25	13	64	899	1,039
Mean	114	(37)	181	(58)	7	8	310	1,315	37	18	33	1,385	1,694

[a] Includes only residents of Subunits 14(A) and 14(B).
[b] Includes all Alaskan residents in 1983-1985, and all Unit 14 residents in 1986 and 1988.

Table 4. Moose harvest chronology in Subunit 14B, 1983-1988.

Year	Before season opened	Weeks of season 1st	(%)	2nd	3rd	4th	After season closed	Unknown	Total
1983	4	219	(51)	57	65	54	3	24	426
1984	1	204	(41)	59	79	122	3	22	490
1985[a]	2	113	(52)	46	46	1	1	7	216
1986[a]	1	97	(40)	66	63	0	3	13	243
1987	0	115	(33)	47	56	116	2	11	347
1988	0	49	(35)	19	24	41	3	4	140

[a] 1-20 September season.

Table 5. Successful moose hunter transport methods in Subunit 14B, 1983-88.

Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Orv	Highway vehicle	Unk	Total all methods
1983	32	2	57	0	2	123	202	8	426
1984	53	4	39	60	0	127	163	44	490
1985	31	0	19	42	0	72	42	10	216
1986	26	6	23	53	0	59	59	16	243
1987	45	5	27	90	0	76	83	21	347
1988	25	2	10	27	0	37	34	5	140
Mean	35	3	29	45	<1	82	97	17	310

STUDY AREA

GAME MANAGEMENT UNIT: 14C (2,091 mi^2)

GEOGRAPHICAL DESCRIPTION: Anchorage Area

BACKGROUND

Moose were uncommon in the Anchorage area prior to the 1940's. They began to increase in the late 1940's as brushy regrowth replaced mature forests that had been cut or burned during the development of Anchorage and the Fort Richardson military reservation. Their range and numbers expanded considerably during the early 1950's, and by the late 1950's and early 1960's they were abundant throughout the subunit. The population has remained at a high level over the past 25-30 years.

Prime browse is prevalent 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 have been rehabilitated over the past 14 years. Fringe residential areas throughout the Anchorage bowl also contain considerable browse. Quality riparian habitat is abundant along area streams and rivers. Extensive stands of subalpine willow exist on south-facing slopes in most drainages in the subunit.

Annual harvests have fluctuated dramatically over the past 25 years. A record harvest of nearly 500 moose (50% females) occurred in 1965, and only 18 moose were harvested in 1978. These large fluctuations were caused by the curtailment of various hunts and elimination of cow harvests during certain years, rather than to a fluctuating moose population. Since 1981 the harvest has stabilized; the mean is 148 moose/year (33% cows).

POPULATION OBJECTIVES

To maintain a population of 2,000 moose and a posthunting sex ratio of no less than 25 bulls:100 cows in Subunit 14C.

METHODS

Sex and age composition aerial surveys were conducted throughout Subunit 14C during the fall and early winter. A population census was conducted on the 2 military reservations and upper Ship Creek in late fall. Spring survival surveys were conducted military lands.

RESULTS AND DISCUSSIONS

Population Status and Trend

Despite substantial overall mortalities, the moose populations remained relatively stable during the 1980's. Population stability was partially due to 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 both maturation and urbanization, a decline in the current population level appears likely. A return to more severe winters could hasten a population reduction.

Population Size:

Numbers of moose within Subunit 14C have been determined by composition counts conducted in the mountainous portions and by a stratified census conducted on Fort Richardson-Elmendorf AFB lands in December 1988. The population was estimated at 2,040 moose (Table 1).

Population Composition:

In 1988, 1,434 moose were counted in composition surveys; 41 bulls:100 cows and 50 calves:100 cows were observed. The population composition in Subunit 14C has remained relatively constant over the past 5 years (Table 1). The percentage of calves in the herd has fluctuated between 20% and 26% from 1984 to 1988. Since 1985 the bull:cow ratio has ranged from 33:100 to 42:100; in 1984 the ratio was 66 bulls:100 cows, and unusually large numbers of bulls were observed in the Fort Richardson-Ship Creek, Hillside, and Eklutna count areas.

Distribution and Movements:

Moose are year-long residents, ranging from sea level to an elevation of 3,500 feet. During winters with substantial snow accumulation, most 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 prior to green-up in late April.

Mortality

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 are 6 September to 31 October and 15 December to 15 January. The bag limit is 1 moose by drawing permit and bow and arrow only. Up to 60 permits for antlerless moose and up to 30 permits for bulls will be issued. 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 is 6 to 30 September. The bag limit is 1 moose by bow and arrow and registration permit only. Up to 10 bulls may be taken. The open season for resident and nonresident hunters in the remainder of Subunit 14C is 6 to 30 September. The bag limit is 1 moose; however, antlerless moose may be taken by drawing permit only. Fifty permits will be issued to Alaska residents only.

Human-induced Mortality:

During the 1988-89 season, 164 moose were harvested, including 120 bulls and 44 cows (Table 2). Seventy-nine of the bulls were taken during the general bull season. The remaining moose were taken in permit hunts.

The harvest has remained relatively stable since the early 1980's. The mean annual harvest since 1981 has been 148 moose (33% cows); during the 1970's, approximately half that many were taken annually, because the seasons were shorter and fewer cows were taken.

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

Hunter Residency and Success. Residents of Subunit 14C accounted for approximately 80% of the moose harvested (Table 3). Residents of other units or subunits accounted for slightly less than 20% of the total harvest; nonresidents, less than 1%.

Permit Hunts. During the 1988-89 season, 296 hunters were issued permits to hunt moose in Subunit 14C. Of these, 84 (28%) were successful. Fifty-four of the 84 hunted in the 6 Fort Richardson archery hunts (Table 4). Drawing-permit hunts were extremely popular. During 1988, 3,066 applicants applied for the 160 available drawing permits. An additional 136 hunters were issued registration permits for the Eklutna Valley hunt.

Harvest Chronology. Because of variable opening days tied to the timing of Labor Day, harvest comparisons during the 1st week of September are meaningless. Harvests during the 2nd, 3rd, and 4th weeks were comparable (Table 5). In recent years, a winter 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 utilized highway vehicles to reach preferred hunting areas (Table 6). Prohibition of 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% of successful hunters used boats, and 6-8% used horses.

Natural Mortality:

Because of relatively low numbers of predators and mild winters, natural mortality has been minimal in the Fort Richardson and Anchorage Hillside moose populations. Natural mortality elsewhere in the subunit, where predators are more abundant, was comparable to other areas in Southcentral Alaska.

Habitat Assessment

Large tracts of subalpine and riparian habitat are protected throughout the 500,000-acre Chugach State Park and on U.S. Forest Service lands from Girdwood to Portage. Several thousand acres of prime lowland habitat exist on military lands between lower Ship Creek and Eagle River. Extensive urbanization has significantly reduced winter range on private land from the Knik River to Potter Creek.

During severe winters when moose are concentrated on prime lowland habitat areas below an elevation of 500 feet, substantial starvation can occur. This probably would have been the case during the winter of 1988-89, if significant snow accumulation had occurred after early January. Some calf mortality was documented, despite minimal snowfall from February through April. No solutions exist for private property. On military and municipal lands well-planned habitat enhancement could help alleviate the problem. Lack of funds and regulations limiting habitat alteration on these lands have precluded enhancement programs in recent years.

Game Board Actions and Emergency Orders

Game regulations have changed substantially over the past 5 years. A major revision in 1988 involved the conversion of the 3 Fort Richardson either-sex archery hunts to 6 separate bull or cow hunts; four during September-October and two held from mid-December through mid-January. A total of 90 permits were issued, the same as for 1987.

In March 1989 the Game Board increased the number of Fort Richardson permits to 125 and allocated 25 to hunters using muzzle-loading rifles only. Other regulatory changes that will take effect in FY90 included elimination of the Ship Creek antlerless hunt and reestablishment of antlerless hunting in the Portage area and Eklutna Valley. These regulatory changes were the result of reduced counts in Ship Creek and a substantial increase of moose observed in the Portage and Eklutna composition counts. No Emergency Orders have been issued during the past 5 years.

CONCLUSIONS AND RECOMMENDATIONS

Major population objectives for the subunit have been met. The ratio of bulls to cows exceeded 25:100, and approximately 2,000 moose occupied defined count units; and additional 100-150 moose may reside in areas that have not been surveyed.

Existing management programs were developed over the past decade. During that period, numerous consultations with the 2 major land managers (i.e., Fort Richardson and Chugach State Park) took place. Through restrictions on harvest methods and compromises on open and closed areas, management strategies acceptable to all involved parties 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 remains a significant problem not easily dealt with. Public education regarding the habits of moose may improve public tolerance for moose and reduce conflict situations.

PREPARED BY:	SUBMITTED BY:
Dave Harkness	Gregory N. Bos
Wildlife Biologist III	Management Coordinator

Table 1. Fall aerial moose composition counts (1984-88) and estimated population size (1988) for Subunit 14C.

Area	Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calves %	Total moose	Moose/ hr.	Estimated population size
Portage	84	34	25	52	28	199	67	
	85	24	11	44	26	168	47	
	86	22	18	44	27	176	65	
	87	30	13	50	28	189	57	
	88	33	16	80	37	294	113	320
Hillside	84	106	12	38	16	83	83	
	85	--	--	--	--	--	--	
	86	37	22	35	19	83	66	
	87	62	26	35	18	130	41	
	88	48	19	35	19	148	53	250
Fort Richardson	84	65	--	39	18	260	--	
	85	40	--	34	24	216	--	
	86	47	--	60	29	474	50	
	87	41	20	38	21	494	29	
	88	45	19	47	25	511	35	630
Eagle River	84	22	5	24	17	121	33	
	85	--	--	--	--	--	--	
	86	--	--	--	--	--	--	
	87	44	16	27	16	109	39	
	88	--	--	--	--	--	--	170

Table 1. Continued

Area	Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calves %	Total moose	Moose/ hr.	Estimated population size
Peters Creek	84	27	8	42	25	44	34	
	85	--	--	--	--	--	--	
	86	8	8	46	30	40	47	
	87	14	6	39	25	55	39	
	88	17	6	40	26	74	44	100
Eklutna	84	61	16	43	17	152	52	
	85	--	--	--	--	--	--	
	86	45	16	23	13	104	41	
	87	47	11	22	13	86	27	
	88	43	14	33	19	135	36	200
Bird-Indian	84	83	26	35	16	50	50	
	85	--	--	--	--	--	--	
	86	--	--	--	--	--	--	
	87	--	--	--	--	--	--	
	88	49	20	24	14	85	43	120
Hunter Creek	84	--	--	--	--	--	--	
	85	--	--	--	--	--	--	
	86	41	15	49	26	152	91	
	87	51	14	40	21	147	77	
	88	44	17	55	28	187	94	250
Subunit 14C Total	84	66	11	52	20	931	66	
	85	33	--	38	22	384	26	
	86	39	18	48	26	1,029	56	
	87	42	17	38	21	1,210	37	
	88	41	17	50	26	1,434	49	2,040

Table 2. Annual moose harvest and accidental death in Subunit 14C, 1984-88.

	Reported			Estimated			Accidental		
Year	M	F	Total	Unreported	Illegal	Total	Road	Train	Total
1984	128	53	181	10	10	201	130	3	334
1985	91	37	128	10	10	148	87	3	238
1986	88	33	121	10	10	141	105	3	249
1987	106	52	158	10	10	178	105	28	311
1988	120	44	164	10	10	184	91	13	288

Table 3. Moose hunter residency and success in Subunit 14(C), 1985-88.

Year	Successful				Unsuccessful			
	Local[a] resident	Nonlocal resident	Nonresident	Total	Local resident	Nonlocal resident	Nonresident	Total
1985	87	26	3	116	275	69	5	349
1986	101	17	0	118	310	62	0	372
1987	97	22	0	119	282	84	3	369
1988	121	29	8	158	342	89	6	437

[a] Residents of Subunit 14C.

Table 4. Harvest data by permit hunt in Subunit 14C, 1984-88.

Permit hunt	Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows
Portage	1984	60	8	22	30	22	8
	1985	60	7	15	38	25	13
	1986	20	--	--	9	9	0
	1987	20	1	9	10	10	0
	1988	20	3	6	11	11	0
Fort Richardson (archery)	1984	25	1	4	20	11	9
	1985	--	--	--	--	--	--
	1986	15	0	10	5	5	0
	1987	90	6	23	60	24	36
	1988	90	6	30	54	22	32
Hillside	1984	--	--	--	--	--	--
	1985[a]	12	0	4	8	2	6
	1986	--	--	--	--	--	--
	1987				No hunt held		
	1988				Hunt eliminated		
Eklutna	1984	116	21	84	11	4	7
	1985	100	--	--	6	1	5
	1986	183	27	131	14	9	5
	1987	204	33	154	13	6	7
	1988	136	31	107	8	8	0
Hunter-Knik	1984	15	--	--	4	--	4
	1985	15	2	6	7	--	7
	1986	15	3	8	4	--	4
	1987	15	1	9	4	--	4
	1988	15	3	9	3	--	3

Table 4. Continued.

Permit hunt	Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows
Ship[b]	1984	20	--	--	1	--	1
	1985	20	4	12	4	--	4
	1986	20	4	14	2	--	2
	1987	20	6	12	2	--	2
	1988	20	3	11	6	--	6
Peters[b]	1984	15	--	--	1	--	1
	1985	15	0	10	5	--	5
	1986	15	2	10	2	--	2
	1987	15	6	6	3	--	3
	1988	15	3	10	2	--	2

[a] Special airport hunt.

[b] Antlerless moose hunt.

Table 5. Moose harvest chronology and percentage by time period during the general season in Subunit 14C, 1985-88.

Year	9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5
1985	15	20	19	28	17
1986	30	25	25	16	4
1987	2	24	22	34	19
1988	18	31	14	28	9

Table 6. Successful moose hunter percentages by transport method in Subunit 14C, 1985-88.

Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Off-road vehicle	Highway vehicle
1985	2	4	10	9	0	5	71
1986	1	8	12	7	0	4	68
1987	1	8	9	3	0	4	75
1988	6	9	5	1	1	4	74

STUDY AREA

GAME MANAGEMENT UNIT: 15A (1,538 mi^2)

GEOGRAPHICAL DESCRIPTION: Northern Kenai Peninsula

BACKGROUND

Historical records and reports from residents indicated moose were relatively 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 the 500-mi^2 forest fire in 1947 were 2 events that stimulated moose numbers to increase throughout the 1950's and 1960's. Although seasons were long and either-sex harvests were allowed, the moose population increased beyond its carrying capacity and extensive overbrowsing occurred by the late 1960's. Harsh winters from 1971 to 1974 reduced the moose population throughout the Kenai Peninsula. Population estimates for Subunits 15A and 15B indicated a decline from 7,900 in 1971 to 3,375 moose by 1975. Subunit 15A represented approximately 75% of this decline (i.e., from 5,925 to 2,531 moose).

By 1982 the population estimate for Subunit 15A had increased slightly to 3,041. The population then declined gradually until 1987, when 2,702 were counted in a census. The next census scheduled for Subunit 15A is during the winter of 1989-90.

POPULATION OBJECTIVES

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

METHODS

Aerial surveys were conducted in November and December of each year in selected trend count areas to determine the sex and age composition of the moose population. The Department, working with the U.S. Fish and Wildlife Service, plans to conduct a Subunit 15A moose census during February 1990.

Randomly selected survey units were intensively surveyed. Fall sex and age composition surveys were conducted in 6 of 13 count areas of Subunit 15A during 1988.

RESULTS AND DISCUSSION

Population Status and Trend

The 1987 population estimate for wintering moose was 2,702. The variance was 9.7% of the population estimate with 90% confidence limits. The density was 2.1 moose/mi^2 of habitat. Comparing this most recent estimate with the one for 1982 (i.e., 3,041 moose) suggested a decline of 11%; however, census methods were not comparable, so an interpretation of trend cannot be accordingly made.

Population Composition:

In Subunit 15A 1,155 moose were classified. Calves composed 28% of the sample and occurred at an observed ratio of 45:100 cows. The observed bull:cow ratio was 18:100 or two higher than that observed in 1987. The number of moose observed per hour ranged from 33 to 144; the mean was 78. For each 100 cows observed with calves, 14 had twins.

Mortality

Season and Bag Limit:

The open seasons for resident and nonresident hunters in Subunit 15A are 25-29 August and 1-20 September. The bag limit is 1 bull with spike-fork or 50-inch antlers; during 25-29 August season, moose may be taken by bow and arrow only.

Human-induced Mortality:

In August and September 1988, 156 moose (140 bulls and 16 unspecifieds) were reported harvested by 1,208 hunters; hunter success was 13%. One hundred thirty-three (85%) successful hunters were unit residents, 16 (10%) were nonunit residents, and two (1%) were nonresidents. Five (3%) successful hunters failed to report their residency. Residencies reported for unsuccessful hunters were as follows: 826 unit residents, 186 nonunit residents, 12 nonresidents, and 28 unspecifieds. Seventy percent (n = 95 of 135) of the successful and 75% (n = 668 of 886) unsuccessful hunters reported highway vehicles as their means of transportation. The second-most-common transportation means was boats; i.e., 13% (n = 18 of 135) and 11% (n = 96 of 886) for successful and unsuccessful hunters, respectively. Hunters using aircraft, ATV's, and horses accounted for 9% and 8% of successful and all hunters, respectively. The crippling losses by hunters using rifles and losses to predation are unknown.

Included in the total harvest figure for Subunit 15A are the results of an 25-29 August archery season initiated during 1987. Since required information on harvest ticket reports does not include when a person hunted, it was not possible to determine how many hunted during the archery season. An estimate from the

2 field check stations operated by the U.S. Fish and Wildlife Service on the Refuge portion of Subunit 15A suggested approximately 400 archers participated, up from 250 during 1987. Archers hunted primarily in the area burned in 1969 and used the Swanson River Road for their primary access route; 16 bulls were harvested. In addition, 10 bulls were reported shot but not retrieved, suggesting a 38% minimum crippling loss reported by archers. 135 moose were reported killed in Subunit 15A by vehicles: 49% (66) calves, 29% (39) adults, and 22% (30) undetermined ages.

<u>Antler Study</u>. Of the 156 moose harvested in Subunit 15A, 95 (61%) were reported with antler spread data. Since the current bag limit for moose was designed to focus the harvest on yearlings and mature bulls, an assumption was made that bulls <30 inches met the yearling (spike-fork) requirement and those $\geq$30 inches were mature bulls (i.e., having 3 brow tines or an antler spread >50 inches). Sixty-five percent ($\underline{n}$ = 62 of 95) of the harvest were spike-fork bulls, and 35% ($\underline{n}$ = 33 of 95) were mature bulls. Seven percent ($\underline{n}$ = 7 of 96) of the reported harvest were bulls with an antler spread $\geq$50 inches.

<u>Habitat Assessment</u>

The 85,000-acre burn in 1969 is still providing moose browse; the majority of the moose wintered there in Subunit 15A; however, this area and small areas of improved habitat north of Skilak Lake only make up 10-15% of the moose habitat in the subunit. The remaining moose habitat is relatively unproductive, because of plant succession to mature forest.

<u>Game Board Actions and Emergency Orders</u>

A proposal establishing a restrictive harvest strategy for bull moose was adopted during the 1987 spring Board of Game meeting. This proposal, specifying a legal bull as one having a specific antler size, was adopted for Units 7 and 15.

CONCLUSIONS AND RECOMMENDATIONS

Apparently as a result of the Board's actions in 1987, both effort and harvest remained at about half of those occurring prior to 1986, before the antler regulation had been adopted. Bull:cow ratios improved from 16:100 to 18:100 in the 1988 fall sex and age composition surveys. If a similar increase in the bull:cow ratio is observed during the 1989 fall survey, I recommend an increase in season length to 1-25 September to 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.

Since the new spike-fork, 50-inch regulations have only been in place 2 seasons, I recommend no change for the 1989 season;

however, if the number of sublegal bulls harvested increases, a change in bag limit from 3 to 4 brow tines may be necessary to reduce confusion by hunters who may knowingly shoot a bull with less than 50-inch antler spread thinking it has 3 brow tines. Moose with 4 brow tines on the Kenai Peninsula rarely have an antler spread of less than 50 inches.

PREPARED BY:

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Game Biologist III

SUBMITTED BY:

John N. Trent
Management Coordinator

STUDY AREA

GAME MANAGEMENT UNIT: 15B (1,262 mi^2)

GEOGRAPHICAL DESCRIPTION: Kenai Peninsula

BACKGROUND

Historical records and reports from Kenai Peninsula residents suggest moose in Subunit 15B have been relatively abundant throughout the century; the most recent peak was in 1971. The near absence of wolves from 1913 to 1968 was one of the primary reasons for the expansion of this population. A wildfire that burned approximately 500 mi^2 in Subunit 15A in 1947 also benefitted moose with improved winter range. A series of harsh winters from 1971 to 1974 subsequently reduced the moose population in Subunit 15B. The population declined from 1,975 moose in 1971 to 843 in 1975. Although there are no recent census data available, harvest and survey data indicated that the population was stable or slightly declining.

POPULATION OBJECTIVES

To maintain a population of moose with a bull to cow ratio of 15:100 in Subunit 15B west.

To maintain a population of moose with a bull to cow ratio of 40:100 in Subunit 15B east.

METHODS

Aerial surveys were conducted in November and December of each year in selected trend count areas to determine the sex and age composition of the moose population. Harvest were assessed by harvest reports in Subunit 15B west and by permit reports in Subunit Subunit 15B east.

RESULTS AND DISCUSSION

Population Status and Trend

Unsuitable snow conditions have prevented composition counts in Subunit 15B since 1983; however, there have been no major habitat improvements and winters have been relatively mild, with the exception of 1987-88. Moose densities have probably not changed significantly, and the population has remained stable.

Mortality

Season and Bag Limit:

The open seasons for resident and nonresident hunters in that portion of Subunit 15B bounded by a line running from the mouth of Shantatalik Creek on Tustumena Lake, northward to the west of Funny River to the Kenai National Wildlife Refuge; then east along the refuge boundary to its juction with the Kenai River and Skilak Lake; then south along the western side of Skilak River, Skilak Glacier and Harding Icefield; then west along the Subunit 15B boundary to the mouth of Shantatalik Creek are 1-20 September and 26 September to 15 October. The bag limit is 1 bull with 50-inch antlers by drawing permit only; up to 100 permits will be issued. The open season for resident and nonresident hunters in the remainder of Subunit 15B is 1-20 September; the bag limit is 1 bull with spike-fork or 50-inch antlers.

Human-induced Mortality:

In Subunit 15B west, 48 moose (40 bulls, 1 cow, and 7 unspecifieds) were reported by 272 hunters for 1988. This September moose harvest represented a reduction of one, compared with that for 1987. A significant reduction in harvest (45%) occurred in 1987, the first year of the selective harvest strategy.

Of the 48 moose reported by hunters in Subunit 15B west, 37 (77%) included antler spread data. Since the current bag limit was designed to focus harvest on yearling and mature bulls, an assumption was made that antlers <30 inches met the yearling (spike-fork) requirement and antlers $\geq$30 inches were from mature bulls. Sixty-eight percent were spike-fork and 32% were mature bulls. Twenty-four percent ($\underline{n}$ = 9 of 37) of the harvest were bulls having antler spreads $\geq$50 inches. In addition to the human harvest, 59 moose were reported killed in Subunit 15B west by vehicles.

Hunter Residency and Success. Hunter success was 18% in Subunit 15B. Forty-one successful hunters were unit residents, and four were nonunit residents; there were no nonresidents. Three successful hunters failed to report residency. Of the unsuccessful hunters, 119 were unit residents, 16 were nonunit residents, two were nonresidents, and seven were unspecified.

Permit Hunts. Subunit 15B east was administered as a trophy moose hunting area. Hunters were selected by drawing permit, and a total of 100 permits were issued for the 2 separate seasons; 2,097 applications were received during 1988 for these 100 permits. Only bulls with an antler spread of at least 50 inches or with 3 brow tines are legal game. In September and October 1988, permittees reported harvesting 30 bull moose. Seventy of the 100 permit holders hunted, resulting in a hunter success of 30%. Twenty-six successful hunters were unit residents, three were nonunit residents, and one was a nonresident. The mean antler spread from bulls harvested during 1988 was 57.3 inches (range = 43 to 75). Mean age was 7 years (range = 4 to 12.

Transport Methods. In Subunit 15B west, 71% ($\underline{n}$ = 30 of 42) of the successful and 77% ($\underline{n}$ = 133 of 173) unsuccessful hunters reported highway vehicles as their primary means of transportation. The second-most-common transportation means was horses: 21% for successful and 14% for unsuccessful hunters. In Subunit 15B east, 90% of the successful hunters used horses as their primary transport method.

Habitat Assessment and Enhancement

No significant habitat enhancement has occurred since a wildfire burned a large portion of the subunit in about 1890. Approximately 2,000 acres of primarily winter habitat was enhanced using a variety of mechanical tree removal techniques during the early 1950's by the U.S. Fish and Wildlife Service on the refuge. Several small acreages (less than 50 acres) have also been designated as wood-cutting areas for noncommercial use. Judging from the relative density of moose found in the wood-cutting areas, 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.

Game Board Actions and Emergency Orders

In response to a public desire for a change in the current harvest of any bulls, the Alaska Board of Game initiated a selective harvest strategy on most of the Kenai Peninsula for the 1987 season. Subunit 15B west was changed from a 1986 bag limit of 1 bull to the current requirement of 1 bull with spike-fork or 50-inch antlers. Subunit 15B east remained unchanged (since 1977) as a trophy moose hunting area, with a bag limit of 1 bull with 50-inch antlers by drawing permit only.

CONCLUSIONS AND RECOMMENDATIONS

The reported harvest of 48 moose in Subunit 15B west during 1988 was one lower than the previous year's harvest. The harvest was expected to increase annually before approximating the 1986 level in about 5 years, as protected age classes of bulls matured and became legal; however, the harvest failed to increase during the second year (1988) of the selective-harvest program, and the cause is unknown. No change in regulations is recommended at this time for Subunit 15B west, in order to evaluate the harvest in 1989 and compare it with those for 1987 and 1988.

The trophy bull moose hunt in Subunit 15B east continued to provide excellent hunting opportunities, and it is popular among resident hunters. The harvest of 30 bulls during 1988 was well within acceptable guidelines for maintaining a minimum bull:cow ratio of 40:100. Additionally, a harvested bull with an antler spread of 75 inches officially scored 239-6/8 points in the Boone and Crockett Book. This score ranks as the largest bull taken on the Kenai Peninsula in 30 years. I recommend no changes in season. I further recommend that the bag limit be maintained to preserve a control for evaluating changes in the male segment of the moose subpopulations in adjacent areas where both small and large bulls have been harvested.

Summer and winter moose range on the Kenai National Wildlife Refuge in Subunit 15B continues to deteriorate because of wilderness lands management policies favoring advanced forest succession. The Department and the U. S. Fish and Wildlife Service should cooperate on selected habitat enhancement projects (i.e., mechanical manipulation and prescribed burnings) to improve moose habitat in the Slikok and Coal Lake areas.

PREPARED BY:

Ted H. Spraker
Wildlife Biologist

SUBMITTED BY:

John N. Trent
Management Coordinator

STUDY AREA

GAME MANAGEMENT UNIT: 15C (3,414 mi^2)

GEOGRAPHICAL DESCRIPTION: Southern Kenai Peninsula

BACKGROUND

Moose are the dominant forest-dwelling ungulates on the southern Kenai Peninsula. As the primary browser-grazer species in the forest, they assume a crucial ecological role in the transfer of energy and nutrients in the terrestrial food chain. Moose are also considered the region's most economically important wildlife species.

Declining availability and quality of suitable winter habitat are serious limiting factors for moose on the lower Kenai Peninsula. Because of heavy snow accumulations in the uplands and the distribution of lowland vegetation types, moose in Subunit 15C are restricted to low-elevation riparian habitats and southerly facing benchlands from December through April. 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 and the attendant competition for space and other resources in these areas pose a serious long-term problem for moose. Local public awareness of this resource conflict lead to designation of the Anchor River/Fritz Creek Critical Habitat Area by the Alaska Legislature in 1985.

POPULATION OBJECTIVES

To maintain a population size of approximately 3,000 moose and a posthunting sex ratio of not less than 15 bulls:100 cows.

METHODS

Population trend and sex-age composition aerial surveys were conducted by Super Cub (PA-18) in standardized count areas during October and November. Since 1980 aerial surveys were conducted only during those years when there was extensive snow cover on the ground and moose sightability was high (e.g., 1982, 1983, and 1985). Surveys were made at an intensive rate of 4.5-6.5 minutes/mi.

Annual moose harvest data were collected through the statewide harvest ticket system. The moose hunt was usually monitored several times each season using fixed-winged aircraft in the Deep Creek, Anchor River, and Fox River drainages. In addition, remote portions of the Deep Creek and Anchor River drainages were monitored from the ground using a 3-wheeler (1-10 September) and horses (11-21 September).

Moose mortalities from the Homer Bench winter range were documented. Whenever practical, carcasses were inspected to determine their location, sex, age class, and probable date and cause of death. The lower jaw and lower front leg were collected from calves to document tooth eruption patterns and mandible lengths and to examine bone marrow for fat content, respectively.

RESULTS AND DISCUSSION

Population Status and Trend

Moose are 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 to maintain a stable trends; i.e., an estimated minimum density of between 2 and 3 moose/mi^2.

Population Size:

There were between 2,500 and 3,000 moose in Subunit 15C during the reporting period.

Population Composition:

An intensive composition survey of count area No. 15C-26 (South Fork/Anchor River) was conducted between 17 and 19 November 1988. Survey conditions were very good, and a total of 346 moose were counted and classified, including 22 bulls, 220 cows, and 104 calves. Fall recruitment was within the normally observed range for this count area (47 calves:100 cows). The number of bulls sighted and the bull:cow ratio (10:100 cows) were substantially higher than those from all surveys conducted in this area during the past 20 years. I observed a postrutting aggregation of moose (7 young bulls and 7 cows) on Crossman Ridge during this survey. This is the first time in 8 years that bulls have been observed in this count area.

Mortality

Season and Bag Limit:

The open season for subsistence hunters in the portion of Subunit 15C southwest of a line from Point Pogibshi to the point of land between Rocky Bay and Windy Bay is 1-30 September; the bag limit is 1 bull. The open season for resident and nonresident hunters in the remainder of Subunit 15C is 1-20 September; the bag limit is 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.

Human-induced Mortality:

The 1988 reported harvest was 169 moose, including 159 bulls and 10 unspecifieds (Table 1). This harvest was 26% higher than the 1987 harvest (n = 127) and 29% lower than the 1983-1986 mean annual harvest ($\bar{x}$ = 223). During the past 2 seasons, 62% or less of the harvest occurred in the first half (1-10 September), compared with a mean of 69% for the first halves of the seasons from 1983 to 1986 (Table 1).

In 1988, 773 hunters reported hunting moose in Subunit 15C. During the 4 years prior to implementation of the spike-fork/50+ inch antler spread harvest strategy (1983-1986), an average of 1,162 hunters hunted moose annually in Subunit 15C (Table 1). The success rate of moose hunters increased from 16% in 1987 and a previous 4-year mean of 18% to 22% in 1988. The relative frequency of the various transportation types used by moose hunters was identical to that for 1987: highway vehicle > offroad vehicle > horse > boat > airplane.

The percentage of successful moose hunters who did not report antler spreads decreased moderately in 1988 (41%, n = 69); however, it remained substantially higher than the unreported rates for the 2 years prior to implementation of the spike-fork/50+ inch antler spread harvest strategy (12%). Antler spread information was collected from 101 hunters as follows: 44 bulls, <30 inches; 6 bulls, 30.0-39.0 inches; 12 bulls, 40.0-49.0 inches; and 39 bulls, >50.0 inches. The number of bulls in the >50-inch category, even though it is a minimum value, was the highest reported during this decade.

Hunter Residency and Success. Residency of hunters was as follows: Kenai Peninsula, 90%; nonlocal residents, 9%; and nonresidents, 1%. These proportions are comparable to those previously reported (Holdermann 1986, 1987).

Natural Mortality:

I confirmed 32 cases (19 males, 12 females and, 1 undetermined) of starvation in moose calves on the Homer Bench and Fritz Creek winter ranges. The chronology of calf mortalities was as follows: 9 calves in January, 15 calves in February, 7 calves in March, and 1 calf in April. I estimate that between 85% and 95% of the calves (n = 80-110) entering these ranges in December died of starvation.

In addition, 2 of 19 (11%) radio-collared cows that either wintered on the Homer Bench or Fritz Creek ranges died between February and April of stress-related causes. Both cows were old aged (>12 years). Winter mortality in prime-aged adult moose on the Homer Bench appeared to be low. Furthermore, nutrition-related winter mortality among moose populations associated with other lower Kenai Peninsula ranges appeared to be low.

Habitat Assessment

The Homer Bench winter range represents the most depleted moose winter habitat on the lower Kenai Peninsula. The availability and quality of habitat on this range has steadily declined over the past 30 years because of human settlement and urbanization, advancing plant succession, and eventual overutilization of foraging areas by moose. The moose population that winters along the Homer Bench remained stable at an estimated level of 200 to 250 during the period of mild winters since 1980. The decadent condition of winter browse plants and the high rate of starvation among calves during the moderate winter of 1988-1989 were indicators that this moose population exceeded range carrying capacity. Moose numbers are expected to drop during the next decade, as a result of continued low calf recruitment and gradual attrition of the adult population.

Completion of the Subunit 15C Moose Identity Study in 1991 will provide DWC with information about the Homer Bench moose subpopulation that would be applicable to intensive habitat and population management. The public on the lower Kenai Peninsula feels negatively about killing cow moose, so the biggest challenge for managers would be in convincing the public of the need for population control.

The Homer Bench is in near-exclusive private ownership. Property values along the Homer Bench are some of highest in Alaska, which probably negates state purchase of any meaningful acreage for wildlife conservation. A promising alternative involves the concept of "conservation easements," whereby a government entity or conservation organization purchases the rights to preserve and/or manipulate wildlife habitat on private land for a set period of time. Conservation easements have the primary advantage of costing a fraction of deeded land, thereby stretching the value of wildlife dollars.

At least 1 revenue source for the purchase of conservation easements on the Homer Bench winter range seems close to being a reality. The Alaska Energy Authority, the U.S. Fish and Wildlife Service, and the Alaska Department of Fish and Game are negotiating a wildlife mitigation settlement for the Bradley Lake Hydroelectric Project. The favored strategy calls for part of the settlement to be used for the purchase of management rights and/or deed of privately owned moose winter range in lower Fritz Creek, with the balance of the settlement going into a "moose conservation trust account." The trust account would be used exclusively to purchase and manage moose winter habitat on the lower Kenai Peninsula.

The Land Trust, a local nonprofit organization that promotes the conservation of open space in the Kachemak Bay region for recreation and wildlife, is negotiating easements on several tracts of private land on the Homer Bench, and they have expressed an interest in managing these tracts for moose and other wildlife. The Land Trust offers an existing mechanism for negotiating future conservation easements. The Agricultural Stabilization and Conservation Agency (U. S. Department of Agriculture) provides a cost-incentive program for upland soil and water stabilization that may be coordinated with wildlife habitat enhancement efforts. Many private-land owners on the Homer Bench have indicated that they would voluntarily implement wildlife habitat enhancement practices on their land, if DWC formalized a winter range restoration program.

Game Board Actions and Emergency Orders

Hunting regulations have been modified during the past decade to address declining and/or chronically low bull populations in Subunit 15C. In 1985 the Lower Kenai Controlled Use Area was created to reduce hunting pressure and increase bull population size in remote trail-accessible portions of the subunit. Additionally in 1987 the harvest of bulls was restricted to individuals with either a spike or fork antler on at least one side or to older individuals with at least 3 brow tines on 1 side or a minimum antler spread of 50 inches.

CONCLUSIONS AND RECOMMENDATIONS

A census of the moose populations in Subunit 15C is needed to more accurately delineate management objectives. It should be conducted during October or November, when moose are concentrated in subalpine habitats and highly visible.

Information concerning the composition of moose populations since the spike/fork or 50-inch harvest strategy was implemented are incomplete. The bull:cow ratio in count area No. 15C-26 (10 bulls:100 cows) has shown considerable improvement, but it is still under the minimum objective. Continued emphasis should be placed on obtaining population composition data for count areas Nos. 15C-21, 15C-24, and 15C-25. Although the number of hunters in 1988 (773) was similar to those in 1987 (768), hunter success increased by 6%. Moose harvests increased 25% over the same 1-year period. These are the first 2 years of spike/fork-50 inch moose management strategy on the Kenai Peninsula. A thorough evaluation of this strategy will be presented in the next survey-inventory report.

Loss of moose winter range to human occupancy is a significant concern in Subunit 15C. Unless steps are soon taken to protect and intensively manage moose foraging areas on the Homer Bench, the opportunity to meaningfully address this matter may be lost. I recommend that the Division of Wildlife Conservation (DWC) consider the adoption of a program to intensively manage and restore winter range on the Homer Bench. Control of moose population size within carrying capacity limits would be a necessary feature of such a program.

Other sources of revenue for managing wildlife on private lands should be explored by DWC. Vegetation management will be needed to maintain and restore moose winter range in Subunit 15C. Relatively small plots of less than 4.5 acres would be treated throughout the winter range. Maintenance of existing browse sites would be maintained through burning or mechanical clearing. Introduction of browse plants would also be required. Extensive use of volunteers would be necessary. Local interest by Homer area residents in moose management is high and could be tapped for range improvement work. The Homer Bench moose winter range management program is strongly recommended.

PREPARED BY:

David A. Holdermann
Game Biologist II

SUBMITTED BY:

John N. Trent
Management Coordinator

Table 1. A summary of the annual harvests and number of hunters in Subunit 15C, Kenai Peninsula, 1983-1988.

Year	No. hunters	Success %	September bull harvest 1 - 10 n	September bull harvest 1 - 10 %	September bull harvest 11 - 20 n	September bull harvest 11 - 20 %	Total[a]
1983	1,153	21	160	69	72	31	242[b]
1984	1,265	17	132	63	79	37	217[c]
1985[d]	1,079	17	120	72	46	28	179[e]
1986[d]	1,150	22	165	72	64	28	256[f]
1987[d,g]	768	16	59	60	40	40	126[h]
1988[d,g]	773	22	99	62	60	38	169[i]

[a] Totals include male plus "unspecified sex" categories.
[b] 10 hunters did not specify date of kill.
[c] 6 hunters did not specify date of kill.
[d] Lower Kenai Controlled Use regulation in effect.
[e] 13 hunters did not specify date of kill.
[f] 27 hunters did not specify date of kill.
[g] Spike-Fork/50+ inch spread regulation in effect.
[h] 27 hunters did not specify date of kill.
[i] 10 hunters did not specify date of kill.

STUDY AREA

GAME MANAGEMENT UNIT: 16 (12,445 mi^2)

GEOGRAPHICAL DESCRIPTION: West side of Cook Inlet

BACKGROUND

Prior to 1940 moose were uncommon in Unit 16. Since then habitat changes and reduced predator populations have allowed a large population to develop. Winter die-offs occurred in response to deep snow, but the population rebounded during periods of mild winters. Moose numbers peaked in the 1960's. Since then the population has been declining. Moose densities may be returning to population levels characteristic of a mature spruce-hardwood habitat. Nonlocal Alaska residents and nonresident sportsmen harvest a substantial number of moose each year. In addition local residents take moose for subsistence use.

Moose were transplanted to Kalgin Island in the late 1950's. In the predator-free environment, the island became overpopulated and severely overbrowsed by the late 1970's. Liberal sport hunting seasons and bag limits were instituted to reduce numbers and maintain an overwinter population of approximately 1 moose/mi^2. Browse recovery has been slow, and the moose population is still vulnerable to heavy winter losses when deep snow conditions occur.

POPULATION OBJECTIVES

To maintain a moose population of 10,000 with a posthunting sex ratio of no less than 20 bulls:100 cows in Unit 16, excluding Kalgin Island.

To 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

Fall sex and age trend area surveys were conducted throughout the unit. Additional observations on distribution and survival were obtained in conjunction with a moose population identity study in portions of Subunit 16B. Harvest data were obtained from harvest reports and permit hunt reports. Browse recovery on Kalgin Island was monitored.

RESULTS AND DISCUSSION

Population Status and Trend

Although moose were abundant, numbers have been declining in some areas because of poor calf recruitment and reduced overwinter survival. The population on Kalgin Island has grown slightly and probably exceeds 1 moose/mi^2.

Population Size:

The mainland population was estimated at nearly 10,000 in 1985 (i.e., 2,500 moose in Subunit 16A, and 7,500 in 16B). The population has probably declined slightly since then. The overwinter population on Kalgin Island is estimated at 25-30.

Population Composition:

Fall sex and age survey data are presented in Tables 1 and 2. A total of 1,843 moose were observed during 35 hours of surveying. The overall bull:cow ratio was 35:100 and the calf:cow ratio was 26:100.

Distribution and Movements:

In February 1987 moose were radio-collared on their Alexander Creek winter range. As of June 1989, 23 collars had been relocated a total of 507 times, with individual collars providing data for from 1 to 26 months. Data have not been digitized, and home range information on individual moose has not been generated. In general 2 types of seasonal movements have occurred. In the spring most of the radio-collared moose moved from the winter range into the higher elevations of the Susitna and Beluga Mountains or to the foothills of the Alaska Range. Late-summer range and rutting activities occurred well away from wintering areas. The greatest movements by late fall were to the Hayes River (40 miles northwest), Chichatna River (35 miles southwest), and to Trinity Lakes (25 miles northwest); however, most moose moved shorter distances. Some moose remained all year within the forested lowlands close to their winter range. These radio-collared moose will continue to be monitored until 1991.

In February 1988, 21 moose wintering in the Lake Creek and lower Skwentna River areas were radio-collared to gather data on their home ranges. An additional 6 moose were collared in March 1989. These radio-collared moose have been relocated 277 times. Data from individual moose covered periods of 3 to 17 months. Home ranges have not yet been plotted, but most Skwentna River moose moved westward in the spring to the Beluga Mountain or the foothills of the Alaska Range. Most Lake Creek moose remained in the forested lowlands close to their winter range. Data collection is scheduled to continue until 1992.

Mortality

Season and Bag Limits:

The open season for resident and nonresident hunters in Subunit 16A is 1 to 20 September. The bag limit is 1 bull.

The open season for subsistence, resident, and nonresident hunters in that portion of Subunit 16B encompassing the Redoubt Bay drainages south and west of and including the Kustatan River drainage is 1 to 15 September; the bag limit is 1 bull.

The open season for subsistence, resident, and nonresident hunters on Kalgin Island in Subunit 16B is 25 August to 30 September. The bag limit is 1 moose.

The open seasons for subsistence hunters in the remainder of Subunit 16B are 1 to 30 September and 1 December to 28 February. The bag limit is 1 moose; however, antlerless moose may be taken only from 25 to 30 September and 1 December to 28 February. A 2-week registration permit only season within the latter period will be announced by Emergency Order.

Human-induced Mortality:

Annual harvest and accidental mortality data are presented in Table 3. The reported 1988 harvest was 288 and 381 moose from Subunits 16A and 16B, respectively; the harvest sites for 10 more moose were not identified, and the total harvest for Unit 16 was 679 moose. This is similar to the harvest of 654 moose in 1987 and 693 moose in 1986. On Kalgin Island 8 moose (5 males and 3 females) were reported harvested, compared with seven harvested in 1987 and six in 1986. While fall hunting pressure for Unit 16 as a whole has remained fairly constant over recent years, it has declined in Subunit 16B and increased in Subunit 16A, resulting in a steady increase in moose harvested in Subunit 16A (i.e., 1985, 101; 1986, 162; 1987, 224; and 1988, 288 moose). Mortality of moose in Subunit 16A from winter trains and highway accidents was moderate after heavy snows moved animals into Subunit 14B in December. Radiotelemetry studies indicated that as many as 60% of the moose lost to such accidents lived in Subunit 16A during the remainder of the year.

Hunter Residency and Success. Although Unit 16 is hunted primarily by Alaska residents in September (88% of all hunters), only 4% are residents of the unit (Table 4.). Winter subsistence hunts are restricted to Subunit 16B residents. For both the fall and winter seasons, the combined harvest reported by local residents was 83 moose (12.2% of the total harvest). Harvest by nonresidents increased from 49 moose in 1987 to 78 in 1988, and the number of nonresident hunters increased from 99 to 176 hunters. In 1988 the Kalgin Island moose hunt was changed from a registration permit hunt to a general harvest ticket hunt. Twenty-one hunters reported hunting on Kalgin Island; eight moose were harvested (i.e., success rate of 38%), compared with 1987 when 62 registration permit hunters reported taking 7 moose (i.e., success rate of 11%). Most likely, the number of hunters that reported hunting on Kalgin Island in 1988 was well below the actual number.

Permit Hunts. The harvest in the Subunit 16B winter subsistence hunt declined in 1988, because extremely cold weather discouraged hunters. Only 68% of the permittees reported hunting. A total of 53 moose were reported taken (24 bulls and 29 cows), compared with 72 moose in 1987, when deep snows and moderate winter temperatures had favored hunter success. The number of permits issued has remained relatively constant for the past 3 years (i.e., 125 permits in 1988, 126 permits in 1987, and 127 permits in 1986).

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 (35% of all hunters and 43% of successful hunters). Both highway vehicles and boats were used by 20% of all hunters. Of successful hunters, 20% used boats and 12% used automobiles. Transport methods reported by hunters differed between subunits as well as between the fall and winter seasons. In Subunit 16A, 9% and 37% of all hunters used aircraft and highway vehicles, respectively; however in Subunit 16B, 64% used aircraft and only 3% used highway vehicles. Use of snowmachines was reported by 83% of hunters for the winter subsistence hunt near Skwentna, but south of Beluga the small Tyonek-Beluga road system allowed 93% of these hunters to use highway vehicles.

Natural Mortality:

During the winter of 1987-88 snow came early and persisted into late spring. Data are lacking to quantify loses, but mortality of calves and old age moose occurred. Neonatal calf predation by bears was one of the major factors responsible for low fall calf:cow ratios (Table 2).

Game Board Actions and Emergency Orders

Emergency Orders were used to set the season dates for Hunt Nos. 981 and 982.

CONCLUSIONS AND RECOMMENDATIONS

Conflicting land use and development has had little negative impact on moose populations in Unit 16. Some habitats that formerly produced excellent successional moose forage (e.g. the Texas Creek Burn or failed homesteads in Subunit 16A) are now returning to mature spruce-hardwood forest having lower carrying capacities. To date, critical habitat (necessary for winter range, rutting and calving) does not appear to be limiting. The moose population in Subunit 16B appears to be declining as a result of poor survival of calves in their first year. Although calf:cow ratios in individual fall trend areas varied because of moose distribution, counting conditions, or other factors, the Subunit 16B ratios have consistently been below the 25 calves:100 cows level generally considered necessary to maintain a stable population (Tables 1 and 2). Observations by the public and staff supported the opinion that major losses of newborn calves have been caused by bear predation. The additional winter calf mortalities over the past 2 deep-snow winters have resulted in a net population decline. Cow moose harvests in Subunit 16B should be limited to maximize calf production. Bull:cow ratios obtained in the fall appeared adequate to insure sufficient bulls for impregnating all mature cows.

Fall data obtained for Subunit 16A indicated initial calf survival was inadequate for maintaining the population (Table 2.). Highway and railroad mortalities of moose from Subunit 16A in Subunit 14B may cause problems for the subpopulation from Subunit 16A wintering in that area, if severe winters cause continuing high losses (Table 3).

The overall number of hunters in Unit 16 has stayed relatively constant during the past 4 years; however, the number of hunters in Subunit 16B has declined, while pressures have continued to increase during the reporting period. Subunit 16A is popular with urban hunters because it is connected to the road system and does not have the restrictive antler regulations of adjacent roadside units (i.e., 13 and 15). In addition to hunting along the road system, hunters also used boats or all-terrain vehicles to access remote areas. The hunter transport data reflected a hunting pattern similar to that observed in other road-accessible areas.

Subunit 16B is a popular hunting area because it has significant "wilderness acreage" close to large Alaska communities. Fall hunting pressure has declined from its 1984 peak. Over recent years fewer hunters appeared willing to make the higher cash outlay necessary to hunt the roadless areas of Subunit 16B. This may relate to the loss of either-sex bag limits. Highway vehicles can be used along the limited Beluga-Tyonek road system, but the area is not connected by road to other areas of the state. Aircraft was the most common transport used by nonlocal hunters. Boats and rafts, often transported to the area by aircraft, were popular on lakes and along waterways. ATV's may become more important in the future, if inexpensive ways can be found to get them into the hunting area.

The winter seasons in Subunit 16B have been open only to local hunters, and the harvests have occurred close to their homes. The 14-day subsistence season opened after migratory moose, moving in response to snow accumulation, mixed with local moose on the winter range. Severe low temperatures curtailed harvest in hunt No. 982; many permittees did not bother to hunt, even though snows had concentrated moose on the winter range.

Although mature spruce-hardwood communities in much of Unit 16 have a lower carrying capacity than earlier successional stages, habitat quality has not limited moose densities in most areas. Recent harvests have only impacted some subpopulations, and large areas have been lightly hunted. In Subunit 16B management should focus on maximizing the number of calves present in the fall. Initial calf production does not appear to be limited by either the carrying capacity or breeding success. Cow harvests should continue to be limited to local winter subsistence hunts.

A mid-winter census should be conducted in Subunit 16B to update the 1985 population estimate of 7,500 moose. If the population has declined significantly, all harvest of females should be eliminated; reductions in sport harvest may also become necessary (i.e., antler restrictions).

Liberal seasons and bag limits should be maintained on Kalgin Island to keep the population at the desired density. The island is a difficult place to hunt, and sport hunters in the fall have demonstrated an inability to overharvest the population.

No changes in season or bag limits are recommended at this time.

PREPARED BY:	SUBMITTED BY:
James B. Faro	Gregory N. Bos
Wildlife Biologist	Survey-Inventory Coordinator

Table 1. Moose composition counts in Unit 16, 1984-1988.

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calves %	Adults	Total moose	Moose /hour	Moose/mi^2
Subunit 16A								
1984	30.1	9.3	36.2	21.8	766	979	68.5	1.8
1985	36.1	9.9	31.6	18.8	358	441	51.3	1.3
1986	39.6	11.4	33.9	19.5	4162	517	76.4	1.7
1987	40.5	10.8	43.2	23.5	52	68	42.1	0.8
1988	36.1	12.0	34.6	19.0	392	484	45.7	1.9
Subunit 16B								
1984	40.1	8.9	27.1	16.2	1652	1971	65.5	1.3
1985	36.9	8.8	22.6	14.2	964	1123	56.7	.9
1986	35.6	7.7	22.8	14.4	1017	1188	59.1	1.7
1987	31.9	8.9	18.4	11.3	1475	1629	83.1	2.6
1988	34.7	11.2	22.4	12.4	1190	1359	54.8	1.8
Unit 16 Totals								
1984	36.7	9.1	30.1	18.0	2419	2950	66.4	1.4
1985	36.7	8.3	25.0	15.5	1322	1564	55.1	.9
1986	36.8	8.8	26.0	15.8	1452	1725	64.1	1.8
1987	32.2	3.8	19.2	11.8	1497	1697	80.0	2.4
1988	35.0	11.4	25.5	14.2	1581	1843	52.1	1.7

Table 2. Moose composition counts in Unit 16, 1988.

Area	Date	Males: 100 females	Yearling males 100 females	Calves: 100 females	Calf % of herd	n	Moose /hr	moose/mi^2
Kroto Creek	88/03/10	0.0	0.9	108.3	23.6	55	21.2	0.8
NE Peters	88/11/09	38.6	10.2	26.1	15.9	145	40.1	1.8
SW Dutch	88/11/08	40.0	13.3	33.3	19.2	130	96.3	1.6
SW Peters	88/11/08	35.2	13.3	34.1	20.1	154	50.8	1.9
Total 16A		36.1	12.0	34.6	19.0	484	45.7	1.5
Mt. Susitna	08/11/25	18.3	4.6	29.4	19.8	162	59.3	2.2
Lt. Susitna	88/11/19	29.6	11.1	25.6	16.5	309	71.6	2.7
Wolf Lakes	88/11/25	28.3	13.3	10.8	7.7	169	88.9	2.5
S. Beluga Mt.	88/11/26	40.5	18.9	21.6	13.3	120	51.8	2.0
Yenlo East	88/11/08	35.1	9.9	22.1	13.6	213	67.6	4.0
Yenlo West	88/11/08	0.0	0.0	14.3	9.1	11	34.7	2.8
Sunflower G.	88/12/06	57.1	10.2	32.7	17.2	93	69.8	1.5
Big River	88/12/06	0.0	0.0	0.0	9.0	120	50.7	0.9
Kustatan R.	88/12/06	0.0	0.0	0.0	0.0	39	27.5	0.5
Lone Ridge	88/12/06	61.7	8.3	8.3	4.9	102	39.0	1.0
Kalgin Is.	88/12/05	114.3	71.4	85.7	28.6	21	9.0	0.9
Total 16B		34.7	11.2	22.4	12.4	1359	54.8	1.8
Total Unit 16		35.0	11.4	25.5	14.2	1843	52.1	1.7

Table 3. Moose harvest and accidental mortality in Unit 16, 1984-88.

Year	Reported			Estimated		Total	Accidental mortality		Total
	Male	Female	Total	Unreported	Illegal		Road	Train	
1984	692	226	930	45	25	1000	40	115	1155
1985	389	103	496	35	35	566	1	2	569
1986	569	115	693	45	50	788	8	25	821
1987	601	45	654	45	50	749	50	90	889
1988	632	29	679	45	50	774	20	65	859

Table 4. General season moose hunter residency and success in Unit 16, 1984-88

	Successful				Unsuccessful			
Year	Local res.	Nonlocal res.	Nonres.	Total	Local res.	Nonlocal res.	Nonres.	Total
1984	34	656	66	767	72	1785	55	1938
1985	21	375	47	454	54	1521	61	1678
1986	24	540	47	631	60	1332	38	1448
1987	22	491	49	582	64	1364	50	1550
1988	30	486	78	626	64	1420	98	1659

Table 5. Harvest[a] by permit hunt in Unit 16, 1984-88.

Hunt No.	Year	Permits issued	Did not hunt	Unsuccessful hunters	Successful hunters	Bulls	Cows	Total
Subunit 16A								
945	1984	150	36	81	33	2	31	33
946	1984	25	5	1	19	6	13	19
947	1984	200	104	62	34	17	17	34
Subunit 16B								
981	1984	62	19	27	16	9	7	16
	1985	53	14	13	26	12	14	26
	1986	54	22	7	25	13	12	25
	1987	58	18	7	33	10	23	33
	1988	60	18	13	29	12	17	29
982	1984	74	17	21	36	5	26	31
	1985	41	13	12	16	8	8	16
	1986	73	19	18	29	17	12	29
	1987	68	14	13	39	21	18	39
	1988	65	23	18	24	12	12	24

[a] Excluding Kalgin Island.

Table 6. Successful moose hunter transport methods in Unit 16, 1984-88.

Year	Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV vehicle	Highway vehicle
1984	439	10	147	54	22	52	128
1985	248	3	97	11	16	20	45
1986	334	7	142	44	36	31	65
1987	269	12	112	51	35	30	99
1988	270	15	126	62	32	46	93

STUDY AREA

GAME MANAGEMENT UNIT: 17 (18,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Northern Bristol Bay

BACKGROUND

Moose have never been historically abundant in Unit 17, because much of it is open tundra with forested areas occurring only along the riparian portions of major drainages. West of the Wood-Tikchik Mountains riparian areas are limited to willow, alder, and occasional stands of cottonwood.

The human population of this area has increased considerably during this century because of the commercial fishing activity in Bristol Bay. Until very recent years, moose, caribou, and beaver were dietary staples for most area residents. Season dates have varied over the past several decades, but the bag limit has remained 1 bull moose since before statehood (1959). A general disregard for bag limit restrictions by unit residents during most of the 20th century has been the principal factor contributing to historical low densities of moose in this unit.

Increased availability of caribou because of the rapid expansion of the Mulchatna herd during the 1980's resulted in less pressure on the moose populations along the Nushagak River, where local residents have customarily taken cow moose during winter months. The recent trend has been towards an increase in the moose populations in this area.

POPULATION OBJECTIVES

To establish a minimum population of 100 moose in Subunit 17A.

To achieve and maintain a density of 1 moose/mi^2 on habitat considered good moose range in Subunit 17B.

To maintain a minimum density of 0.5 moose/mi^2 in Subunit 17C.

METHODS

Fall sex and age aerial composition surveys were scheduled in trend areas throughout Subunits 17B and 17C. The surveys in Subunit 17A were cooperatively scheduled to be conducted with the Togiak Fish and Wildlife Refuge staff. Harvest monitoring and an enforcement presence was maintained along the Mulchatna and Nushagak Rivers during the September portion of the hunting season. A cooperative radiotelemetry program between ADF&G and FWS was initiated in February to determine seasonal movements, distribution, and rate of immigration of moose into Subunit 17A.

RESULTS AND DISCUSSION

Population Status and Trend

Moose were scarce in the northern Bristol Bay area prior to 1900 (Faro 1976). The population in Subunit 17A has historically been extremely low; i.e., less than 1 moose/ 10 mi^2 (Taylor, 1986). Subunit 17A has a long history of illegal harvests of both sexes. While the riparian habitat along the Togiak and Kulukak Rivers and their tributaries provides excellent winter browse, adjacent lands are primarily tundra vegetation, providing little escape cover in an area where conditions for traveling by snowmachine are generally excellent.

The first major survey of Subunit 17A was completed in January, 1981. Three moose (all yearlings) were observed in 5.5 survey hours, and the season was subsequently closed by the Board of Game. Populations adjacent to the east of the Togiak River drainage have been increasing, and surveys since 1981 have shown a slight upward trend.

Few data are available for moose populations in Subunit 17B prior to the 1970's. Faro (1976) estimated the population within the Kvichak-Mulchatna River drainages to be 1,500 moose. Local residents reported high densities in the upper Nushagak River drainage, particularly along the King Salmon and Tikchik Rivers in the early 1970's, but wolf densities were particularly high in this area between 1974 and 1976, and they had severely depleted this population by 1979. A succession of mild winters from the mid-1970's through 1987 had a positive effect on moose populations in most drainages of Unit 17; however, the 1988-89 winter, was the most severe one in the past 10 years. Deep snow throughout Unit 17 forced moose to winter on the main branches of the Nushagak and Mulchatna Rivers. They left the snowpack over the river ice only to browse along the river margins, and no escape cover was available, so both predation and the illegal take were high from January through March. The moose density in Subunit 17B was estimated to be 0.6 to 0.8 moose per mi^2 of moose habitat during the reporting period.

The moose population in Subunit 17C has been historically low; i.e., 300 (Faro 1976). Mild winters, closures of major wintering areas to late-season hunting, and increased use of the expanding Mulchatna herd by unit residents as their primary meat source contributed to growth of this population from the late 1970's through the reporting period. A 1983 density estimate of 1,834 mi^2 of this subunit was 1,212 moose (+/- 24%) (Taylor, 1984). Winter conditions were severe during the 1988-89 winter, and some mortality because of starvation occurred.

Population Size:

Survey conditions are generally poor prior to January. Composition count data from trend areas are of limited use in estimating moose densities in the various subunits. Based on the most recent surveys and censuses, I estimate the posthunting season populations of the subunits as follows: Subunit 17A, 50 to 100; Subunit 17B, 2,500 to 3,000; Subunit 17C, 1,400 to 1,700.

Population Composition:

Composition surveys were conducted in November and December in portions of Subunits 17A and 17C (Table 1). Snow depths were sufficient in all areas to obtain excellent results; however, survey aircraft were unavailable during most of this period.

Bull:cow ratios in all areas of Subunits 17B and 17C have remained consistently high (i.e., above 50:100). Some counts reflected an unrealistic representation of the sexes because of sexual segregation and distribution during the surveys. Calf production and survival have fluctuated between areas and years, but they have generally been good to excellent; however, a slight but steady decline in the percentage of calves in the herd has occurred in Subunit 17C since 1984.

Distribution and Movements:

Much of Unit 17 is mesic and alpine tundra, and most moose are found along the riparian tributaries of the major drainages of Subunits 17B and 17C. Little is known about specific movement patterns, except that they are influenced primarily by the rutting season in late September and by snow conditions in early winter. Extensive use of snowmachines during the January to March beaver trapping season displaces moose from many of their wintering areas, principally along the Nushagak River. Snow depths during the winters of 1987-88 and 1988-89 were severe along the King Salmon River and most of the tributaries to the upper Nushagak River and in the Tikchik Lakes region. Virtually all moose inhabiting the Nushagak and Mulchatna River drainages wintered along the main channels of these rivers, where snow depths were less severe.

A cooperative study with the Togiak National Wildlife Refuge was initiated during this reporting period. Thirty-two moose (22 cows and 10 bulls) were radio-collared in March and April along the eastern boarder of the refuge, primarily in the wintering areas along Killian Creek, the Weary River, and in Sunshine Valley. All moose tagged were in fair-to-poor condition. Two mortalities occurred as a result of the tagging project, and two more were killed by brown bears in late April. Very little movement occurred in this population before May, when some moose began migrating to their calving locations.

Mortality

Season and Bag Limit:

There is no open season in Subunit 17A. The open season for all hunters in that portion of Subunit 17B that includes all drainages of the Mulchatna River upstream from and including the Chichitna River is 1-20 September. The bag limit is 1 bull. The open seasons for subsistence hunters in the remainder of Subunit 17B are 20 August to 15 September and 1-31 December; for resident hunters it is 1-15 September, and for nonresident hunters is it 5-15 September. The bag limit is 1 bull. The open seasons for subsistence, resident, and nonresident hunters in Subunit 17C are 20 August to 15 September, 1 to 15 September, and 5-15 September, respectively. The bag limit for Subunit 17C is 1 bull. The open season for subsistence hunters in Subunit 17C, excluding the Iowithla drainage and Sunshine Valley is 1-31 December.

Human-induced Mortality:

The 1988 reported harvest of 188 moose is the second highest on record for Unit 17. All harvests except one were bulls, and most (157) came from Subunit 17B. Zero was reported taken in Subunit 17A, 28 were taken in Subunit 17C, and three were taken from unknown locations. Of the 157 harvested in Subunit 17B, 73 were killed in that portion of the Mulchatna River drainage upstream from and including the Chilchitna River.

The incidence of illegal harvests of moose increased sharply from January to March, primarily by villagers along the Nushagak River. Moose were highly visible and very vulnerable because of the deep snow in this area. Additionally, the Mulchatna herd, a portion of which is usually accessible during most winter months and the major source of red meat for villagers in this area, was forced by deep snow between the Nushagak River and Iliamna Lake to winter between Kokhanok and King Salmon. These two factors combined with low enforcement effort encouraged a significant level of poaching in this area throughout the winter. Four residents of Aleknagik were cited for possession of moose and brown bear during a closed season.

Hunter Residency and Success. While the annual moose harvest by unit residents has remained relatively stable in recent years, both the harvest and hunting pressure by nonresidents and nonlocal residents have increased rapidly (Table 2). Nonresident hunting pressure in this unit has tripled since 1984, and the portion of the harvest taken by nonresidents has steadily increased since 1982. Most of this increase has been in the upper Mulchatna River drainage, where several outfitters and air-taxi pilots have drop-off points for hunters on float trips. The upper Nushagak River is becoming increasingly popular as well, and conflicts between local subsistence hunters and nonresidents are developing.

Permit Hunts. A registration permit hunt designed primarily to increase opportunity for local residents began in 1983. Harvests have ranged from a high in 1986 of 51 moose to a low in 1987 of 30 moose. The number of hunters participating in this hunt declined in 1986 and 1987. The registration permit requirement was deleted from the regulations in March 1988, and the dates of the permit hunt were adopted as part of the subsistence regulations for this area.

Harvest Chronology. Because of different seasonal opening dates for unit resident, nonlocal resident, and nonresident hunters, the harvest was fairly uniformly spread throughout the fall season. No weekly period was substantially different from another. Hunting pressure appeared to be highest during the Labor Day weekend, but hunter success was greater later in the season. Both hunter effort and success were very low during the December season.

Transport Methods. According to harvest reports, transport methods have not significantly changed in the past decade. Aircraft access was reported for 61% of the successful hunters, boats were reported by 28%, and snowmachines by 4%; however, only the primary method of transport was reported. Combinations of transport means such as aircraft access to the area and ORV transport around the hunting area were increasing, although it has generally been reported as aircraft transport.

Natural Mortality:

The winter of 1988-89 was the most severe one recorded for northern Bristol Bay in 15 years. Snow depths were abnormally high throughout Subunits 17B and 17C. Villagers along the Nushagak River reported finding dead moose in January and February that had apparently died of starvation. Wolf populations were high, and several wolf-killed moose were reported throughout the winter. Two of 30 radio-collared moose were killed by brown bears in late April in the Sunshine Valley portion of Subunit 17C. Three additional brown bear kills were found in the same vicinity, and two were reported on the Iowithla River. While none of these data are quantifiable, natural mortality was significantly higher during this reporting period than it had been in previous years.

Habitat

Winter range in most of Unit 17 was in very good-to-excellent condition. Exceptions occurred in the upper portion of Subunit 17B in the Twin Lakes area and Bonanza Hills and in the Weary River, Killian Creek, Sunshine Valley portion of Subunit 17C. I believe the moose densities in these areas were at or exceeded the present carrying capacity of the range. Browsing was much more evident along the Nushagak River than it had been 10 years previously; however, this range could support substantially more moose than it does. The moose population in Subunit 17A is far below carrying capacity of the habitat.

CONCLUSIONS AND RECOMMENDATIONS

Hunting pressure and annual harvests have steadily increased, particularly in Subunit 17B. Separating opening dates for local, resident, and nonresident hunters has reduced the potential for difficulties between these user groups, but conflicts are certain to increase along the Mulchatna and Nushagak Rivers as the number of hunters grows.

Annual moose harvest data for unit residents were very poor prior to initiating the registration permit hunt in 1983. Issuing permits provided an opportunity to explain to local hunters the necessity for accurate harvest data. Harvest reports from the 1988 season indicated that a major portion of the unsuccessful local hunters did not mail in their harvest reports. The quality of harvest information has deteriorated since the registration permit was deleted, and more effort is necessary to get compliance by local residents.

Residents of the Togiak River drainage have expressed an interest in working with the Department to increase the number of moose in Subunit 17A. Several informal meetings with village elders have been held, and they have agreed to prohibit by village law the taking of cow moose. Some village residents assisted the Department on the Togiak Refuge caribou transplant, and the concept of protecting these animals to provide a meat source for the future seems to be having a positive effect on their perception of the moose situation in the Togiak River drainage. Thirty-two moose were radio-collared during this reporting period as part of a cooperative project between ADF&G and USFWS along the eastern boarder of the refuge in order to determine the rate of moose emigration into the Subunit 17A portion of the refuge. Active monitoring of this population should help discourage illegal harvests.

Because of the highly variable distribution of moose in late fall and early winter as a result of variable snow conditions, trend count information for most areas in Unit 17 has been difficult to interpret. While some trend count areas are necessary, funds would be better spent on periodic census efforts in different portions of the unit. Monitoring hunting pressure during the fall season, assuring compliance with wanton waste statutes, and discouraging local harvesting of cow moose should be the immediate funding priorities for this unit.

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Table 1a. Moose composition counts and population estimates in Subunit 17A, 1981-88.

Year	Males: 100 F	Calves: 100 F	Calf %	Adults	n	Moose /hr.	Pop. size/density
1981	--	0	0	3	3	.5	<20
1983	No Data						
1984	No Data						
1985	No Data						
1986	37.5	100.0	33.3	16	27	2.2	
1987	No Data						
1988	--	0	0	10	10	--	<100

Table 1b. Moose composition counts and population estimates in Subunit 17B, 1983-88[a].

Year	Males: 100 F	Calves: 100 F	Calf %	Adults	n	Moose /hr.	Pop. size/density
1983	--	--	27.0	40	55		
1984	110.7	35.9	14.2	393	458	67	
1985	85.6	21.0	10.0	180	200	26	
1986	--	--	13.2	374	57	N/A	$0.74/mi^2$
1987	159.1	45.5	13.9	114	134	32	3,300
1988	No Data						

[a] NPS data included in 1983-85 except for moose/hr. calculations.

Table 1c. Moose composition counts and population estimates in Subunit 17C, 1983-88.

Year	Males: 100 F	Calves: 100 F	Calf %	Adults	n	Moose /hr.	Pop. size/density
1983	86.1	77.7	29.5	67	95	24	$0.74/mi^2$
1984	113.3	54.0	20.2	241	302	58	
1985	No Data						
1986	--	--	18.5	384	455	52	
1987	73.4	37.1	17.6	215	261	64	1,700
1988	80.1	36.4	16.8	272	327	76	1,400-1,700

Table 2. Regular season hunter residency and success in Unit 17, 1982-88.

Year	Successful					Unsuccessful					Total Hunters
	Local res.	NonLocal res.	Non-res.	?	Total	Local res.	Nonlocal res.	Non-res.	?	Total	
1982	22	17	6	2	47	65	22	12	2	101	148
1983	35	18	22	3	78	129	21	9	7	166	244
1984	58	21	38	1	118	105	51	32	1	186	304
1985	27	41	37	5	110	110	87	47	9	253	363
1986	65	36	45	5	151	99	91	92	2	284	435
1987	47	56	70	4	177	114	89	76	7	286	463
1988	27	39	82	40	188	42	89	106	32	269	457

Table 3. Hunter success in that portion upstream from and including the Chilchitna River in Subunit 17B, 1983-1988.

Year	Successful	%	Unsuccessful	%	Total
1983	22	49%	23	51%	45
1984	28	51%	27	49%	55
1985	27	31%	60	69%	87
1986	45	36%	81	64%	126
1987	59	40%	90	60%	149
1988	73	46%	86	54%	159

Table 4. Harvest data for registration permit hunt No. 983 in Unit 17, 1983-87.

Year	Permits Issued	Did not hunt	Unsuccessful. hunters	Successful hunters	MM	FF	Total	Total Hunters
1983	452	116	287	49	49	0	49	336
1984	316	101	175	40	40	0	40	215
1985	304	68	180	42	42	0	42	222
1986	275	61	110	51	51	0	51	161
1987	225	43	137	30	30	0	30	167

1986 Open to resident hunters only.
1987 Open to subsistence hunters only.

STUDY AREA

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

GEOGRAPHICAL DESCRIPTION: Yukon-Kuskokwim Delta

BACKGROUND

Moose were absent from the Yukon-Kuskokwim Delta prior to 1950 (Helmericks 1944), but they have since colonized the riparian corridors of the Yukon and Kuskokwim Rivers in low-to-moderate numbers. Futher expansion of range and population numbers is limited by spring flooding, availability of winter habitat, and hunting. Most of the Yukon-Kuskokwim Delta is lowland treeless tundra, which is unsuitable as moose winter habitat. Moose are confined during the winter to forested and willowed riparian habitats along the major rivers.

Moose densities were moderate and growing in the Yukon River drainage upriver from Ohogamuit, but low in the remainder of the Yukon River and the entire Kuskokwim River drainages. Moose are now more common than they have been in the past; overall densities are still extremely low, compared with habitat availability.

Heavy hunting pressure has effectively limited moose population growth in most 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 the many communities along the lower Yukon and Kuskokwim Rivers.

In 1988 a regulatory proposal was adopted by the Board of Game to completely close the moose hunting season in the lower Yukon Delta downriver of Mountain Village to allow the moose population to become established. That population is being monitored to assess the impact of the season closure.

POPULATION OBJECTIVES

To allow the moose population in Unit 18 to increase above its estimated size of 1,000.

To maintain the current sex and age structure of the moose population.

To allow for some harvest of bulls and a high rate of population increase.

To minimize conflicts between user groups harvesting moose.

METHODS

A check station was opened from late August through September 1988 At Paimiut Slough along the Yukon River near the border of Unit 18 and Subunit 21E to monitor moose hunting in the vicinity. No aerial surveys were conducted on the Yukon River in Unit 18 during the reporting period because of budget constraints. Only the lower section of Subunit 21E was surveyed in February 1989. A complete survey of the Yukon River in Unit 18 was completed in early 1988, and the results were summarized in Patten (1989).

A cooperative study of seasonal movements of moose along the Yukon River was initiated by the U. S. Fish and Wildlife Service (USFWS), the Department, and the village school at Marshall to document the suspected downriver movement of moose from high-density areas in Subunit 21E to suitable, unused habitat along the lower Yukon River. Five cows and 1 bull were captured, using standard darting techniques. The bull and 2 cows were fitted with satellite telemetry collars, and the other 3 cows were fitted with conventional VHF telemetry collars. All 6 moose were captured within 20 miles of Marshall (Table 1).

RESULTS AND DISCUSSION

Population Status and Trend

The total number of moose observed during winter surveys along the riparian corridor of the Yukon River, especially on islands located upriver of Paimiut, has slightly increased in recent years. A portion of Subunit 21E adjacent to Unit 18 on the Yukon River from Paimiut to Holy Cross was surveyed in February 1989, resulting in a small increase in the population from that of the previous year. The density of moose observed (i.e., moose per hour of flight time) increased slightly from 164/hour in 1988 to 189/hour in 1989. Past survey data indicated that moose have steadily increased in number since 1985 on the Yukon River in Unit 18 (Figs. 1 and 2); however, the flood in the spring of 1989 was very severe, and many of the major islands and riparian zones along the river were inundated in late May. Initial calving success may also have been adversely affected. Moose were observed on ice flows during break-up near Russian Mission and Saint Mary's. Essentially all of the lowlands adjacent to the Yukon River in Unit 18 was flooded. Moose numbers remained low downstream of Mountain Village on the Yukon River, and only a single cow and calf were observed near Kotlik.

Moose populations were very low but stable along the Kuskokwim and its tributaries in Unit 18, including the Johnson, Gweek, Tuluklsak, Kisaralik, Kasigluk, and Kwethluk Rivers. Only residual numbers of moose were present in each of these drainages; however, no recent surveys have been conducted because of staffing shortages. Surveys are planned for the fall of 1989.

Population Size:

Although censuses or surveys were not conducted in Unit 18 during the reporting period, anecdotal information received from the staff and public indicated the number of moose may have increased slightly in the Yukon River drainage. The Yukon and Kuskokwim River populations numbered approximately 600-900 and 100-200 moose, respectively (i.e., 700-1,000 overall); however, because a census has never been conducted, these estimates should be viewed with caution. Flooding during the spring of 1989 may have caused considerable calf mortality, and we will not be able to revise our estimates until the late winter and early spring composition counts have beem completed in 1990.

Population Composition:

No composition surveys were conducted in the fall of 1988-89 because of staffing and budget shortages. Although spring survey data indicated that yearling recruitment averaged 31% from 1981 to 1985, overall densities have remained very low. Fall composition counts conducted during the same period yielded a mean bull:cow ratio of 46 bulls:100 cows. Most bulls in the Unit were young, and large antlered bulls were rare.

Distribution and Movements:

The moose population in Unit 18 moves to coastal regions near the mouth of the Kuskokwim River, Nelson Island, Scammon Bay, and the lower Yukon Delta in late summer. With the advent of winter and hunting pressure, moose retreat to the mountainous, forested regions approximately 80 miles up the Yukon River drainage. Moose are also found in alpine and subalpine regions of the Kilbuck and Andreafsky Mountains in the summer, but they descend to the Tikchik lakes, forested tributaries of the Kuskokwim River, and lowlands and islands of the Yukon River during the winter. The Yukon lowlands between Holy Cross and Paimuit (i.e., near the border of Subunit 21E and Unit 18) support large numbers of moose, particularly during the winter.

Habitat Assessment

The islands and adjacent sloughs along the Yukon River from Paimuit to Mountain Village represent productive moose habitat. No overbrowsing is evident; however, just upstream of Paimuit on the Innoko River some overbrowsing is evident in the better winter yarding areas, and moose may have begun migrating downriver into better browsing areas. Except for the expanse of willows towards Kusilvak Mountain and the Kashunak River, the narrow bands of willow downriver of Mountain Village along the Yukon River are overgrown and senescent. The willow stands downstream of the Anuk River are so narrow that cover may be inadequate for moose in winter.

The riparian habitat along the Kuskokwim River in Unit 18 downstream of Kalskag also represents good moose habitat. Between lower Kalskag and Akiachak, the forest and brush along the Kuskokwim River may provide sufficient escape cover for moose. Moose were occasionally observed by pilots, standing in meadows surrounded by a thick willow, spruce, and cottonwood forest. Downstream of Akiachak towards the mouth of the Kuskokwim River, the riparian corridor narrows and escape cover is lacking.

Tributaries of the Kuskokwim River bordered by spruce, cottonwood, willow, and alder extend onto the tundra along the Gweek and Johnson Rivers to the west and the Tuluksak, Kisaralik, Kasigluk, and Kwethluk Rivers to the east. Each of these tributaries supports a small, residual moose population.

Mortality

Season and Bag Limits:

There is no open season in that portion of Unit 18 north and west of a line from Cape Romanzof to Kusilvak 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 are 1 to 30 September and 20 to 30 December: the bag limit is 1 bull. The open season for nonresident hunters in the remainder of Unit 18 is 1 to 30 September; the bag limit is 1 bull.

Human-induced Mortality:

Hunting remains the most significant source of moose mortality in Unit 18. Although reported harvests declined from 1981 to 1987, increased harvests were reported for the 1988-89 season; i.e., 68 moose. The 1988-89 harvest was higher than the 48 moose reported for 1987-88 and only slightly lower than the 1978-79 harvest, which has been the 2nd-highest for the last 10 years (Figure 4). The number of people who reported hunting moose in Unit 18 also increased in 1988, after steadily declining since 1984-85.

With the exception of the 1979 season, the annual reported moose harvest for Unit 18 has been stable for the last 10 years (Fig. 5). The moose population in Unit 18 is heavily utilized by local residents, and the harvest is estimated to exceed or equal 15% of the population annually on the Yukon River; it may exceed the annual recruitment rate for the Kuskokwim River.

The high harvests in Unit 18 in 1988 were associated with economic "boom" times and increasing moose populations on the Yukon River. The recent closure of the hunting season on the Yukon Delta forced hunters to travel upriver to better hunting areas near the Unit 18 and Subunit 21E boundary. Hunters during the 1988-89 season could afford to travel further because of the successful local commercial fishing seasons.

The reported harvest of moose in Unit 18 does not reflect the actual harvest; the percentage of local residents hunting in season with licenses and harvest tickets has been increasing, particularly during the fall. The estimated 1988-89 harvest in Unit 18, including the unreported and illegal harvests, was approximately 100 to 200 moose.

Approximately 81% of the reported harvest (55 moose) were taken along the Yukon River drainage upstream of Mountain Village. Among those moose taken from the Yukon River, 54% were from the area between the communities of Marshall and Paimiut; 19% of the overall harvest (13 moose) were taken from the Kuskokwim River drainage (i.e., 46% from the Kwethluk and Kisaralik Rivers, 38% from the upper Johnson River, and the remainder from other portions of the Kuskokwim River drainage). Only a few moose were reported taken from the remainder of the unit.

During September 1988, Department and USFWS staff operated a check station for the 4th consecutive year at the junction of Twelve Mile and Paimiut Sloughs on the Yukon River. Voluntary participation has increased from previous years. During the fall of 1988, 198 hunters stopped at the check station in 79 boats. During the fall of 1987, 169 hunters in 70 boats stopped at the check station. As in previous years, nearly all hunters reporting there were residents of Unit 18. Hunters were from 17 communities along the Yukon River.

Fifty-five moose taken from an area extending from the Innoko River in Subunit 21E to Russian Mission in Unit 18 were brought through or processed near the check station; antler width averaged 39.5 inches. The moose sampled at the check station were primarily young bulls in good condition.

Most (69%) of the bulls harvested, were young (i.e., antler widths of 25 to 50 inches. The ages of moose determined from a sample of sectioned teeth collected at the check station ($\underline{N}$ = 44) indicated 77% were between 1-3 years of age.

Approximately 117 moose were killed in northeastern Unit 18 and Subunit 21E along the Yukon and Innoko Rivers and adjacent sloughs. Approximately 62 of these were not sampled, having been harvested well away from the check station.

<u>Hunter Residency and Success</u>. As reported in past years, local residents accounted for most of the moose harvested in Unit 18. Only 4% of the reported harvest was taken by nonresident hunters. Based on hunters contacted at the check station, the success rate was 33%; overall, the success rate for reporting hunters was 25%. An average of 6.3 days was required to obtain a moose.

Harvest Chronology. Sixty-eight and 1 moose were harvested during the September and December seasons, respectively. Substantially more moose were taken during December and not reported.

Weather conditions during the fall of 1988 were generally cooler than those in 1987, and snowfall occurred on 24 September. Moose rutting activity in the vicinity of the check station began in mid-September. The majority of the hunters (66%) were afield during the first 2 weeks of September.

During the December season moose were concentrated on islands with large cottonwood stands and brushy willow fringes along the Yukon and the Kuskokwim Rivers and their tributaries. Although the actual harvest was undoubtedly higher than reported, we believe that excessive harvests did not occur, because extreme wind-chill conditions hindered travel by snow machines.

Transport Methods. Boats were most frequently used by successful resident hunters (80%), followed by snow machines (2%), aircraft (8%), and unspecified (10%). Because harvest reporting is poorer in the winter than in the fall, snow machines were used to a much higher degree than reported.

Natural Mortality:

A resident wolf pack was reported near Russian Mission and Paimiut Slough during 1988-89. Approximately 25 to 50 wolves were in Unit 18 during the reporting period. The distribution of wolves reflected the distribution of moose, especially on the Yukon River. In the Kilbuk Mountains east of the Kuskokwim River, caribou serve as an alternate prey species. Although the wolf population may be increasing slightly as ungulate numbers increase, the overall numbers are very low.

Grizzly bears outnumber moose in the Andreafsky and Kilbuck Mountains. Black bears are abundant in both the Kuskokwim and Yukon River drainages. Predation by bears, particularly on calves, may significantly impact moose population growth, especially in the lower Kuskokwim River drainage; however, quantitative information is lacking.

Spring flooding of lowlands along the Yukon and Kuskokwim Rivers may follow winters characterized by heavy snowfall and severe temperatures (e.g., January 1989). Heavy mortality among neonate calves may result. Calving success will not be known until the upcoming 1989-90 composition counts have been completed.

Game Board Actions and Emergency Orders

Local advisory committees submitted a proposal to the Board of Game in 1989 requesting an antlerless moose season along the Kuskokwim River. Because moose numbers in the Kuskokwim drainage are extremely low, the Board of Game did not adopt the proposal.

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 Ohogamiut; however, they remain at very low densities throughout the remainder of the unit. Although much of Unit 18 is lowland tundra, which is unsuitable as winter habitat, population growth is possible because of the extensive riparian habitat that is unoccupied. Although calf production and yearling recruitment are usually high in years without major flooding, heavy hunting pressure from the relatively dense human population in the unit has effectively limited moose population growth.

The illegal harvest, particularly of cows and calves, remains the most serious moose management problem in Unit 18. Although compliance with regulations is improving, a lack of alternative ungulate resources, a poorly developed cash economy, and high density of communities along the major rivers complicate effective management. The concurrent growth of muskox and caribou populations in Unit 18 (i.e., Kilbuck caribou and mainland muskoxen) may eventually lessen the pressure upon the moose population, although demand for moose will probably always exceed the supply.

We recommend that further monitoring of the moose population remain a primary goal, especially the continuation of fall composition counts along the Yukon River and intensive spring aerial surveys along the Kuskokwim and Yukon Rivers and their major tributaries. This information is needed to determine numbers, composition, and recruitment levels. If it is determined that the recruitment levels are low and the population cannot sustain further harvest in the Kuskokwim River drainage, it may become necessary to restrict the harvest.

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

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Figure 1. Number of moose observed during late winter surveys, Yukon River, Unit 18, 1980-89.

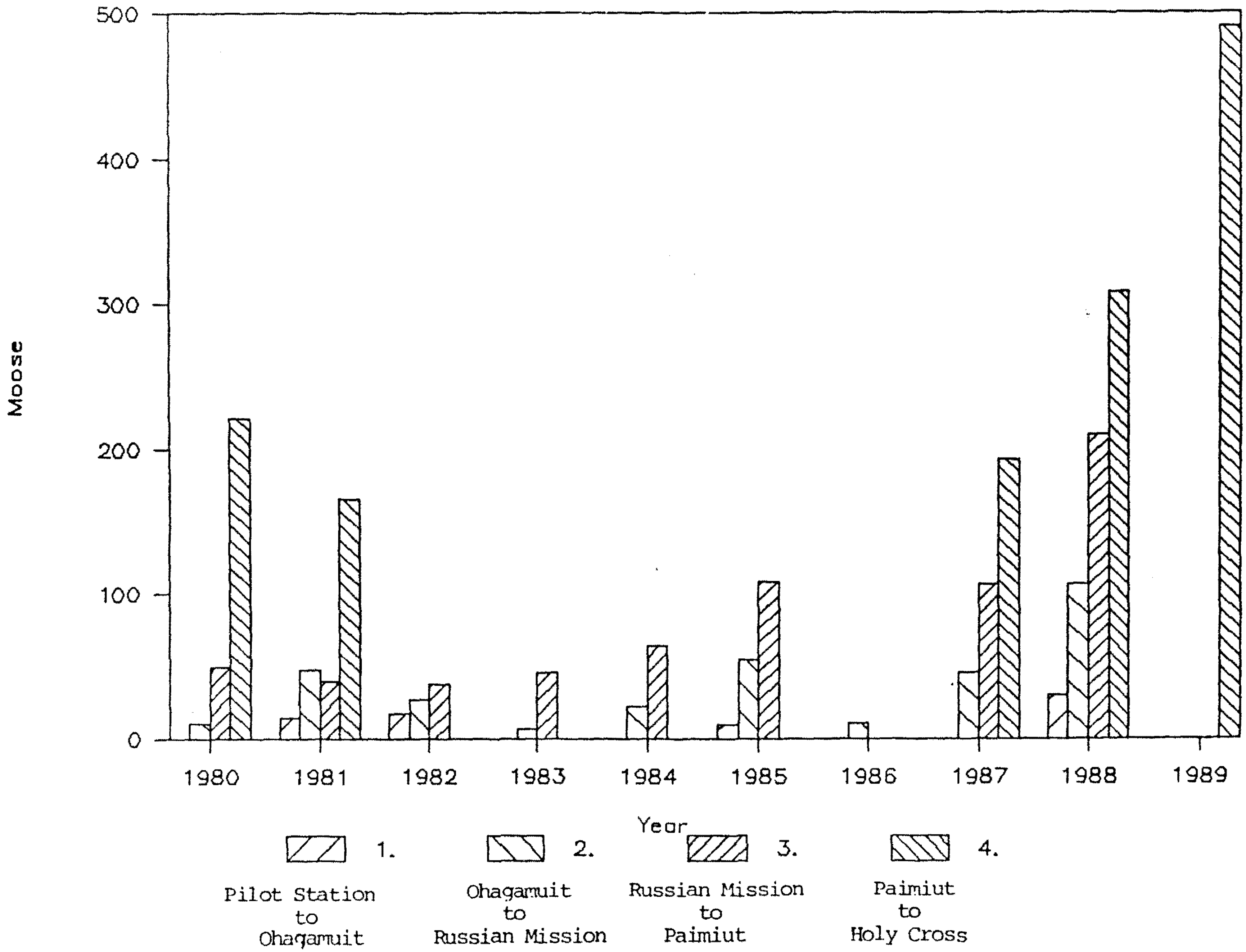

Figure 2. Number of moose observed per hour during late winter surveys, Yukon River, Unit 18, 1980-89.

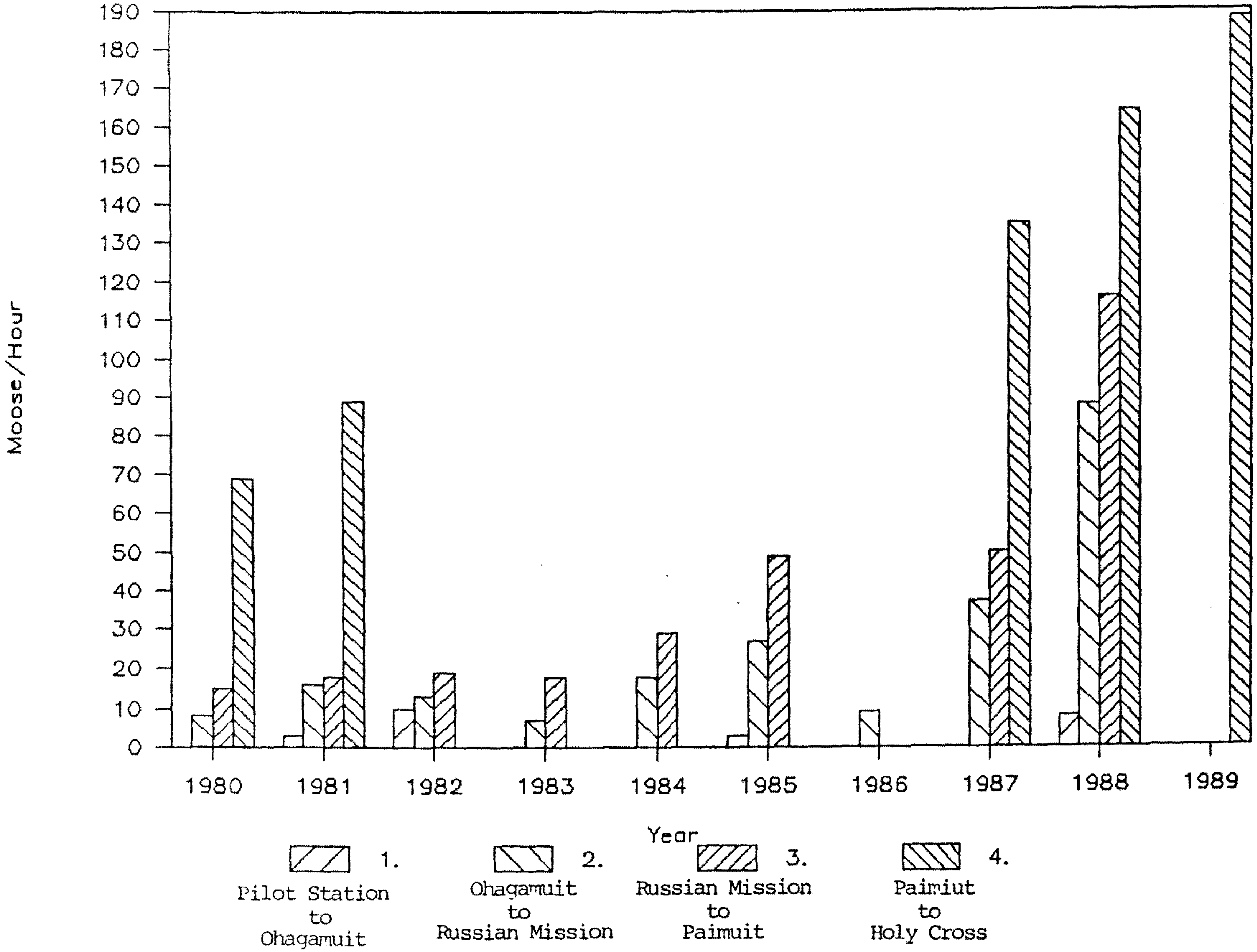

Figure 3. Unit 18 reported moose harvest, 1978-89.

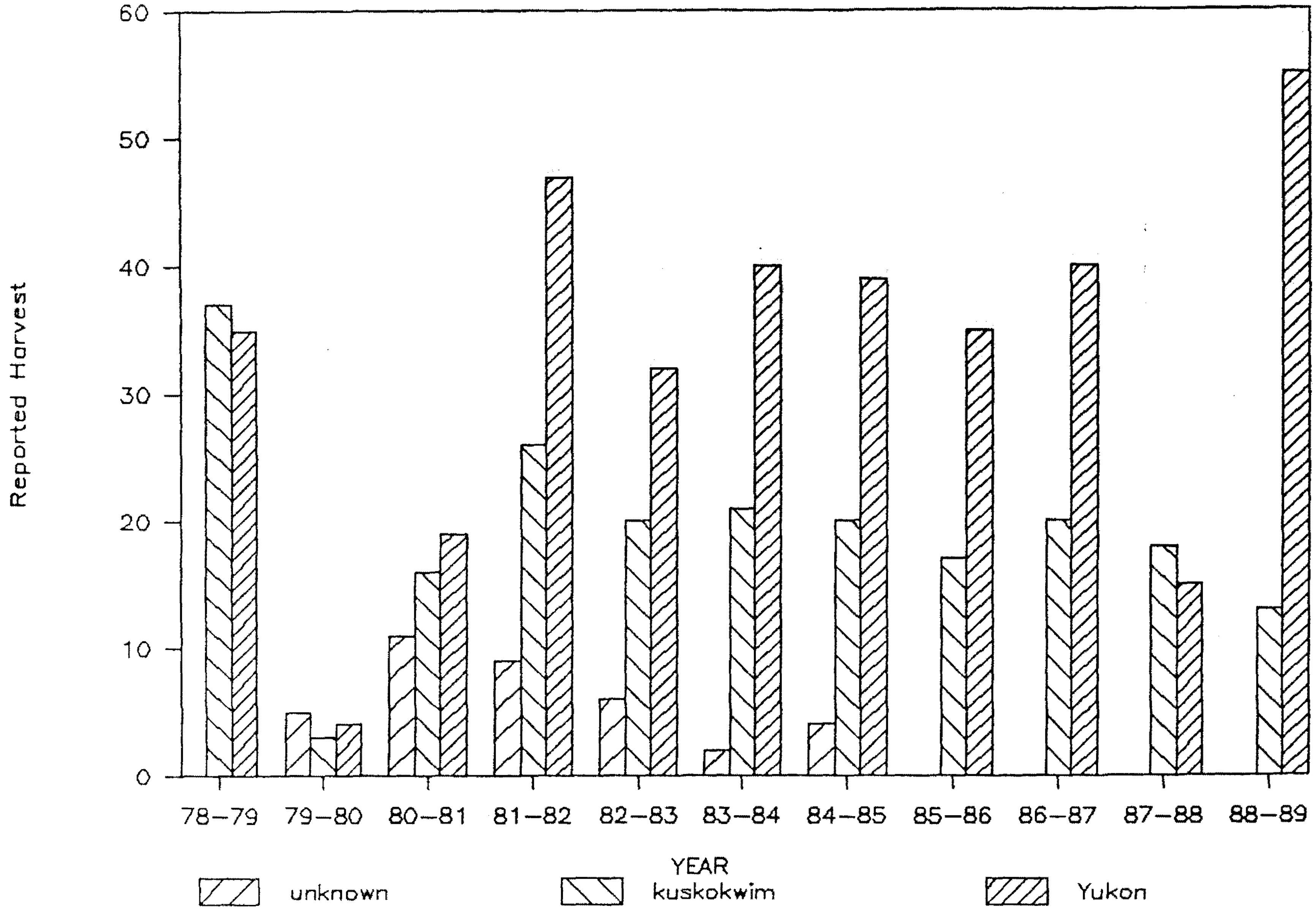

Figure 4. Mean number of hunters per moose harvested, Unit 18, 1978-89.

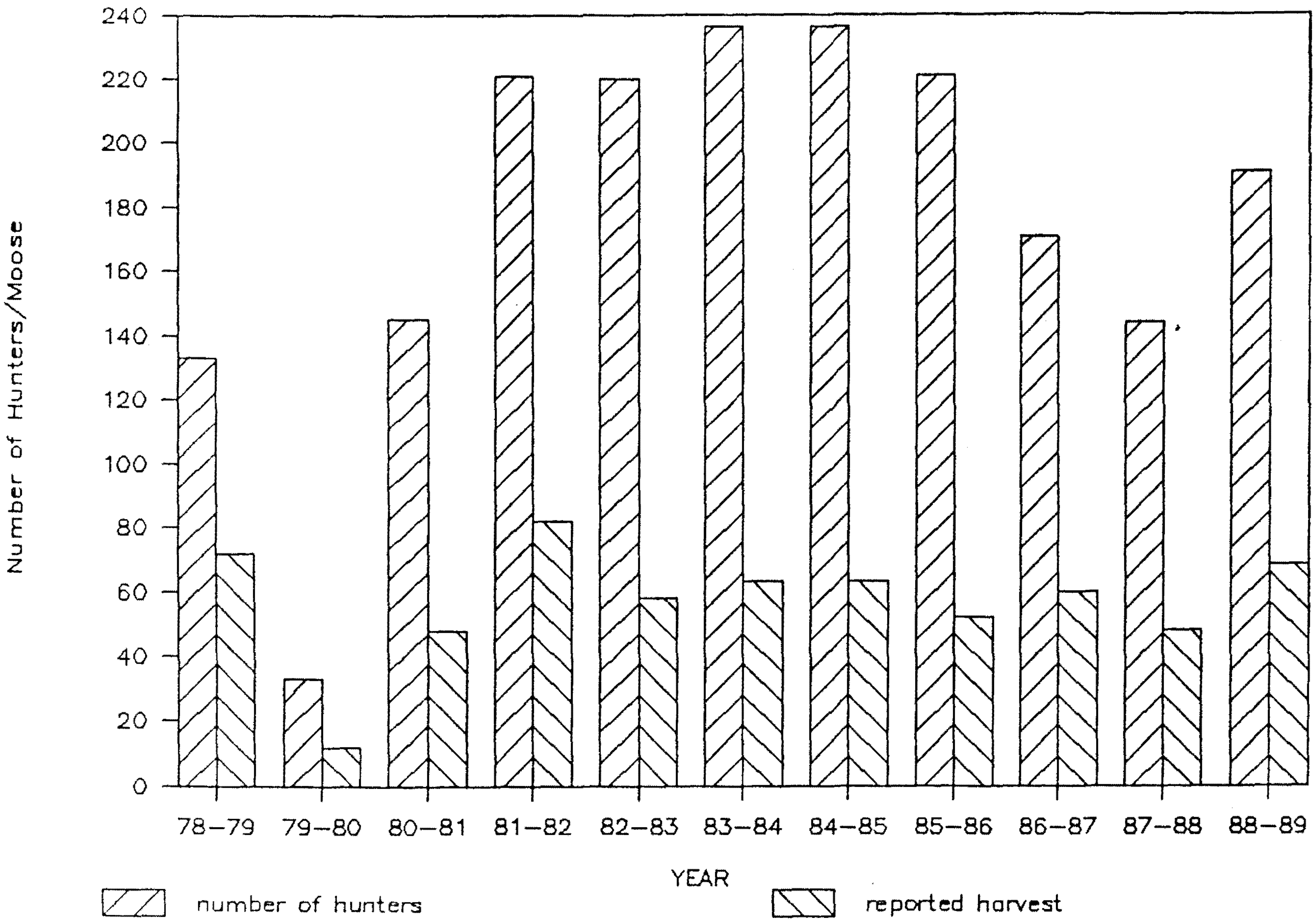

Figure 5. Historical moose harvest, Unit 18.

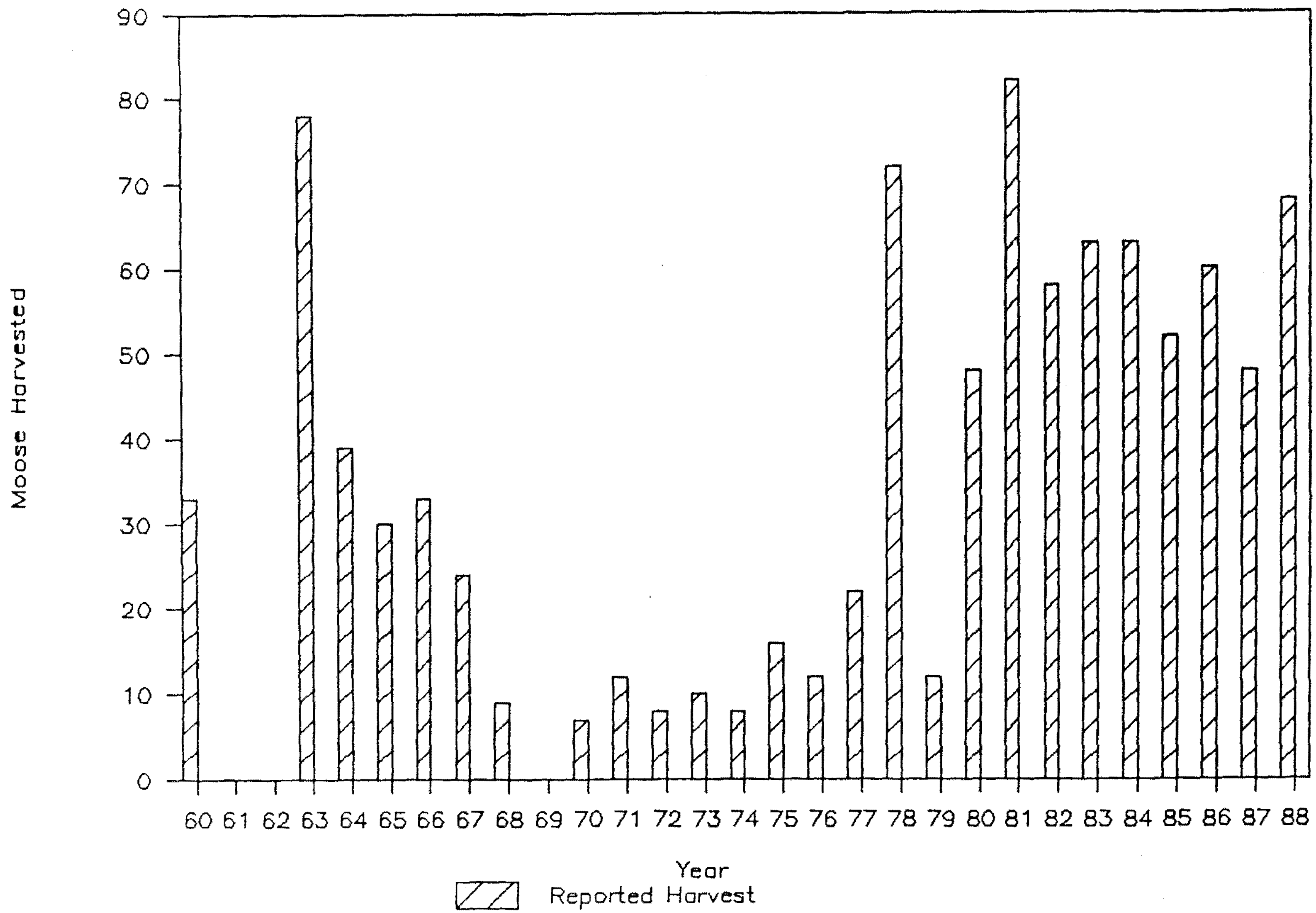

Table 1. Summary of information on capture of moose along the Yukon River, Unit 18, 1988-89.

Collar frequency	Collaring location		Sex	Age	Animal condition[a]	Drug dosages (milligrams)		Blood sample taken
	Latitude	Longitude				Carf	Nalox	
150.160[b]	61 59.2	162 29.5	F	4	8-9	4.5	550	yes
150.140[b]	61 50.0	162 09.3	M	3	7	4.5	550	yes
150.030	61 51.1	162 10.9	F	4	8	4.5	600	no
150.120[b]	61 44.8	160 00.2	F	4	8-9	4.5	550	no
150.590	61 45.3	162 01.3	F	3	8	4.5	550	yes
151.680	61 36.2	162 02.2	F	<3	8	4.5	550	no

[a] Based on a 1-10 scale with 10 being excellent.

[b] VHF frequency of back-up beacon, satellite collar.

STUDY AREA

GAME MANAGEMENT UNIT: 19 (36,850 mi^2)

GEOGRAPHICAL DESCRIPTION: Upper Kuskokwim River watershed, including all drainages into the Kuskokwim River upstream of Lower Kalskag

BACKGROUND

Moose are found throughout the forested portions of Unit 19, and their populations appear to be stable or slightly increasing. The major factors influencing moose abundance in the unit include predation, hunting, habitat condition, and weather. Hunting pressure is thought to be moderate, except in a few easily accessible drainages. Failure to report harvests is a chronic problem.

Unit 19 can be conveniently divided into 2 regions that have distinctive differences in moose habitat, user access, and hunting practices. Subunits 19A and 19D are generally lower-elevation areas that are accessible by boat. Hunters generally live in either Unit 19 or adjacent Unit 18. Most hunt moose for food. Subunits 19B and 19C are generally higher elevation areas, where access is largely restricted to aircraft. Few people live in these areas, and those traveling to these areas to hunt are mainly seeking large bulls for their trophy quality, although acquisition of meat is an important consideration as well.

Aerial composition surveys have been the primary means of assessing population status and trend in this large area. There is a history of surveys dating back several decades. Unfortunately, these data are of limited value because of inconsistencies in survey areas and methods that have compounded the usual problems caused by annual variations in snow and weather conditions.

POPULATION OBJECTIVES

To develop statistically sound population estimates for select portions of the unit by the spring of 1993.

To annually assess population status and trend in portions of the unit where harvest levels make significant impacts on moose populations.

To maintain a unitwide reported harvest of at least 500 moose.

To maintain a unitwide reported hunter success rate of at least 45%.

To maintain a reasonable harvest of cow moose in Subunits 19A and 19D.

To maintain an annual average antler spread measurement of at least 48 inches in Subunits 19B and 19C.

To assess accuracy of harvest reporting in select portions of the unit.

METHODS

Population composition surveys were conducted in selected portions of the unit using standard aerial survey techniques. Information received from harvest tickets and a seasonal check station were used to monitor hunter demographics and harvest distribution. Information was collected on the sociological aspects (i.e., hunter residence, boat size, caliber of gun used, and history of use by hunters) of the hunt as well as the biological characteristics of the harvest.

Browse utilization surveys were conducted on foot using standardized ADF&G transect methods. Eight sites were evaluated. Fifty individual shrubs were sampled at each site. An index of the overall importance of each particular 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.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

No population estimation surveys have been conducted in Unit 19. Historical data from composition surveys suggested that moderate moose numbers exist in the unit and that the populations are relatively stable.

Population Trend:

Historical data, which can be used to depict population trends, are available from 2 areas within Unit 19; however, year-to-year 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 have been surveyed 13 times since 1976; however, some of these surveys were conducted in late winter, when moose distribution and observability are entirely different than those conditions during early winter surveys.

Data from early winter surveys (Table 1) suggested that calf survivals to 6 months have increased and the bull:cow ratio has decreased since the early 1980's. Moose abundance increased, based on the numbers of moose seen per hour of survey; however, this trend may have been an artifact of either the way the surveys were conducted or changes in moose distribution from year to year. Late-winter surveys (Table 2) suggested that calf survivals have been good in most winters, except the winter of 1985-86. Few calves were seen during the April 1986 survey; consequently, few yearling bulls were observed during the November 1987 survey (Table 1).

In Subunit 19C, the Farewell Burn-Alaska Range foothills area has been surveyed 12 times since 1973 (Table 3). From 1973 to 1985 the population has been experiencing a long-term decline in calf survival to 6 months ($r = -0.7865$, $\underline{P} \leq 0.01$, 8 df). The 1987 and 1988 survey data indicated a real increase in survivals, because of the enhanced habitat in the Bear Creek burn or the increased survey efforts in forested areas. There are no significant trends in either the success rates in Unit 19 or the mean antler size among bulls harvested in Subunits 19B and 19C, suggesting the moose population has not declined.

Population Composition:

Subpopulations of moose within Unit 19 that are subject to differing climatic conditions, hunting regimes, and predation factors displayed a wide variation in herd composition (Table 4). In the Holitna and Hoholitna River drainages of Subunit 19A, few bulls were left after the fall season, because of the large amount of hunting pressure in this easily accessible area. In Subunit 19C, where access is more difficult and hunting pressure lighter, the posthunting bull:cow ratio was higher.

Calf survivals to 6 months ranged from extremely good in the Holitna and Hoholitna River drainages of Subunit 19A to only fair in Subunit 19D (Table 4). Differences in the calf:cow ratios between count areas related to real differences in predation upon calves during the first months of life. However, habitat differences between count areas also influenced herd composition. Cows with calves were often underrepresented in surveys of large open burns or areas above treeline (e.g., Subunit 19C).

Classification of bulls according to antler spread in the Farewell burn and the Alaska Range foothills above Farewell suggested good age distribution among bull moose remaining after the hunt. In the burn, yearlings (≤30 inches), young adults (31-50 inches), and older bulls (>50 inches) composed 35%, 34%, and 25% of the 80 bulls classified, respectively. In the foothills, yearlings, young adults, and older bulls composed 25%, 37%, and 37% of the bulls classified, respectively.

Distribution and Movements:

No specific information was collected on relative distribution or movements of moose in Unit 19 during this reporting period. The planned stratification of Subunit 19A was not done. The work has been rescheduled for early winter 1989-90.

Mortality

Season and Bag Limit:

The open subsistence seasons for residents of Lime Village only are 10 August to 25 September and 20 November to 31 March; the bag limit is 2 moose, only one of which may be antlerless. The open season for resident and nonresident hunters in Subunit 19A is 1-20 September. The open seasons for subsistence hunters in Subunit 19A are 1-20 September, 20-30 November, and 1-10 February. The bag limit for all hunters in Subunit 19A is 1 moose; however, antlerless moose may be taken by subsistence hunters from 20-30 November and from 1-10 February. The open season for all hunters in Subunit 19B and that portion of Subunit 19D in the upper Kuskokwim Controlled Use Area within the drainage of the North Fork upstream from the confluence of the South Fork to the mouth of the Swift Fork is 1-30 September; the bag limit is 1 bull. The open season for all hunters in Subunit 19C is 1 September to 10 October; the bag limit is 1 bull. The open season for resident and nonresident hunters in the remainder of Subunit 19D is 1 to 30 September; the bag limit is 1 bull. The open seasons for subsistence hunters in the remainder of the Upper Kuskokwim Controlled Use Area in Subunit 19D are 1 to 30 September and 1 December to 28 February; the bag limit is 1 bull. The open seasons for subsistence hunters in the remainder of Subunit 19D are 1 to 30 September and 1 to 15 December; the bag limit is 1 bull.

Human-induced Mortality:

During the 1988-89 season, 1,148 hunters reported harvesting 637 moose in Unit 19, representing the highest harvest recorded during the past 26 years (Fig. 1) and more than a 3-fold increase over the 1963 harvest. I believe several factors have contributed to this increase: (1) increased moose hunting pressure and harvest, (2) stable or increasing moose numbers, and (3) increased compliance with harvest reporting requirements.

Successful hunters averaged 6.9 days afield. Unsuccessful hunters averaged 8.2 days afield. The mean for all hunters was 7.5 days per hunter. No significant changes were noted from harvest ticket data of the previous 5 years.

The reported harvest in Subunit 19B and 19C was fairly representative of the actual harvest. Probably 90% of the actual harvest was reported in these subunits; however, reporting was still extremely low in Subunits 19A and 19D.

Only 45% of the successful hunters interviewed at the Holitna River check station during the fall of 1988 later submitted harvest reports. If these data were representative of the entire subunit, the reported harvest of 155 moose probably represented an actual harvest of 344 moose from Subunit 19A.

The reporting rate in Subunit 19D was similarly low. Only 1 moose was reported by residents of the village of Nikolai during the 1988-89 season; however, unofficial reports from the village indicated that residents take 25-35 moose annually. When the harvest data from the check station and the village of Nikolai are applied to the reported harvest (i.e., 637), the actual 1987-88 harvest was approximately 1,000 moose.

After talking with hunters at the Holitna River check station, it was apparent that many people used hunting techniques that caused a high incidence of wounding loss. Many hunters who were from tundra and coastal areas used small-caliber weapons, and they often failed to follow and retrieve fatally wounded animals.

Hunter Residency and Success. In Subunit 19A, residents of Unit 18 and Subunit 19A accounted for 80% of the reporting hunters for which residency was known (Table 5). Other resident, nonresident, and alien hunters accounted for the remaining 20%.

Most (85%) of the 243 people who reported hunting in Subunit 19D were residents (Table 5). Although local residents composed nearly half of those who reported hunting there, the incidence of Unit 18 hunters traveling to Subunit 19D by boat increased.

In Subunits 19B and 19C, only 2% of the reporting hunters were from Unit 19 (Table 5). This was largely because residents of Unit 19 cannot easily get into these areas to hunt using boats.

The overall success rate among reporting hunters in Unit 19 was 54.3%. Mean hunter success varied from a low of 45% in Subunit 19D to a high of 65% in Subunit 19C. Unitwide, mean hunter success has varied from a low of 49% (1981, 1982, 1985) to a high of 66% (1979).

Harvest Chronology. Similar to previous years (Table 6), the vast majority of the harvest occurred during September. A significant portion (13%) of the annual harvest in Subunit 19A occurred during the 20-day February subsistence season. Similarly, 9% of the Subunit 19C harvest occurred during the 10-day extension of the season into October.

Antler Spread and Age. The mean antler spread for moose during the 1988-89 season was 45.2 inches, based on antler spread measurements supplied by hunters on their harvest report cards. This is not significantly different from the means for the previous 8 years, and no trends in antler sizes were evident. When mean antler sizes were analyzed by residency status of the reporting hunters, nonresidents (who often hunt with guides) harvested significantly larger bulls (mean = 51.1 in) than residents (mean = 42.3 in).

When the harvest report card data were compiled by subunit, mean antler spread measurements of 38.8, 48.6, 47.9, and 43.3 inches were obtained for bulls from Subunits 19A, 19B, 19C, and 19D, respectively. The larger averages for Subunits 19B and 19C reflected that most hunters in these subunits were nonlocal residents who were seeking large-antlered moose.

Antler spread measurements of harvested bulls were also recorded during 1987 and 1988 at the Holitna River check station in Subunit 19A. Mean antler size declined from 41.8 inches in 1987 to 38.9 inches in 1988. If these data were representative of the moose population in Subunit 19A and hunter selectivity had not changed between years, then it seems reasonable to conclude that fewer large-antlered bulls were available to harvest in 1988.

Tooth specimens were also collected from moose examined at the Holitna River check station during the 1987 and 1988 hunting seasons. Ages of the harvested moose were determined by counting cementum annuli. Yearling bulls composed 40% and 43% of the 103 and 159 moose aged during 1987 and 1988, respectively. Examination of the frequency with which various age classes occur in these data suggested that moose born in 1984 and 1985 were underrepresented in the harvest (Fig. 2). Although this distribution could be caused by factors other than scarcity of these age classes in the population, I believe that these data reflected the actual situation existing in Subunit 19A. This conclusion was based on (1) consecutive year's data showing similar age distributions and (2) poor representation of calves during an April 1986 survey of the Holitna and Hoholitna Rivers (Table 2). I expect the poor survival of the 1984 and 1985 calf cohorts to be reflected in the harvest for 3 to 4 more years. No survey data were available concerning the calf cohort of 1986; however, because of the high number of yearlings in the 1987 harvest, I suspect that recruitment was good during 1986. Survey data from the early winter of 1987 indicated good initial survival of calves during summer and fall of that year (Table 1), which again led to an abundance of yearlings in the fall 1988 harvest.

Hunter Profiles. The size of the boat motors used by hunters on the Holitna and Hoholitna Rivers was found to reflect the distance hunters had to travel to their hunting areas. Hunters living near their hunting area (i.e., Unit 19 residents) used motors averaging 51.8 HP (n = 31, range = 20-150), while hunters traveling from Unit 18 used motors with a mean rating of 83.9 HP (n = 116, range = 15-200). This difference was significant at the 99% level. Comparable results were obtained in 1987.

Check station data indicated that nearly one-fourth of the successful hunters on the Holitna River used rifles of .243 or smaller caliber to kill their moose. Calibers ranged from .222 Remington to 300 Winchester magnums.

Hunters who stopped at the check station on their way into the hunt area were reminded about common violations of the regulations for which they could be cited. In addition, articles were printed in local newspapers to remind hunters to leave evidence of the moose's sex attached to the carcass and to validate their harvest ticket after getting a moose. Twenty-one of the hunters who stopped at the Holitna River check station on their way out of the hunt area were cited for failure to validate their harvest tickets.

Transport Methods. Methods of transportation have not changed significantly during the past 4 years (Table 7). Most hunters (75%) in Subunits 19A and 19D used boats for transportation to their hunting areas. In Subunits 19B and 19C, aircraft were the primary (83%) means of access.

Natural Mortality:

Only anecdotal information on natural moose mortality is available from Unit 19. During 1988-89, wolf numbers were apparently quite high in many areas, accounting for a number of predation-related moose deaths. Spring flooding during 1988 in lowland areas where moose were concentrated on the calving areas may have also accounted for limited survival of calves.

Unusually deep snow during the early winter of 1988 resulted in high moose densities along seral riparian habitats. Survey of a 25-mi^2 area on 4 February 1989 revealed a density of almost 9 moose per mi^2. Moose remained in this area from early January through early April; however, there is no evidence that snow depths were great enough to result in starvation of moose. Gross examination of the bone marrow from 8 winter-killed moose revealed adequate fat levels. I suspect that severe temperatures were responsible for these deaths. Temperatures as low as -75°F were recorded during January 1989.

Habitat Assessment and Enhancement

During the period 8-13 June 1989, moose browse surveys were conducted along the main Kuskokwim River in the vicinity of McGrath in Subunit 19D. Transects were located in young seral stage shrub communities that are subjected to periodic ice scouring. These riparian areas are important moose winter range. The winter of 1988-89 was severe, resulting in particularly high moose densities in these areas. This browse survey was conducted to document the extent of browsing on various shrub species during a severe winter.

Nearly 400 plants were examined along 8 transects. Feltleaf willow was the most common (68%) species encountered. Littletree willow, balsam popular, alder, and grayleaf willow composed an additional 14%, 9%, 6%, and 2% of the plants available at the sites, respectively. Diamondleaf willow and dwarf birch were each present in very small amounts (<1%).

As expected, overall browsing intensity was extremely high (Table 8). Nearly 86% of the plants examined showed signs of having been browsed by moose. All of the diamondleaf willow and dwarf birch and most of the feltleaf and littletree willow had received some use by moose. Aspen received the least use.

Diamondleaf willow plants were the most heavily browsed (Table 8). All plants examined had more than three-fourths of their stems browsed. Conversely, less than one-fourth of the alder and dwarf birch stems were browsed.

The importance of a browse species to moose is a function of both availability in the stand and its preference by moose. An importance index was devised that incorporated both parameters (Table 8). Based on this evaluation, feltleaf willow was by far the most important (i.e., largest index value) food species for moose in the sampled area. Its importance index was almost 10 times greater than littletree willow, the secondranked plant species.

No moose browse enhancement efforts have been recently conducted in Unit 19. Contact with ADNR fire personnel was continued to ensure compliance with earlier planning efforts. Naturally occurring wildfires that do not threaten people's lives or property must be allowed to burn with only limited fire suppression effort in those areas where fire may benefit moose populations.

Game Board Actions and Emergency Orders

Few Board of Game actions affected management of moose in Unit 19. The Board reapproved the current cow seasons in Subunit 19A and designated new subsistence moose seasons for residents of Lime Village.

The Board also determined that only individuals living in either Subunit 21E or the village of Russian Mission (Unit 18) could qualify as subsistence users in Subunit 21E. This action will probably affect the moose harvest in Subunit 19A, because it will effectively eliminate late-winter moose hunts in Subunit 21E by residents of Bethel and other lower Yukon-Kuskokwim communities. I suspect that many who hunted in Subunit 21E prior to this Board ruling will now go to Subunit 19A instead, where they would still qualify for the late-winter antlerless moose hunt. Monitoring of moose hunters should be increased in the Aniak, George, and Holitna River drainages to determine if hunting pressure from Unit 18 hunters increases as a result of the Board ruling.

CONCLUSIONS AND RECOMMENDATIONS

No changes in either seasons or bag limits are recommended for Unit 19 at this time. The hunter check station at the mouth of the Holitna River in Subunit 19A should be continued. Increased emphasis should be placed on the education of hunters about need for ethical hunting practices, following wounded moose, using harvest tickets, complying with reporting requirements, disposing of garbage, and showing respect for private property. Now that the Board of Game has created special regulations for residents of Lime Village, some efforts should be expended to document the actual harvest of moose from the area affected by the regulations.

Site-specific analyses of moose harvest ticket reports should be continued to identify potential problems such as overharvesting localized areas. The increased hunter effort in the Farewell Station area should be monitored closely to determine the effects of that increase on the moose herd.

Moose composition counts should be continued in established trend count areas in Subunits 19A, 19B, and 19C. The planned stratification of Subunit 19A should be completed and used as a basis for establishing additional trend areas. In Subunit 19D, efforts should focus on the identification and delineation of standardized trend count areas along the Kuskokwim River and elsewhere in the subunit.

The Fish and Wildlife Service (FWS), Bureau of Land Management (BLM), and Alaska Department of Natural Resources (ADNR) must be encouraged 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 Plans, so that fire can fulfill its natural role of maintaining young, highly productive, and diverse habitats.

A spring controlled burn designed to maintain or enhance browsing conditions for moose should be conducted in the Farewell area of Subunit 19C in cooperation with ADNR staff. Existing browse surveys in Subunit 19D should be continued annually.

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Table 1. Moose composition information from aerial surveys conducted during early winter (Nov-Dec) in the Holitna and Hoholitna River drainages of Subunit 19A, 1976-88.

Year	Bulls: 100 cows	Yrlg bulls: 100 cows	Calves: 100 cows	Percent calves	Sample size	Moose/ hour
1976	49	11	49	25	69	46
1980	59	22	41	21	92	42
1981	45	14	59	29	187	33
1984	55	6	52	26	200	33
1987	23	4	72	36	140	85
1988	31	16	56	30	343	95

Table 2. Moose composition information from aerial surveys conducted during late winter (Feb-Mar) in the Holitna and Hoholitna River drainages of Subunit 19A, 1977-86.

Year	Percent calves	Sample size	Moose/ hour
1977	17	169	65
1979	22	286	106
1984	26	151	151
1985	25	167	93
1986	11	359	75

Table 3. Moose composition information from aerial surveys conducted during early winter (Nov-Dec) in the Farewell Burn-Alaska Range Foothills of Subunit 19C, 1973-88.

Year	Bulls: 100 cows	Yrlg bulls: 100 cows	Calves: 100 cows	Percent calves	Sample size
1973	28	2	30	19	95
1974	28	9	31	19	103
1975	No data				
1976	66	5	25	13	139
1977	35	23	30	11	363
1978	No data				
1979	5	21	25	11	129
1980	No data				
1981	64	6	29	15	690
1982	56	18	17	10	200
1983	53	10	22	13	184
1984	41	7	20	10	399
1985	90	12	12	6	546
1986	No data				
1987	72	16	25	13	395
1988	69	20	33	16	534

Table 4. Moose composition information from aerial surveys in Unit 19, winter 1988-89.

Subunit	Specific area	Bulls: 100 cows	Calves: 100 cows	% Calves	n	Moose/ hour
19A	Holitna River	33	56	29.5	312	115
19A	Hoholitna River	11	61	35.5	31	35
19A	Kiokluk-Chuilnuk	61	58	24.2	91	58
Subtotal		36	57	29.3	434	84
19B	Upper Stony River	42	34	19.4	72	36
19B	Cairn-Sparrevohn	131	25	9.7	93	30
Subtotal		83	30	14.0	165	32
19C	Ak Range Foothills	81	31	16.0	269	87
19C	Farewell Burn	58	34	17.7	265	126
Subtotal		69	33	16.1	534	103
19D	White Mountains	190	17	5.6	89	41
19D	McGrath-Selatna[a]	--	--	26.7	217	167
Subtotal		190	17	25.9	306	88
Total		64	40	20.6	1439	75.8

[a] Late winter sample, so bulls were not differentiated from cows.

Table 5. Residency of hunters in Unit 19 during the 1988-89 moose season as indicated by moose harvest ticket reports (percentage of total reporting for each category in parentheses).

Area hunted	Unit 18 residents	Unit 19 residents	Other Alaskan residents	Total Alaska	Non-residents	Other countries	Residency unknown	Total
19A	31 (42.1)	98 (31.5)	30 (9.6)	259 (83.3)	25 (8.0)	1 (0.3)	26 (8.4)	311
19B	20 (6.0)	7 (2.1)	131 (39.2)	158 (47.3)	150 (44.9)	4 (1.2)	22 (6.6)	334
19C	0 (0.0)	4 (1.9)	132 (63.2)	136 (65.1)	58 (27.8)	6 (2.9)	9 (4.3)	209
19D	38 (12.3)	133 (43.0)	72 (23.3)	243 (78.6)	34 (11.0)	9 (2.9)	23 (7.4)	309
Unknown	0 (0.0)	0 (0.0)	2 (20.0)	2 (20.0)	6 (60.0)	0 (0.0)	2 (20.0)	10
Total	189 (16.1)	242 (20.6)	367 (31.3)	798 (68.0)	273 (23.3)	20 (1.7)	82 (7.0)	1,173

Table 6. Reported historical harvest chronology of moose in Unit 19 during the period 1980-88 expressed as a percentage of total annual harvest.

Year	Month of harvest										
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Unk	Total
1980	0.0	0.5	88.6	6.0	3.3	0.3	0.0	0.0	0.0	1.4	100.1
1981	0.0	0.3	84.8	5.7	1.4	0.3	0.3	4.3	0.3	2.7	100.1
1982	0.0	0.3	85.1	5.7	1.8	1.2	0.3	3.6	0.0	2.1	100.1
1983	0.0	0.2	87.4	5.5	0.8	0.2	0.2	1.6	0.0	3.9	99.8
1984	0.0	0.5	84.8	2.1	1.1	0.7	0.0	7.4	0.0	3.4	100.0
1985	0.0	0.7	88.2	2.1	0.5	0.5	0.2	5.1	0.5	2.1	99.9
1986	0.0	0.2	93.6	2.8	0.2	0.0	0.0	3.1	0.0	0.0	99.9
1987	0.2	0.5	83.4	5.1	0.9	0.7	0.2	6.2	0.0	2.7	99.9
1988	0.0	0.5	90.4	2.2	0.8	0.0	0.2	3.1	0.0	2.8	100.0
Mean	trace	0.4	87.4	4.1	1.2	0.4	0.2	3.8	0.1	2.3	99.9

Table 7. Method of transportation (%) used by all moose hunters in Unit 19 during the period 1984 to 1988.

Transport means	1984	1985	1986	1987	1988
Aircraft	45	43	46	38	44
Horse	tr	1	tr	1	1
Boat	45	45	46	44	40
Motorbike	1	1	2	3	2
Snowmachine	7	6	3	7	2
ORV	1	2	1	2	1
Highway	tr	1	1	tr	1
Unknown	--	--	--	5	9
Total	100	100	100	100	100

Table 8. Browse availability and use by moose along the Kuskokwim River near McGrath in Subunit 19D, June 1989.

Browse species	% of plants with use by moose[a]	% in each browse category[b] None	Light	Moderate	Heavy	Importance Index[c]
Feltleaf willow (*Salix alaxensis*)	94	6	13	30	51	0.415
Littletree willow (*S. arbusculoides*)	90	11	26	53	11	0.055
Balsam popular (*Populus balsamifera*)	32	68	19	11	3	0.009
Alder (*Alnus crispa*)	68	32	60	4	4	0.008
Grayleaf willow (*S. glauca*)	75	25	13	63	0	0.007
Diamondleaf willow (*S. pulchra*)	100	0	0	0	100	0.002
Dwarf birch (*Betula glandulosa*)	100	0	100	0	0	trace

[a] Percentage of total sample for each species.

[b] Browse categories: None = 0%, Light = 1-25%, Moderate = 26-74%, and Heavy = 75-100%.

[c] Importance Index = $[(a_1*b_1)+(a_2*b_2)+(a_3*b_3)+(a_4*b_4)/c] * d$ where

$a_1 \ldots a_4$ are the median values for each browse category, and

$b_1 \ldots b_4$ are the number of plants for a given species that are in each browse category, and

c = the total number of plants examined for a given species, and

d = frequency of occurrence of the species in the site sampled.

STUDY AREA

GAME MANAGEMENT UNIT: 20A (6,500 mi^2)

GEOGRAPHICAL DESCRIPTION: Tanana Flats, central Alaska Range

BACKGROUND

The number of moose increased in Subunit 20A during the 1950's, reaching a high density in the early 1960's. High densities persisted until the early 1970's; then the population declined rapidly, reaching its lowest point in the mid-1970's. Following predator reduction, which began in 1976 and ended in 1982, the moose population again increased.

Four population estimation surveys (Gasaway et al. 1986) have been completed in Subunit 20A since 1976. The entire subunit was censused in both 1978 and 1988, and the Tanana Flats and Alaska Range foothills were censused in 1982 and 1984, respectively. Population estimates from those surveys were 3,511 (1978), 7,663 (combined 1982 and 1984), and 9,430 (1988) moose.

Moose occur throughout the foothills of the Alaska Range and the Tanana Flats. Preferred moose habitat consists of riparian willow, second-growth forest, and subalpine shrub communities. Habitat may have limited moose population growth during the 1960's when moose densities were high, but recently browse availability has not limited moose population growth. During the 1960's when average moose densities may have exceeded 3 moose/mi^2, moose undoubtedly affected browse production (W. Gasaway, pers. commun.). A detailed history of the moose population through 1978 was published by Gasaway et al. (1983).

Harvests averaged 311 moose between 1963 and 1969. From 1969 to 1974 harvest increased to an average of 617 moose per year. Thirty-four percent of the annual harvest from 1963 to 1974 were cows. Beginning in 1975, seasons and harvests were dramatically reduced and the taking of cows was prohibited. From 1975 to 1978 the mean annual harvest was only 64 bulls. From 1979 to 1982 harvests averaged 226 bulls per year. Since 1982 the annual harvest has averaged 370 bulls.

POPULATION OBJECTIVES

To maintain an adult population (i.e., excluding calves) of at least 8,000 and a total population of 10,000 moose.

To maintain a bull:cow ratio of at least 30 bulls:100 cows overall and at least 20 bulls:100 cows in Tanana Flats, western foothills (Yanert River and Alaska Range foothills west of the Totatlanika River), and central and eastern foothills (Alaska Range foothills east of the Totatlanika River).

To maintain an annual harvest of no more than 300 adult bulls and a total harvest of less than 400 bulls, including yearlings.

To allow the harvest of females when the population is above the objective of 8,000 adult moose and is exhibiting a positive growth rate.

METHODS

Population surveys were conducted throughout Subunit 20A in early November 1988. The subunit was divided into 3 areas, and a complete census was conducted in each one. Although the 3 small censuses required more intensive sampling than if 1 large census had been attempted, this approach ensured that some results could be salvaged if survey conditions or weather suddenly deteriorated.

Growth rates were calculated for the total moose population for the periods 1978-84 and 1984-88. Because the entire subunit was not censused in 1984, a 1984 population estimate was made by adding the 1984 foothills census results to a Tanana Flats population estimate that had been extrapolated from the 1982 census; this extrapolation was based on the 6% finite growth rate calculated for the interval between the 1982 and 1988 Tanana Flats censuses.

Unless otherwise stated, reference to the adult population in this report includes moose ≥ 1 year of age. I used composition data from the 1982 and 1984 censuses to estimate the adult populations in the flats and foothills. Then, I extrapolated the 1982 estimate for the flats in the manner previously described to derive an estimated adult population for 1984.

The calculation of natural mortality rates required an estimate of yearling recruitment (R), where R = number of yearlings/ (number of older adults + number of yearlings). Yearlings were estimated by doubling the number of yearling males observed on the 1988 population estimation survey, extrapolating to a total population estimate of yearlings using composition proportions, then adding the number of yearling males taken by hunters in 1988 to correct for yearling females not accounted for by doubling of yearling males. However, the composition sample was not evenly distributed between the flats ($\underline{n}$ = 1,304) and the foothills ($\underline{n}$ = 2,274). Therefore, the final estimate of total Subunit 20A recruitment was calculated by weighting the individual recruitment values (flats and foothills) according to the census estimate for adults on the flats ($\underline{n}$ = 3,431) and the foothills ($\underline{n}$ = 3,610).

Moose were captured by darting from a helicopter on 11-13 April 1989. For each moose, body measurements were taken, body condition was assessed, and blood samples were drawn to determine pregnancy and packed-cell volume. We used body condition indices as described by Franzmann (1977).

Girth measurements were made perpendicular to the spine immediately behind the front shoulder. Hind foot measurements were made from the hoof tip, over the front of the hoof, along the front of the metatarsal and to the rearmost point of the hock. Generally the hoof and lower leg (i.e., hind foot) were curled under the moose when measured.

During the period 1987 to 1989, aerial surveys were conducted from fixed-wing Super Cub aircraft in 190 mi^2 of the northeastern Tanana Flats during the peak of calving (20-24 May). In 1989 a helicopter search was added to test the ability of the Super Cub pilot and observer to consistently identify single and twin calves. Fixed-wing surveys in 1989 were flown using the same pilot-observer team that had been used during the previous 2 years. The helicopter, with 3 observers, was directed to each cow after the fixed-wing team had identified the cow to be without calves, with 1 calf, or with 2 calves. The results of the helicopter search were not given to the fixed-wing team until after the surveys were completed. During the survey the fixed-wing team made 1 to 8 passes over cows, depending on the ground cover. In general, cows without calves did not require as many passes as did cows with calves. The fixed-wing team discontinued the search around each sampled cow when the pilot and observer decided that additional passes would not likely locate additional calves.

RESULTS AND DISCUSSION

Population Status and Trend

The November 1988 census yielded a preliminary population estimate of 9,430 (± 8%) moose in Subunit 20A. Moose were distributed approximately evenly between the foothills (4,855 ± 9%) and the flats (4,575 ± 13%; 90% CI) (Table 1). Although the 1988 population estimate represented a substantial increase over the 1978 estimate of 3,511 moose, the rate of population growth declined from 14% during 1978-84 to 5% during 1984-88 (Table 2).

Moose population estimates reported from Alaska most commonly include calves; however, between-year variability in calf crops can significantly affect the comparison of 2 or more estimates. True population growth is better reflected by changes in the adult segment of the population. The foothills moose population contained 16% and 24% calves in 1984 and 1988, respectively. If only the adult segment of the population is considered, the 1984-88 finite growth rate was probably 3.2% (Table 2).

If the adult population of approximately 7,100 moose continues to grow at an annual growth rate of 3.2%, the population objective of 8,000 adults would be achieved by 1994. However, the 3.2%

growth rate represents a mean annual rate from 1984 to 1988. Because 1984 growth rates were possibly much higher than 3.2% (Table 2), current growth rates may be near zero percent.

Measured moose population growth rates on the Tanana Flats have been higher than corresponding growth rates in the foothills since 1978 (Table 2); however, the difference in growth rates between the 2 subpopulations has become less in recent years. Wolf control between 1975 and 1979 was most effective on the Tanana Flats (73% reduction) and marginally effective in the foothills (42% reduction) (Gasaway et al. 1983). In recent years wolves have recovered to near precontrol levels in both areas. The consequent increase in adult moose mortality from increasing wolf predation on Tanana Flats moose is responsible for the recent parity in growth rates between the flats and foothills moose subpopulations.

Population Composition:

During the 1988 population estimation survey, 3,578 moose were classified into sex and age categories. Overall bull:cow ratios were 38:100 and calf:cow ratios were 44:100. Calves made up 24% of the total classified sample (Table 3). Yearling recruitment was 18%.

Composition data from the foothills and from the Tanana Flats were similar in 1988. Bull:cow ratios were 35:100 and 39:100 in the foothills and flats, respectively. Calf:cow ratios were 45:100 in the foothills and 44:100 in the flats. Yearling recruitment was 20% in the foothills and 17% in the flats (Table 4).

Despite a 1988 regulation which limited the harvest to bulls with either spike/fork or >50-inch antlers, there has been no detectable improvement in bull:cow ratios in southwestern Subunit 20A. The bull:cow ratios in the Yanert River drainage and western foothills (i.e., 16:100 and 19:100, respectively) during 1988 (Table 3) were below the minimum objective of 20 bulls:100 cows and are similar to the 1987 ratios of 13:100 in the Yanert drainage and 20:100 in the western foothills. Additional regulatory changes to improve these ratios will be considered if they have not increased by 1990 in southwestern Subunit 20A .

Calf:cow ratios in southwestern Subunit 20A (i.e., Yanert River and Moody Creek count areas) were well below the overall ratio of 44:100. Although the causes of chronic poor calf recruitment in southwestern Subunit 20A have not been documented, 8 cow moose were captured and evaluated for pregnancy and body condition in the Healy Creek, Yanert River, and Moody Creek drainages during April 1989. All eight were pregnant and in average or good body condition; therefore, it seems unlikely that initial productivity was low. Predation by both bears and wolves undoubtedly contributed to low calf:cow ratios.

Low twin production was suggested by surveys conducted during the peak of calving in 1987, 1988, and 1989. Paired airplane-helicopter surveys in 1989 indicated the low observed twinning rate was not related to a sightability handicap from the airplane. Among 84 cows observed during the paired surveys, 6 and 7 twin sets were observed from the airplane and helicopter, respectively (Table 5). In each case 16% of the cows observed with neonates had twins (Table 6).

Total bull:cow ratios in the foothills in 1988 (39:100) were similar to those for 1984 (41:100), but the proportion of medium and large bulls was substantially lower in 1988 (i.e., 49:100 in 1984, 28:100 in 1988) (Table 4). On the Tanana Flats total bull:cow ratios were 60:100 in 1982 and 35:100 in 1988. The bull:cow ratios in 1988, compared with 1982 and 1984, reflected liberalized hunting seasons in the mid-1980's following several years of restrictive seasons. Under the current regulations bull:cow ratios are expected to stabilize.

On the Tanana Flats, yearling recruitment was lower (17%) in 1988 than that estimated in 1982 (26%). The lower 1988 value was consistent with the reduced rate of growth that was observed from 1982 to 1988, compared with 1978 to 1982. In the foothills, the estimated 1988 yearling recruitment was slightly higher (20%) than that estimated in 1984 (16%). Twinning frequencies among calves observed during November were consistently low in all areas during 1982, 1984, and 1988 (Table 4).

Moose Condition Assessment:

Between 11 and 13 April 1989, 38 cow moose were captured in Subunit 20A to evaluate their pregnancy rate and body conditions (Table 7). Moose were captured in the northeastern Tanana Flats (13), the western Tanana Flats (13), the western foothills (4), and the southwestern mountains (8). Thirty-four of 37 adult cows (92%) were pregnant; the only yearling captured was also pregnant. Only 1 of 17 captured cows with calves was accompanied by twins.

Packed cell volume values ranged from 42 to 52, and body condition indices ranged from class 5 to class 8 and averaged class 7. The calf:cow ratio among captured adult cows (49:100) was similar to that found during the fall population estimation survey (44:100).

Although body condition indices and pregnancy rates were normal among the moose sampled during April, ovulation rates and, hence, twinning rates may have been affected by the nutritive condition of the cows during and just before the breeding season (Nalbandov 1976). Genetic disposition and age also influence ovulation rates. Although the causes of chronically low twinning rates observed in Subunit 20A remain unknown, poor body condition during late gestation did not appear to be a factor.

Mortality

Season and Bag Limits:

The open season for subsistence, resident, and nonresident hunters in Subunit 20A is 1-20 September. In the Yanert Controlled Use Area and in that portion of Subunit 20A south of the Rex Trail and west of the Wood River Controlled Use Area, the bag limit is 1 bull with a spike/fork or 50-inch antlers. In the remainder of Subunit 20A the bag limit is 1 bull.

Human-induced Mortality:

Because of its proximity to Fairbanks and traditional ability to support a large moose population, Subunit 20A receives high hunting pressure. During 1988, 1,035 hunters reported taking 351 bulls. That harvest is 14% higher than the 1987 harvest, but it is slightly below the previous 5-year (1983-87) mean of 374 (Table 9). Based on the posthunting population estimate of 9,430 moose, hunters harvested approximately 4% of the prehunting total population and 18% of the prehunting bull population.

Distribution of the Subunit 20A moose harvest during 1988 was similar to that for previous years (Table 9). Fifty-nine percent of the 1988 harvest came from the Tanana Flats. Harvests declined only slightly in the western foothills and the Yanert Controlled Use Area, where a new spike-fork/50-inch regulation took effect in 1988 (Table 9). Yearling bulls (≤30 in) composed 14% of the total harvest and large bulls (≥50 in) composed 40% of the harvest. Of the 731 bulls classified during the 1988 census, 43% were yearlings and 22% were large bulls. Apparently hunters selected for large bulls (Table 10).

Subunit 20A harvests during the period 1983-86 averaged 392 bulls annually. Those harvests, taken from smaller populations than existed in 1988, exceeded the harvestable surplus of bulls and caused the decline in bull:cow ratios that were documented during the 1988 census. Consequently, future harvests must be lower than those of the 1983-86 period, despite a slowly increasing population. Given an assumed annual adult population growth of 3.2%, the harvest level needed to stabilize bull:cow ratios was calculated using estimates of the natural mortality for bulls (Table 14) and the current bull population and recruitment from the 1988 census data (Appendix A). Those calculations suggested that approximately 300 bulls ≥2 years old could be taken by hunters during 1989 without causing a decrease in bull:cow ratios.

Hunter Residency and Success. Overall hunter success was 34% during 1988. That value is higher than success rates reported for 1987 (28%), 1986 (32%), and 1985 (30%) (Table 11). Local residents took 66% of the harvest, while other residents and nonresidents each reported taking 17% of the harvest.

Harvest Chronology. The harvest in 1988 was distributed evenly throughout the 20-day season (Table 12); however, many hunters preferred to hunt late in the season in the Fairbanks area because of increased movement and vocalization of bulls, cooler temperatures, and better hunting visibility after leaf drop.

Transport Methods. Aircraft and boats were the methods of access used by 63% of the successful hunters during 1988 (Table 13). Traditionally, more hunters use boats, but success rates were higher for hunters using aircraft.

Natural Mortality:

Natural mortality among adult moose in Subunit 20A was estimated as 11.4% and 10.8% using 2 independent methods of calculation. The first estimate was based on a model using 1987 composition and harvest statistics that assumed zero population growth since 1984 (Table 15). This model would have required natural mortality among adults to be nearly 14.6%; however, comparison of the 1988 census data with the 1984 population estimate suggested a mean annual growth of 3.2%, rather than zero growth. Therefore, natural mortality as estimated by this model was 11.4%. The second estimate used Bergerud's and Elliot's (1986) equation of recruitment, mortality, and the finite growth rate (λ = 1-M/1-R) to relate the observed population growth rate (3.2%) to the estimated 1988 recruitment (18%). Total adult mortality was estimated to be 15.4% using this method. Furthermore, natural mortality (M_n) can be expressed as $M_n = 1-(\lambda\ (1-R/1-M_h))$, where M_h is hunting mortality. In this case M_h is expressed as the number of bulls killed in the 1988 season divided by the estimated posthunting adult population in 1987 (351/6,902 = 0.051). This relationship suggests a 10.8% natural mortality among adult moose for the period 1 November 1987 to 1 November 1988.

Natural mortality rates among adult moose have differed between the Tanana Flats and foothills subpopulations during the last decade. The Tanana Flats moose subpopulation experienced high recruitment and low natural mortality in the late 1970's (Table 15). Natural mortality then increased from an estimated 1% in 1978 to 8% of the population, excluding calves, by 1988. Concurrently, recruitment declined from 26% in 1978 to 17% in 1988. The flats subpopulation is growing at 4% or less annually.

The foothills moose subpopulation experienced a substantial increase in natural mortality from 5% in 1978 to 15% in 1988, excluding calves. Despite the increase in recruitment, the growth rate dropped from 11% in 1978 to 2% or less in 1988.

Wolf Predation. Wolves killed approximately 927 moose (704 adults, 223 calves) during the 1 June 1988-1 June 1989 period in Subunit 20A. Thus, wolves removed 9.9% of the estimated November 1988 adult population of 7,121 moose. If total natural mortality during the November 1988-October 1989 period was similar to the

10.8% natural mortality calculated previously for the November 1987-October 1988 period, then wolf predation alone composed approximately 92% of the natural mortality experienced by adult moose during the year.

Reported kill rates of moose by wolves have varied, relative to predator and prey densities, pack size, availability of alternate prey, and season. Gasaway et al. (1983) reviewed reported kill rates by wolves in North America and estimated 1 kill every 3 to 6 days as upper and lower estimates for kill rates in primarily wolf-moose predation systems during the winter.

Ballard et al. (1987) reported summer (Jun-Sep) and winter (Oct-May) kill rates of 1 moose/7-16 days/pack and 1 moose/5-11 days/pack, respectively, in the Nelchina Basin, where caribou were available as alternate prey. Peterson et al. (1984) reported an average kill rate of 1 moose/4-7 days/pack >2 wolves during the winter (Oct-May) on the Kenai Peninsula.

During March 1989, ADF&G biologists monitored 4 wolf packs in the foothills of Subunit 20A for 30 consecutive days. Three packs contained more than 2 wolves (pack sizes = 14, 7, and 4). Wolves in these 3 packs killed a minimum of 16 moose, 11 caribou, 1 sheep, 1 wolf, and several snowshoe hares. Therefore, despite an abundance of alternate prey, the kill rate was 1 moose/5.6 days/pack during the 30-day period.

There were approximately 183 wolves in a minimum of 21 packs in Subunit 20A during winter 1988-89. Seventeen packs contained 4 or more wolves. Five of those 17 packs had territories that did not normally contain caribou; caribou occurred seasonally in part of the home ranges of the remaining 12 packs. Therefore, I believe an average kill rate of 1 moose/5.6 days/pack yields a reasonable, conservative estimate of the Subunit 20A moose mortality caused by those 17 wolf packs during the October-May period. For the June-September period I applied a kill rate of 1 moose/11 days/pack, based on the median value reported by Ballard et al. (1987).

Peterson et al. (1984) reported that calves composed a much higher proportion (47%) of the winter diet of wolves on the Kenai Peninsula than their frequency of occurrence (20%) in the winter moose population; however, Ballard et al. (1987) reported the proportion of calves in the wolf kill approximated the proportion of calves in the winter moose population. Similarly, preliminary data from Subunit 20A during March 1988 showed no evidence of calves being killed by wolves disproportionately to their occurrence in the moose population.

Game Board Actions and Emergency Orders

The Game Board took no action regarding Subunit 20A moose during the reporting period; however, regulations that were passed during the spring 1988 Board meeting were implemented during the fall of 1988. Those regulatory changes extended the moose season in the western foothills and southwestern mountains from 1-15 September to 1-20 September and placed a spike/fork or 50-inch antler restriction on the expanded season.

CONCLUSIONS AND RECOMMENDATIONS

A population survey of the 4,690 mi^2 of moose habitat in Subunit 20A was completed during November 1988. The estimated population was 9,430 ($\pm$ 8%) moose: 4,855 ($\pm$ 9%) in the foothills and 4,575 ($\pm$ 13%) in the flats (90% CI). The estimated adult population was 7,121 moose: 3,431 on the Tanana Flats and 3,690 in the foothills. Thus, the current population level is below the objective of 8,000 adult moose.

The annual finite growth rate in the Subunit 20A population was 3.2% from 1984 to 1988. Given that rate of population growth, the population objective will not be reached until 1994. The 3.2% mean annual population growth documented since 1984 occurred during 4 years of mild winters. Any significant increase in environmental resistance (e.g., deep prolonged snow, spring flooding on calving grounds, or reduced quality or availability of forage) would curtail population growth. Because 5 more consecutive years of mild conditions are unlikely, it seems improbable that the population objective will be met under the current levels of mortality and recruitment within 5 years.

Natural mortality of adult moose was 10.8% for the period November 1987-November 1988. The following year (Nov 1988-Oct 1989) the natural mortality rate from wolf predation alone was 9.9% of the adult population. Wolf predation likely accounts for more than 90% of the current adult natural mortality. Reported hunting-caused mortality was 4.7% of the estimated prehunting adult moose population in 1988. Total mortality among adult moose was approximately 15% during each of the last 2 years.

During November 1988, the overall bull:cow ratio was 38:100, calf:cow ratio was 44:100, and yearling recruitment was 18%; however, bull:cow ratios remained unacceptably low in the western foothills (19:100) and in the Yanert River drainage (16:100). The calf:cow ratio was also substantially lower in the Yanert Valley (29:100) than elsewhere in Subunit 20A. I recommend maintaining and increasing the enforcement of the spike/fork or 50-inch antler regulation in southwestern Subunit 20A to allow an increase in the proportion of bulls in those subpopulations.

The 1983-86 mean annual Subunit 20A harvest of 392 bulls caused bull:cow ratios to decline. Given current recruitment and mortality rates the harvest during the next 5 years should be held at or below approximately 300 bulls $\geq$2 years old. Maintaining that harvest should stabilize or slightly increase bull:cow ratios. Higher bull:cow ratios would provide a buffer against predation on cows. Current seasons and bag limits have resulted in the desired harvest. Reported harvest in 1988 was 351 bulls (304 adults, 47 yearlings).

Neonatal twinning rates were low for the 3rd consecutive year on the major moose calving areas in the northeastern Tanana Flats. Apparently neither winter nutritional stress, low pregnancy rates, nor poor spring body condition was limiting productivity. Of 37 adult cows examined during April 1988, 92% were pregnant.

Subunit 20A habitat conditions were more than adequate to maintain the current moose population, as judged by the assessment of body condition of cow moose captured in April 1989. Habitat enhancement programs, therefore, would probably not improve moose population growth rates in the short term. However, long-term benefits would be derived from natural fires or management actions that perpetuate a mixture of successional stages among forage vegetation.

Increased adult moose natural mortality, rather than a substantial decline in recruitment, appeared to be the most significant factor limiting moose population growth in Subunit 20A. Therefore, determining if the population continues toward the population objective will require estimates of population size, rather than inferring growth rates from recruitment data. I suggest recurrent 3- or 5-year censuses or improved annual survey techniques that precisely estimate population trend will be necessary to adequately manage moose in Subunit 20A during the next 5-10 years.

The current high rates of adult moose natural mortality must be reduced if the population objective is to be achieved. Wolf predation accounts for most adult moose natural mortality in Subunit 20A; therefore, management actions that substantially increase the harvest of wolves are the most expeditious means to reduce adult moose natural mortality. However, in the past, wolf harvests by trappers and hunters have been ineffective by themselves in managing wolf numbers. With only a small increase in natural mortality, the moose population will stabilize or decline in Subunit 20A within the next 5 years.

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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	3,431	1,144	4,575
Foothills			
1978	1,786	419	2,205
1984	3,409	649	4,058
1988	3,690	1,165	4,855
Total 20A			
1978	2,765	746	3,511
1984	6,281[d]	1,382	7,663
1988	7,121	2,309	9,430

[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] Summation of 1984 foothills survey estimate and 1984 calculated flats estimate as described in footnotes a and b.

Table 2. Finite rate of growth[a] estimates for moose populations in Subunit 20A, 1978-88.

Area	1978-82 %	1978-84 %	1982-88 %	1984-88 %
Total population including calves:				
Tanana Flats	25.2	--[b]	6.0	6.0
Alaska Range Foothills	--[b]	10.7	--[b]	4.6
Total 20A	--[b]	14.0[c]	--[b]	5.4[c]
Adult segment only (moose ≥1 yr):				
Tanana Flats	28.0	--[b]	4.0	--[b]
Alaska Range Foothills	--[b]	11.0	--[b]	2.0
Total 20A	--[b]	14.0	--[b]	3.2[c]

[a] Finite rate of population growth = e^r where e is the base of the natural logarithms, a constant 2.171828, and r is the observed exponential rate of change, calculated as: (log e T_1 - log e T_2)/t where T_1 and T_2 are the population estimates and t is the time interval between estimates (Gasaway et al. 1986).

[b] No data available.

[c] Finite rate of growth is based on a 1984 population estimated by using the 1984 foothills census and a 1984 flats population calculated by applying a 6% annual growth rate during 1983 and 1984 to the 1982 flats census.

Table 3. Moose composition from the 1988 census in Subunit 20A.

	Tanana Flats			Foothills						
	East	West	Total	East	Central	West	Yanert	Moody Creek	Total	Total 20A
Total bulls	224	26	250	134	256	38	9	44	481	731
Yearling	61	6	67	45	79	16	5	21	166	233
Medium	116	13	129	70	101	14	4	20	209	338
Large	47	7	54	19	76	8	0	3	106	160
Total cows	608	123	724	362	529	200	55	101	1,247	1,971
Adult[a] cows	547	117	657	317	450	184	50	80	1,081	1,738
Yearling cows	61	6	67	45	79	16	5	21	166	233
Total calves	269	61	330	166	240	100	16	24	546	876
Total classified moose	1,101	203	1,304	662	1,025	338	80	169	2,274	3,578
Total bulls:100 cows	37	21	35	37	48	19	16	43	39	38
Total calves:100 cows	44	50	45	46	45	50	29	24	44	44
2 x male yearling:100 adult cows	22	10	20	28	35	17	20	53	31	27
Calves:100 adult cows	49	52	50	52	53	54	32	30	51	50
Medium + large bulls:100 adult cows	30	17	28	28	39	12	8	29	29	29
Twin frequency (%)	6	13	8	11	11	11	7	9	11	10
% Calves	24	30	25	25	23	30	20	14	24	24

[a] Adult cows were estimated by assuming a 50:50 yearling sex ratio and subtracting the number of yearling males observed from the total cows seen.

Table 4. Moose composition values from population estimation surveys conducted in Subunit 20A during 1982, 1984, and 1988.

Area	Year	Total bulls: 100 cows	Medium + Large bulls:100 adult cows	Calves: 100 cows	% Calves in herd	Recruit-ment[a] (R)	Twin[b] frequency (%)	Sample size
Tanana Flats	1978	56	45	52	26	26%	12	196
	1982	60	49	34	18	26%	7	942
	1988	35	28	45	25	17%	8	1,304
Foothills	1978	29	21	31	19	16%	14	563
	1984	41	33	27	16	16%	8	1,567
	1988	39	20	44	24	20%	11	2,274

[a] $R = \frac{\text{2 x yearling males + yearling harvest}}{\text{Total adults + (2 x yearling males + yearling harvest)}}$

[b] % twins among cows with calves.

Table 5. Results of paired fixed-wing/helicopter moose calf surveys 20-21 May 1989 on the northeastern Tanana Flats.[a]

	Fixed-wing	Helicopter
Cows with no calf	43	39
Cows with 1 calf	35	38
Cows with 2 calves	6	7
Total sample	84	84
% Twins among cows with calves	14.6	15.6

[a] Survey was flown in sample units 96, 97, 100, 101, 104, 107, 109, 110, 116, 117, 118, 119, 120, 122, 125, 126, and 127 as defined by fall 1988 20A moose population estimation survey.

Table 6. Results of fixed-wing moose calf surveys flown between 20-24 May, 1987-89.

	1987	1988	1989[a]
Cows with 1 calf	45	52	43
Cows with 2 calves	5	8	8
Total sample	50	60	51
% Twins	10	13	16

[a] Includes data from surveys when paired helicopter/fixed-wing observations were made (20 and 21 May) and when only fixed-wing observations were made (24 May).

Table 7. Summary of pregnancy and condition-related indices among 37 adult cow moose captured 11-13 April 1989, Subunit 20A.

Capture area	Mean total length, cm (SD)	Mean hind foot length, cm (SD)	Mean girth, cm (SD)	Mean condition class (range)	Packed cell volume % (SD)	Pregnancy rate (%)	Sample size
Tanana Flats	293.2 (11.2)	89.2 (2.7)	184.0 (11.5)	7.0 (5-8)	47.3 (2.7)	92	25
Foothills and mountains	290.8 (10.4)	89.6 (2.3)	189.8 (14.5)	7.3 (6-8)	47.8 (2.2)	92	12
Total 20A	292.4 (10.8)	89.3 (2.6)	185.9 (12.7)	7.1 (5-8)	47.5 (2.5)	92	37

Table 8. Moose harvest in Subunit 20A, 1963-87.[a]

Year	Harvest	% Females in harvest
1963	302	31
1964	274	26
1965	335	22
1966	216	24
1967	299	40
1968	377	31
1969	376	29
1970	449	33
1971	483	30
1972	699	41
1973	964	51
1974	489	47
1975	63	0
1976	62	0
1977	50	0
1978	80	0
1979	130	0
1980	207	0
1981	277	0
1982	291	0
1983	399	0
1984	390	0
1985	360	0
1986	420	0
1987	301	0
1988	351	0

[a] Includes harvests in those portions of current Subunit 20A that were within Subunit 20C prior to 1984.

Table 9. Distribution of moose harvested in Subunit 20A, 1984-88.

Location (Uniform Code Units)	Year 1984	1985	1986	1987	1988
Tanana Flats					
West of Wood River (0100, 0101, 0201, 0301)	48	32	43	50	45
Wood River (1/2 of 0400, 0401)	31	31	34	25	31
East of Wood River (0500, 0501, 0502, 0503, 0504, 0506, 1/2 of 0507, 0185)	124	144	134	85	107
East of Little Delta River (0601, 0701, 0800, 0801)	22	14	17	12	18
Foothills and Mountains					
Western (0102, 0103, 0104, 0105, 0200, 0202)	52	45	57	40	34
Central (0300, 0302, 1/2 of 0400, 0402, 0403, 0404, 0405, 0505, 1/2 of 0507)	42	28	61	39	60
Eastern (0600, 0602, 0603, 0604, 0605, 0702, 0802, 0700)	27	37	40	27	33
Yanert Controlled Use Area (106, 107, 108, 109)	32	21	22	15	12
Unknown location 20A (0000)	12	8	12	8	11
Total Tanana Flats	225	221	228	172	201
Total foothills and mountains	153	131	180	121	139
Total Subunit 20A harvest	390	360	420	301	351

Table 10. Mean antler spread and percentages yearlings and large bulls in the 1988 Subunit 20A moose harvest.

Area[a]	Mean antler spread[b] ($\underline{n}$)	% Yearlings[c]	% Large bulls[d]
Tanana Flats			
West of Wood River	45.1 (42)	17	50
Wood River	45.6 (29)	3	38
East of Wood River	39.1 (97)	25	29
East of Little Delta River	44.6 (18)	11	39
Foothills			
Western	47.0 (29)	3	45
Central	46.7 (56)	11	48
Eastern	42.9 (33)	6	36
Yanert Controlled Use Area	49.3 (11)	18	73
Unknown location 20A	38.8 (10)	20	20
Total Flats	42.0 (186)	18	36
Total Foothills	46.0 (129)	9	47
Total Subunit 20A	43.5 (325)	14	40

[a] Uniform codes for each area are given in Table 9.

[b] Expressed in inches.

[c] Antler spreads $\leq$30 inches.

[d] Antler spread $\geq$50 inches.

Table 11. Moose hunter residency and success in Subunit 20A , 1985-88.

Year	Successful					Unsuccessful				
	Unit res.[a]	Other res.	Non-res.	Unk	Total	Unit res.	Other res.	Non-res.	Unk	Total
1985	265	39	40	16	360	695	97	27	36	855
1986	303	53	51	13	420	727	83	54	28	892
1987	178	51	34	38	301	565	106	31	67	769
1988	193	50	48	60	351	428	101	43	112	684

[a] Includes residents of Subunits 20A, 20B, 20C, and 20D.

Table 12. Moose harvest chronology in Subunit 20A, 1988.

Week	Harvest	% of total reported 9/1-9/20
9/1-9/6	112	34
9/7-9/13	103	31
9/14-9/20	118	35
Out of season or unknown	18	--
Total harvest	351	--

Table 13. Number of successful moose hunters and percentage of total successful hunters (in parentheses) by transport method, Subunit 20A, 1984, 1987, and 1988.

Year	Airplane	Horse	Boat	3- or 4-wheeler	Other ORV	Highway vehicle	Unknown
1984	136 (35)	24 (6)	112 (29)	28 (7)	40 (10)	34 (9)	16 (4)
1987	99 (33)	14 (5)	75 (25)	34 (11)	37 (12)	20 (6)	22 (7)
1988	133 (38)	18 (5)	87 (25)	31 (9)	42 (12)	18 (5)	22 (6)

Table 14. Moose population and mortality estimates derived from 1987 harvest and composition data in Subunit 20A, assuming zero growth since 1984.

Estimate	Adults			Yearlings			Calves			Total population
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
1987 prehunt population	1,044	4,587	5,631	517	517	1,034	868	868	1,736	8,401
Harvest	253	0	253	48	0	48	0	0	0	301
Posthunt population	791	4,587	5,378	469	517	986	868	868	1,736	8,100
Hunt mortality	24%	0	4%	9%	0	5%	0	0	0	4%
Expected prehunt population 1988	1,260	5,104	6,364	868	868	1,736	868	868	1,736	9,836
Projected annual growth rate with zero natural mortality[a]	21%	11%	13%	68%	68%	68%	--	--	--	17%
Mortality (nonhunting) required to obtain zero growth; assumes current hunting level	17%[b]	10%[b]	12%[b]	40%[c]	40%[c]	40%[c]	-[d]	-[d]	-[d]	15%[e]

[a] Growth and mortality rate estimates differ because growth was calculated as a function of 1987 prehunt population; mortality was calculated as a function of 1988 prehunt expected population. Assume current hunting mortality.

[b] Includes mortality of the posthunt yearling cohort from 1 October 1987 to 1 September 1988.

[c] Reflects mortality of posthunt calf cohort from 1 October 1987 to 1 September 1988.

[d] Prehunt calf mortality is already included in prehunt population estimate because that estimate is derived from posthunt composition value.

[e] Combined adult/yearling mortality to achieve zero growth.

Table 15. Relationship of growth rates, mortality, and recruitment of adult moose (excluding calves) in Subunit 20A, 1978-88.

Subpopulation	Year	Natural mortality $(M_n)^a$	Hunting mortality $(M_h)^b$	Yearling recruitment $(R)^c$	Annual growth rate $(\lambda)^d$
Tanana Flats	1978	0.01	0.04	0.26	1.28
	1982	0.06	0.07	0.26	1.18
	1988	0.08	0.05	0.17	1.04
Alaska Range Foothills	1978	0.05	0.02	0.16	1.11
	1984	0.05	0.06	0.16	1.06
	1988	0.15	0.04	0.20	1.02

[a] $M_n = 1 - [\frac{(\lambda(1-R))}{1-m_h}]$

[b] $M_h = \frac{\text{harvest}}{\text{total adult population}}$

[c] $R = \frac{\text{yrlgs.}}{\text{adults + yrlgs.}}$

[d] Values for 1978 and 1988 were calculated from the 1978-82/84 and 1982/84-1988 census intervals. Values for 1982 and 1984 were estimated assuming a linear decline in growth rates between 1978 and 1988.

Appendix A. Calculation of harvest quota for 1989 hunting season in Subunit 20A.

Estimated bull natural mortality (17% from Table 15 for zero growth minus 3.2% estimated annual growth from 1984 to 1988 census)	13.8%

Harvest Quota Calculation:

1988 posthunt adult bulls	1,312
1988 posthunt yearling bulls	+614
1988 posthunt total bulls	1,926
1988 natural mortality (13.8%)	-266
1989 prehunt adult bulls	1,660
1989 prehunt adult bull population necessary for 3.2% growth	-1,354
1989 adult bull harvestable surplus	306

STUDY AREA

GAME MANAGEMENT UNIT: 20B and 25C (15,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Fairbanks and central Tanana Valley

BACKGROUND

Extensive wildfires and the poisoning and aerial shooting of wolves in the 1950's allowed moose numbers to increase and reach high levels in Subunit 20B by 1965. Then 3 severe winters, increasing wolf predation, and liberal either-sex hunting seasons combined to reduce moose numbers. By 1976 moose densities were low and the hunting season had been reduced to 10 days in most of Subunit 20B.

Wolf control in Subunit 20A (1976-82), central Subunit 20B (1982-84), and western Subunit 20B (1984-86) allowed moose populations to recover. As moose numbers increased, hunting seasons were extended from 10 days in 1981 to 20 days from 1983 to 1987. Harvests increased, then stabilized from 1983 to 1986 at approximately 300 bulls per year. During 1987 and 1988, harvests increased to approximately 375 bulls each year, despite a 5-day reduction in the 1988 moose season.

Wolves were not controlled in Subunit 25C; consequently, the moose population did not increase during the early 1980's, and densities were low during the reporting period. The harvests in Subunit 25C have ranged from 25 to 44 bulls since 1983.

Demand for opportunities to hunt moose were high and expected to increase in both Subunits 20B and 25C. Extensive highway systems and numerous mining trails provide motorized access. Waterway access is available along the Tanana, Chena, Salcha, and Chatanika Rivers in Subunit 20B, and along Beaver Creek, Birch Creek, and the Chatanika River in Subunit 25C.

Unit boundaries were changed in 1981, increasing the size of Subunit 20B and creating Subunit 25C. For management purposes, the portion of Subunit 20B west of Fairbanks has been commonly referred to as western Subunit 20B, the portion east of Fairbanks and west of the Salcha River drainage has been referred to as central Subunit 20B, and the Salcha River drainage has been referred to as eastern Subunit 20B. Formerly, the eastern and western portions of present-day Subunit 20B and the entire area of Subunit 25C were managed as Subunit 20C.

POPULATION OBJECTIVES

To increase the moose population to 10,000 by 1993: 4,000 in western Subunit 20B and 6,000 distributed over central and eastern Subunit 20B.

To maintain a minimum bull:cow ratio of 20:100 in each trend count area and an overall Subunit 20B bull:cow ratio of at least 30:100.

To sustain an annual harvest of at least 300 bulls in Subunit 20B.

To increase survey coverage of the Subunit 25C moose population and derive a population estimate by 1990.

To provide annual harvests of 30-50 bull moose and an overall bull:cow ratio above 30:100 in Subunit 25C.

METHODS

Aerial surveys were flown in only 1 trend area each in Subunits 20B and 25C during 1988. Each trend area was less than 100 mi^2, and surveys were conducted at intensities of approximately 4 min/mi^2. It was assumed that most moose within the sampled area were observed and substantial changes in moose density from year to year reflected population changes.

Measurements and weights from road-killed moose were recorded from moose salvaged by the Fairbanks Alternative Placement Center (FAPC) between 1 September 1987 and 30 August 1988. The entire remains of road-killed moose were transferred to the FAPC facility in Fairbanks, generally within 4 hours of the animals' deaths. Department biologists examined the carcasses within 12 hours of death.

RESULTS AND DISCUSSION

Population Size and Trend

During the most recent (1985) stratificaion survey in Subunit 20B, 6,900 moose were counted; 1% of the area was classified as very high density, 6% as high density, 17% as medium density, 54% as low density, 17% as very low density, and 5% as non-moose habitat. Density values for each strata were estimated from intensive surveys flown over approximately 10% of the total stratification area. Densities for the very high, high, medium, low, and very low strata were 5.7, 2.0, 1.4, 0.6, and 0.04 $moose/mi^2$, respectively.

Relative to the 1984-85 reporting period, observed densities in established trend areas during 1987 were higher in western Subunit 20B and lower in central Subunit 20B. The only trend area survey during 1988 was conducted in the Salcha River drainage of eastern 20B. The observed moose density there was higher than those of previous years (Table 1). Although, distribution of the population appears to be changing, there is insufficient evidence to conclude the overall population size has changed since 1985.

Distribution and Movements:

Although radiotelemetry data have documented movement of moose from areas within Subunits 20B and 25C to the Tanana Flats in Subunit 20A during the March-May period and their return to wintering areas during the August-October period, some do not migrate. Ten female moose radio-collared on the Minto Flats during March 1984 remained on the Minto Flats during all seasons, and their maximum movements from the capture sites ranged from 4.5 to 21.5 miles ($\bar{X}$ = 10.3). When last located in the summer of 1986, moose with functioning radio collars were all within 10 miles of their original capture sites.

Population Composition:

During 1988, 270 moose were classified during 8.6 hours of aerial survey in the Salcha River drainage of Subunit 20B. The bull:cow and calf:cow ratios were 22:100 and 20:100, respectively (Table 2). No aerial surveys were conducted in the remainder of Subunit 20B. Between 1983 and 1987, bull:cow ratios declined in central and eastern 20B. During the reporting period, bull:cow ratios in both areas were near the minimum population objective of 20:100.

Composition data from the Minto Flats indicated calf recruitment and incidence of twins were consistently good between 1983 and 1987. No aerial surveys were conducted during 1988. The Minto subpopulation (i.e., youngest, most vigorous in Subunit 20B) has the greatest potential for continued population growth.

In Subunit 25C, composition data have been collected since 1985 in only 1 trend area. Because that survey area was lightly hunted, bull:cow ratios were high. Although calf:cow ratios were low during 1985 and 1986, they were substantially higher in 1987 and 1988 (Table 2).

Mortality

Seasons and Bag Limits:

The open season for resident and nonresident hunters in that portion of Subunit 20B within the Fairbanks Management Area is 1-30 September and 21-27 November. The bag limit is 1 bull by bow and arrow only. The open season for subsistence hunters in that portion of Subunit 20B within the Minto Management Area is 1-20 September and 10 January-28 February. The bag limit is 1 bull by registration permit only. The season will be closed when 15 bulls have been taken.

The open season for all hunters in that portion of Subunit 20B containing the Middle Fork of the Chena River and the portion of the Salcha River drainage upstream from and including Goose Creek is 1-20 September. The bag limit is 1 bull. The open season for subsistence hunters in the remainder of Subunit 20B is 1-20 September. The open season for resident and nonresident hunters in the same area is 1-15 September. The bag limit for all hunters is 1 bull. The open season for all hunters in Subunit 25C is 5-15 September. The bag limit is 1 bull.

Harvest

Human-induced Mortality:

During the 1988 general season, 2,091 hunters reported harvesting 356 moose in Subunit 20B (Table 3). An additional 130 hunters reported killing 20 bulls during the Minto registration hunt. Other documented sources of human-induced mortality included road and train kills. Total known human-induced mortality was 484 moose, or 7% of the estimated population during the 1988-89 regulatory year (Table 4). Additional mortality from crippling loss, poaching, and unreported legal harvest probably put total human-induced mortality at 8-10% of the estimated Subunit 20B moose population. At least 55 of the 107 road- and train-killed moose were adult females (Table 5). The greatest road kill for a single month occurred during September, the period when moose migrate from the Tanana Flats to winter ranges in the surrounding foothills (Table 6).

Mean antler spread of bulls harvested in Subunits 20B and 25C in 1987 were 34.6 inches and 39.8 inches, respectively. In Subunit 20B the percentage of yearlings in the harvest was lowest in western Subunit 20B and highest in central Subunit 20B. Those values reflected the higher exploitation rate of moose in central Subunit 20B, where a larger proportion of the available bulls were yearlings. In western Subunit 20B the harvest is partly restricted by registration hunt No. 985, and survival of all age classes of bulls was higher than in the remainder of the subunit. That pattern was also reflected in mean antler sizes, which were highest among harvested bulls in western Subunit 20B and lowest in central Subunit 20B (Table 7).

During 1988, 27 bulls were reported killed by 185 hunters in the Fairbanks Management Area (Table 8). Although interest appeared to be high in that archery hunt, I suspect some of the reported hunting pressure actually occurred in areas immediately adjacent to the archery area by hunters using firearms. The current harvest ticket system does not allow accurate calculation of archery-hunting activity.

Although only 1 moose was reported killed for a funeral potlatch in Subunit 20B on 10 March 1989; R. Silas (pers. commun.) estimated 2 or 3 moose are taken each year by rural residents of Subunit 20B for funeral potlatches. In Subunit 25C, 123 hunters reported taking 44 bulls during 1988 (Table 9). No data were available for road-killed moose in Subunit 25C, but it was not believed to be high.

Assessment of Moose Condition:

Samples were collected from 35 moose between 1 September and 12 August 1988 to assess moose condition, including 27 moose killed by vehicles, six killed by hunters, four killed by wolves, and two that died of malnutrition. Data from samples collected through June 1988 were presented in McNay (1989). Information from samples collected in July and August 1988 is provided in Table 10, and indices of body condition from September 1987 to August 1988 are provided in Table 11. The winter of 1987-88 was chracterized by shallow snow depths and mild temperatures. Samples were not collected during the winter of 1988-89, when snow was deeper and temperatures colder.

Hunter Residency and Success. During 1988, 65% of the Subunit 20B hunters and 53% of the Subunit 25C hunters were from Fairbanks. Rural residents accounted for only 5% and 8%, respectively, of the hunting pressure in Subunits 20B and 25C (Table 12). Fairbanks hunters took 63% and 48%, respectively, of the harvests in Subunits 20B and 25C. These values represent reported harvests and hunting participation. Because reporting rates among rural residents are lower than among urban-based hunters, both harvest and hunting pressure by rural residents were greater than reflected by harvest ticket returns.

Permit Hunts. Since 1979 hunting for moose within the Minto Management Area has been by permit only; since 1986 only residents of Minto and Nenana have been eligible for registration permits. During the 1987-88 regulatory year, 130 permittees reported taking 20 moose (Table 13). The harvest quota was 15 moose. Chronically late reporting has made administration of this hunt difficult. During the next reporting period proposals will be drafted to increase the annual quota of moose and/or to reinstate participation in this hunt by the general public.

Harvest Chronology. Between 1984 and 1988 the moose season lasted 3 weeks (1-20 September). Harvests were distributed evenly among the three 1-week periods (Table 14). Approximately 10% of the harvests since 1984 have occurred on opening day.

Transport Methods. From 1984 to 1988 most hunters (57%) used highway vehicles for transportation. Boats (21%), three-wheelers (11%), and other offroad vehicles (9%) were also commonly used. Aircraft were only used by 1% of the hunters; horses, by less than 1% of the hunters. Hunters using highway vehicles had the lowest success rate (14%), while hunters using aircraft had the highest success rate (29%). Patterns of transportation use have not substantially differed among years (Table 15).

Habitat

During April 1987 the military proposed improvement of roads on Eielson Air Force Base that could potentially damage or destroy heavily used moose mineral licks. Inspection of the mineral licks by ADF&G biologists was followed by written recommendations to modify construction plans to protect the existing mineral licks. As of fall 1988 the military had postponed major road alterations in the mineral lick area.

Game Board Actions and Emergency Orders

An increase in harvest, declining bull:cow ratios, and evidence of low recruitment in some areas of Subunit 20B prompted the Department to recommend reducing the harvest in Subunit 20B. A proposal was presented to the Board of Game in March 1987: (1) restrict the harvest in the eastern and central portions of Subunit 20B to bull moose having either a spike or fork antler or an antler spread of 50 inches or more or at least 3 brow tines on either antler, (2) reduce the season length from 20 days to 15 days, and (3) implement a drawing-permit system.

Although the problems associated with an increasing harvest did not affect all areas of Subunit 20B, the option to reduce lengths of seasons included all road-connected portions of the subunit. If the length of the season was reduced in only part of Subunit 20B, hunting pressure would be displaced along the road system to areas having traditionally lower harvests, thereby requiring harvest reductions in subsequent years.

Initially, the use of antler restrictions to reduce the harvest in portions of Subunit 20B was the Department's preferred alternative; however, vocal public opinion appeared to be against that alternative. Those opposed to antler restrictions believed the average hunter would have difficulty identifying legal bulls. The Board of Game acknowledged the need to reduce the moose harvest in Subunit 20B and adopted the reduced-season-length option, which was implemented during the fall of 1988. No recommendations were made to change seasons or bag limits during the spring 1989 Board of Game meeting.

CONCLUSIONS AND RECOMMENDATIONS

The moose population in Subunit 20B was below the population objective of 10,000. Moose populations are expected to continue to increase in western Subunit 20B, and recently improved calf recruitment should provide for population growth in central Subunit 20B. Poor calf recruitment in the lower Salcha River drainage has restricted population growth; however, higher calf recruitment and good yearling survivals in the upper Salcha River in recent years have created the potential for slow increase in eastern Subunit 20B.

Bull:cow ratios in central and eastern Subunit 20B were also below population objectives. Harvests in Subunit 20B were stabilized but not reduced by the shortened hunting season in 1988. Bull:cow ratios are expected to slowly increase.

The increasing moose population in western Subunit 20B is expected to reach the population objective of 4,000 moose in the early 1990's. A population estimation survey of western Subunit 20B is planned for 1989. Dependent on the results of that survey, an increase in the allowable harvest may be warranted. Such an increase in harvest could include allowing general public participation in the Minto Flats Management Area hunt, which has been open only to subsistence hunters.

I suspect predation is significant in limiting moose population growth in both central and eastern Subunit 20B; however, there are little data available regarding current predator densities. Habitat may also be a limiting factor, especially in eastern Subunit 20B. Management activities during the next 3 years will include gathering information to assess the significance of predation and habitat on moose populations in eastern Subunit 20B. Selection and mapping of specific habitat-deficient areas is needed so that future decisions regarding fire suppression can be influenced by preestablished habitat improvement priorities. Fire is the most practical tool for enhancing moose habitat in Interior Alaska. Increased coordination with the land and fire management agencies is needed to maximize the benefits to moose from naturally occurring fires.

The winter of 1988-89 was more severe than the previous 2 winters; i.e., greater snow depth and a 3-week period of extreme cold. Although numerous reports of winter-killed moose were received from the public, weather-related mortalities did not cause an overall reduction in the Subunit 20B or 25C moose populations.

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Table 1. Observed densities (moose/mi^2), excluding calves in Subunit 20B and Subunit 25C trend areas, 1983-88.[a]

Year	Baker Creek[b]	Hutlinana Creek[b]	Tolovana River[b]	Swanneck Slough[b]	Tatalina River[b]	Colorado/ Sorrels Creek[c]	Ninety-eight Creek[d]	N. Fork Salcha River[d]	O'Brien Creek[e]
1983	0.5	--	--	--	--	1.3	--	--	--
1984	--	--	--	1.5	0.8	1.9	--	--	--
1985	1.1	1.1	1.0	1.4	0.8	--	3.5	2.6	1.3
1986	--	--	0.9	--	1.5	--	3.2	3.3	1.4
1987	--	0.7	1.2	1.7	1.1	1.6	2.0	--	1.3
1988	--	--	--	--	--	--	4.0	--	1.8

[a] Densities calculated from only those portions of trend areas that were flown each year.

[b] Western Subunit 20B.

[c] Central Subunit 20B.

[d] Eastern Subunit 20B.

[e] Subunit 25C.

Table 2. Fall moose composition data, Subunits 20B and 25C, 1983-88.

Trend areas	Location/ date	Bulls: 100 cows	Calves: 100 cows	% Calves	% Twins among cows w/calves	n	Search area (mi^2)
Baker Creek/	Western 20B						
Hutlinana Creek	1983 (Baker only)	140	0	0	0	24	50.0
	1985	109	23	10	16	123	99.3
	1987 (Hutlinana only)	107	29	12	0	33	39.5
Lower Tolovana/	Minto Flats						
Swanneck Slough	1985	57	47	23	23	118	75.7
	1986 (Tolovana only)	77	50	22	10	50	57.1
	1987	37	41	23	10	146	75.7
Tatalina River	Minto Flats						
	1983	39	43	24	43	42	38.3
	1984	41	41	23	13	40	38.3
	1985	35	44	24	29	111	51.8
	1986	29	39	23	14	104	61.3
	1987	38	58	29	26	102	62.0
Creamers/	Fairbanks Management Area						
Goldstream	1985	50	71	32	13	53	19.3
	1986 (Goldstream)	29	43	25	0	12	12.4
	1987	33	56	29	11	34	30.8
Sorrels Creek	Central 20B						
	1983	42	38	21	0	94	49.7
	1984	43	36	20	8	133	37.9
	1985	33	54	29	11	107	72.1
	1987	20	41	25	2	169	73.6

Table 2. Continued.

Trend areas	Location/ date	Bulls: 100 cows	Calves: 100 cows	% Calves	% Twins among cows w/calves	n	Search area (mi^2)
Colorado Creek	Central 20B						
	1983	45	39	21	0	81	79.8
	1984	22	58	32	11	66	41.0
	1985	14	29	20	0	132	104.7
	1986	39	61	31	0	36	31.0
	1987	19	53	31	4	98	92.8
Ninetyeight Creek	Eastern 20B						
	1984	27	23	15	0	84	33.6
	1985	18	37	24	9	299	88.7
	1986	23	23	16	3	230	77.2
	1987	16	32	22	5	193	65.2
North Fork Salcha	Eastern 20B						
	1985	38	34	20	19	200	69.4
	1986	45	25	15	14	227	56.8
O'Brien Creek	Central 25C						
	1985	84	18	9	16	99	68.3
	1986	98	19	9	11	102	68.3
	1987	82	31	14	19	104	68.3

Table 3. Summary of harvest and hunting pressure in Subunit 20B, 1984-85 to 1988-89.[a]

	Regulatory year									
	1984-85		1985-86		1986-87		1987-88		1988-89	
Area (coding unit)	Harvest	Hunters	Harvest	Hunters	Harvest	Hunters	Harvest	Hunters	Harvest	Hunters
Eastern 20B										
Upper Salcha (0603, 0604, 0605)	5	12	7	24	7	24	7	21	3	20
Lower Salcha & Little Salcha (0600, 0601, 0602, 0683, 0684)	53	305	56	301	52	261	54	225	41	235
Subtotal	58	317	63	325	59	285	61	246	44	255
Central 20B										
French & Moose Creek (0500, 0501, 0583, 0584)	17	176	21	227	18	211	25	216	31	220
Little Chena River (0403)	17	91	20	89	23	87	19	79	15	74
Chena River (0400, 0402, 0404, 0405, 0406, 0486)	80	543	66	588	60	483	68	515	69	570
Upper Chatanika River (0209, 0287)	22	80	15	84	19	87	18	109	21	90
Subtotal	136	890	122	988	120	868	130	919	136	954
Fairbanks Management Area (0401, 0482, 0483, 0484 0213, 0485, 0487)	15	285	14	174	19	217	20	260	27	185

Table 3. Continued.

Area (coding unit)	1984-85 Harvest	1984-85 Hunters	1985-86 Harvest	1985-86 Hunters	1986-87 Harvest	1986-87 Hunters	1987-88 Harvest	1987-88 Hunters	1988-89 Harvest	1988-89 Hunters
	Regulatory year									
Western 20B										
Minto Management Area (Permit Hunt 985)	12	100	6	60	9	118	17	118	20	130
Minto Flats (0201, 0205, 0210, 0281)	8	58	7	31	9	44	5	50	18	50
Washington Creek, Middle Chatanika (0208, 0207, 0214)	19	146	26	117	19	102	30	158	34	183
Upper Tatalina (0206)	3	13	3	16	6	24	12	34	6	21
Tolovana River and West Fork (0200, 0202, 0203, 0204)	31	180	24	184	27	142	37	95	24	92
Dugan Hills-Manley (0100, 0101, 0102, 0156, 0188)	12	75	12	54	10	79	25	83	23	108
Upper Goldstream (0211, 0212, 0282, 0289)	21	83	18	81	10	91	14	70	18	69
Parks Highway (0300, 0301, 0385, 0285)	14	74	6	34	14	58	13	73	12	54
Subtotal	120	729	102	577	104	658	153	681	155	707
Unknown location 20B (0000)	4	103	1	97	13	96	9	96	14	120
Total Subunit 20B	333	2,324	302	2,161	315	2,124	373	2,202	376	2,221

[a] Harvest corrected for double reporting by successful hunters on Minto Flats in registration hunt 985.

Table 4. Known human-induced moose mortality in Subunit 20B, 1984-88.

Year[a]	Mortality source: Reported potlatch moose	Legal reported hunting	Road kill[b]	Train kill	Total
1984	--	333	63	--	396
1985	--	302	81	--	383
1986	--	315	78	6	399
1987	0	373	64	3	440
1988	1	376	79	28	484

[a] Regulatory year in which hunting season occurred.

[b] Data updated and corrected in 1988; disagrees with previous S&I reports.

Table 5. Sex and age of road-killed and train-killed moose in Subunit 20B, 1 July 1988-30 June 1989.

Mortality source	Cows	Bulls	Calves	Unknown	Total
Road	37	7	21	14	79
Train	18	5	2	3	28
Total	55	12	23	17	107

Table 6. Chronology of road and train related moose mortality in Subunit 20B, 1 July 1988-30 June 1989.

	1988						1989					
Mortality	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Road kill	2	7	20	3	4	18	9	11	2	3	0	0
Train kill[a]	--	--	--	--	3	3	5	6	11	0	--	--
Total	2	7	20	3	7	21	14	17	13	3	0	0

[a] Railroad records are not available for the summer months May through October.

Table 7. Mean antler size and percentage of yearlings and large bulls in the 1988 harvest, Subunits 20B and 25C.

Area	Mean antler spread[a] ($\underline{n}$)	% Yearlings (≤30")	% Large bulls (≥50")
Eastern 20B			
Upper Salcha	30.7 (2)	0	0
Lower & Little Salcha	33.5 (37)	32	8
Subtotal	33.4 (39)	31	8
Central 20B			
French & Moose Creek	31.2 (26)	58	4
Little Chena River	32.7 (13)	31	8
Chena River	29.8 (57)	51	7
Upper Chatanika	40.7 (18)	17	22
Subtotal	32.2 (114)	45	9
Fairbanks Management Area (FMA)	28.7 (22)	59	0
Western 20B			
Minto Flats (includes MMA)	42.4 (33)	6	27
Washington Creek/ mid-Chatanika River	33.9 (30)	32	43
Upper Tatalina	37.2 (5)	20	20
Tolovana River & W. Fork Tolovana	36.5 (24)	38	13
Dugan Hills-Manley	41.4 (21)	9	14
Upper Goldstream	30.9 (13)	46	8
Parks Highway	34.6 (11)	18	0
Subtotal	37.5 (137)	23	14
Unknown location 20B	40.2 (13)	23	23
Total Subunit 20B	34.6 (325)	34	13
Total Subunit 25C	39.8 (40)	17	20

[a] Measured in inches.

Table 8. Fairbanks Management Area moose harvest and hunting pressure, 1984-88.[a]

Year	Harvest chronology: Sep	Nov	Unknown	Total harvest	Total hunters
1984	13	1	1	15	285
1985	13	1	0	14	174
1986	16	1	2	19	217
1987	17	1	2	20	260
1988	22	2	3	27	185

[a] The current harvest reporting system is inadequate to identify archery-only hunting. The data above probably include some hunting activity by hunters using firearms, although it was coded to the archery hunting area.

Table 9. Harvest and hunting pressure in Subunit 25C, 1983-88.

Year	Harvest	Total hunters	% Success
1983	26	130	20
1984	25	100	25
1985	29	101	29
1986	32	108	29
1987	27	97	28
1988	44	123	36

Table 10. Measurements from road-killed and hunter-killed moose, July-August 1988.[a]

Date of kill	Cause of death[b]	Accession No.	Sex	Age	Total weight (lbs)[c]	Lengths (mm)				% Fat			Time since death
						Hind foot	Femur	Meta-tarsal	Jaw	Femur	Meta-tarsal	Kidney[d]	
7/24/88	RK	115868	F	Calf	198	--	290	--	271	66	63	12	8 hrs
7/30/88	RK	115869	F	Yrlg	591	765	411	384	402	75	73	30	8 hrs
8/01/88	RK	115870	M	Calf	206	602	0	305	--	82	73	10	9 hrs
8/05/88	RK	115871	F	Adult	733	810	483	--	--	90	--	117	16 hrs
8/12/88	HK	115872	F	Adult	913	815	468	414	484	86	77	43	3 hrs

[a] Measurements of 23 additional moose given in 1987-88 S&I report (McNay 1989).

[b] Cause of death: RK = road kill, HK = hunter kill.

[c] Some body fluid loss at kill site; total weights based on summed weights of all body parts; blood and viscera stored in leak-proof containers.

[d] Kidney fat index = $\frac{\text{weight of fat}}{\text{weight of kidney w/o fat}} \times 100$ (averaged from both kidneys).

Table 11. Mean conditionrelated measurements from road-killed moose, September 1987-August 1988, Subunit 20B.

	Adult females			Yearlings			Calves		
Months	Mean whole wt (n)	% Marrow fat (n)	Kidney fat index (n)	Mean whole wt (n)	% Marrow fat (n)	Kidney fat index (n)	Mean whole wgt (n)	% Marrow fat (n)	Kidney fat index (n)
Sep-Oct	901 (4)	93 (5)	108 (5)	545 (2)	89 (2)	87 (2)	424 (1)	75 (1)	43 (1)
Nov-Dec	973 (1)	87 (1)	138 (1)	--	--	--	434 (3)	51 (3)	18 (3)
Jan-Feb	840 (1)	92 (1)	82 (1)	--	86 (1)	31 (1)	420 (1)	28 (2)	12 (2)
Mar-Apr	870 (1)	86 (1)	79 (1)	--	--	--	429 (3)	25 (4)	11 (3)
May-Jun	787 (1)	54 (1)	11 (1)	437[a] (1)	34 (1)	8 (1)	--	--	--
Jul-Aug	823 (2)	88 (2)	80 (2)	591 (1)	74 (1)	30 (1)	202 (2)	71 (2)	11 (2)

[a] 12- to 13-month-old female killed 13 June.

Table 12. Distribution of harvest by hunter residency, Subunits 20B and 25C, 1988.

Subunit	Residency	Total hunters	Harvest	% Success	% of Total harvest	% of Total hunters
20B	Rural[a]	115	31	27	8	5
	FNSB[b]	1,405	234	17	63	65
	Other Alaska resident	215	32	15	9	10
	Nonresidents	66	15	23	4	3
	Aliens	0	0	--	0	0
	Unknown residency	356	62	17	17	17
25C	Rural[c]	10	3	30	7	8
	FNSB[b]	65	21	32	48	53
	Other Alaska resident	26	9	35	20	21
	Nonresidents	3	0	0	0	2
	Aliens	0	0	--	0	0
	Unknown residency	19	11	58	25	15

[a] Subunit 20B rural residents include residents of Manley, Minto, Nenana, and Tanana.

[b] Fairbanks North Star Borough includes Fairbanks, Ester, Salcha, Ft. Wainwright, Eielson AFB, and North Pole.

[c] All residents of 25C.

Table 13. Summary of Minto moose registration hunt #985, 1979-88.

	Total hunters			%	Harvest by hunter residency				Total harvest by season	
Year	Minto	Nenana	Other	Reporting	Minto	Nenana	Other	Unk	Fall	Winter
1979	65	10	113	90	2	0	4		Sep season only	
1980	28	25	25	76	2	0	3		--	--
1981	34	25	25	68	2	0	5		6	1
1982	41	25	25	48[a]	2	0	4		5	2
1983	50	25	25	52	7	1	8		16	0
1984	No data				6	1	2	3	9	3
1985	60 permits by Tier II drawing			43	4	0	2		6	0
1986	58	56	4	100	7	1	1		8	1
1987	49	69	0	86	12	5	0		16	1
1988	48	72	10	82	9	5	6		18	2

[a] No reminder letter sent; telephone survey conducted to obtain harvest information.

Table 14. Chronology of harvest[a], Subunit 20B, 1984-88.

Time period	1984 Harvest	1984 % of Total	1985 Harvest	1985 % of Total	1986 Harvest	1986 % of Total	1987 Harvest	1987 % of Total	1988 Harvest	1988 % of Total
Opening day	36	13	24	9	34	12	22	7	41	12
Week 1[b,c]	134	46	97	35	99	34	101	30	142	41
Week 2	82	28	97	35	100	34	128	38	141	41
Week 3	77	26	79	29	91	31	104	31	62	18

[a] Does not include harvest reported taken before or after regular season.

[b] Dates for weeks are as follows:

1984: 1 - 9/1-8
2 - 9/9-15
3 - 9/16-20

1985: 1 - 9/1-7
2 - 9/8-14
3 - 9/15-20

1986-88: 1 - 9/1-6
2 - 9/7-13
3 - 9/14-20

[c] Week 1 data include opening day harvest.

Table 15. Summary of hunter transport methods used by successful (S) and unsuccessful (US) hunters in Subunit 20B, 1984-88.[a]

Transport method	1984		1985		1986		1987		1988		1984-88 % of all hunters
	S	US	S	US	S	US	S	US	S	US	
Airplane	10	14	4	20	8	22	9	19	7	20	1
Horse	5	8	1	9	1	9	2	13	4	8	<1
Boat	63	352	69	304	66	299	85	265	77	311	21
3-/4-wheeler	36	160	19	154	53	166	44	141	49	156	11
Snowmachine	1	5	0	7	1	2	0	4	1	5	<1
Other ORV	38	161	29	143	35	117	30	106	26	92	9
Hwy vehicle	140	961	145	926	127	846	171	894	168	877	57

[a] Between 1984 and 1988, 12-14% of reporting hunters did not indicate a transport method on their harvest report.

STUDY AREA

GAME MANAGEMENT UNIT: 20C and 20F (18,140 mi^2)

GEOGRAPHICAL DESCRIPTION: Drainages into the south bank of the Tanana River west of the Nenana River, the west bank of the Nenana River, and the Central Yukon River

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 have been low, relative to the population size; however, the unreported harvest may be substantial. Predation is suspected to be a major limiting factor, but data on predator populations are lacking. These areas contain large tracts of mature black spruce (i.e., poor quality moose habitat); however, many riparian areas, subalpine hills, and old burns have suitable habitat capable of supporting more moose.

Trends in moose populations have also been difficult to identify. Approximately 33% of the study area (6,034 mi^2) has been stratified; however, surveys to determine density, distribution, and composition have often been inconclusive because of small sample sizes or poor survey conditions.

Moose within Denali National Park and Preserve (DNP) have been studied more intensively than moose in the rest of Subunit 20C. These studies have included moose surveys conducted by DNP biologists since 1970 and a study of the movements and behavior of radio-collared moose.

POPULATION OBJECTIVES

To estimate hunting mortality and document nonhunting mortality when possible.

To provide an annual posthunting sex ratio of at least 30 bulls:100 cows.

To estimate moose densities by 1991.

To promote moose habitat enhancement by allowing natural fires to alter vegetation succession.

To establish moose definitive population objectives by 1992.

METHODS

We estimated moose mortality from harvest ticket reports and the Alaska Railroad's (ARR) record of moose-train collisions. These data were taken from computer summaries of harvest ticket reports prepared by Anchorage statistics section and summaries from the ARR. Within the study area, the ARR travels through Subunit 20C between railroad mileposts 327 (Windy) and 371 (Ferry).

To document distribution and relative abundance of moose, we stratified 1,064 mi^2 of the Tozitna River drainage in Subunit 20F from 14 to 26 November 1988. In this cooperative effort, the Bureau of Land Management (BLM) provided the funding and 1 observer and the Department provided 2 observers. At least 2 of the same observers and the same pilot participated in all flights to minimize differences in observer sightability. The area was stratified from a C-185 aircraft using methods described by Gasaway et al. (1986). Neither the Department, BLM, nor National Park Service (NPS) flew moose composition surveys in either subunit in 1988.

RESULTS AND DISCUSSION

Population Status and Trend

Subunits 20C and 20F support low-density moose populations that are probably stable; however, postrutting concentrations result in medium and high densities of moose in some areas. Data are insufficient to adequately determine the status or recent trends in the moose population throughout much of this area. Survey attempts have usually been inconclusive, because of either low numbers of moose observed, poor survey conditions, or small survey areas.

Population status and trend are better understood in DNP, because moose surveys have been conducted in the park since 1970; however, survey methods and areas have been inconsistent, so the results are difficult to compare. In 1984 Singer (1984) attempted a total count of the pre-1980 park lands by searching contiguous counting blocks of approximately 12 mi^2 at an intensity of 4-6 minutes/mi^2. He incorporated a correction factor for moose missed during the surveys; however, it was not derived in a manner that permitted calculation of confidence intervals as described by Gasaway et al. (1986). Singer (1984) concluded that between 1974 and 1984, numbers of moose were stable or had declined in the eastern park (i.e., where moose densities are highest), were stable or had increased in the central park, and had increased dramatically west of the McKinley River.

In 1986 after repeating surveys in Singer's 1984 survey areas, Meier (1986) concluded that moose numbers probably had not changed significantly since 1984. He also compared other portions of DNP and concluded that moose numbers had declined in the Stampede area, rapidly increased in the northwestern foothills of the Alaska Range, and not changed much in the Kantishna area.

Population Size:

Approximately 3,000 moose reside in Subunit 20C. This estimate was calculated by adding estimates from the 1984 stratification (i.e., 388-574 moose in the Minchumina area, excluding DNP; 38-55 moose in the lower Kantishna) (DuBois 1985a, b) to estimates from 1986 surveys for DNP (1,528-2,272) (Meier 1986). Because these estimates only applied to 66% of the subunit, the subtotal of approximately 2,500 moose (range = 1,954-2,901) was increased by several hundred moose to account for animals in the 4,000 mi^2 of unsurveyed land. These latter areas were assumed to contain mostly low densities of moose.

Although adequate data are not yet available to estimate the moose population in Subunit 20F, Osborne (1985) estimated that 377-558 moose resided in approximately 800-mi^2 of the Tozitna River drainage between its mouth and the confluence with Ptarmigan Creek and the drainages along the north bank of the Yukon River from the mouth of the Tozitna to Morelock Creek. He based his estimate on the numbers of moose observed during a stratification survey in early December.

Population Composition:

Within Subunit 20C, composition data are available from surveys in the Minchumina and Kantishna Trend Count Areas (TCAs), Dune Lake, and in DNP (Table 1). The 94-mi^2 Minchumina TCA was not surveyed in 1987 or 1988. This upland burn northeast of Minchumina was established to monitor status and trend of moose presumed to be available to hunters in the Lake Minchumina/Muddy River area in September. Moose are abundant in the lowland area near Minchumina during the hunting season, but largely absent during the early winter period when surveys are conducted. Stratification of the Lake Minchumina/upper Kantishna River in 1984 indicated that the Minchumina TCA was the only area in Subunit 20C where moose densities had been high in November. Based on seasonal moose movement patterns observed elsewhere in the Interior, D. Haggstrom (pers. commun.) assumed that many of the moose observed in November were the same ones available to hunters in September. However, data on moose movement patterns in this area are not available. Composition surveys were attempted in the Minchumina TCA in 1985 and 1986. Poor survey conditions in 1985 and failure to complete the survey in 1986 make interpretation of the data difficult. However, the consistently high bull:cow ratios (92:100 in 1985 and 110:100 in 1986) (Table 1) suggest that harvest levels have not been excessive.

Based on a 1984 stratification, the Lower Kantishna TCA was created in 1985. This TCA is used to monitor the status and trend of the subpopulation of moose in the lower Kantishna River, which is a popular hunting area for the residents of Nenana and other areas. In 1985 a small portion of the TCA (i.e., 37 mi^2) was intensively surveyed. Sixty-five bulls:100 cows, 4 yearling bulls:100 cows, and 24 calves:100 cows were observed. In 1987 a larger portion (i.e., 147 mi^2) was surveyed less intensively to get bigger sample sizes. Twenty-three bulls:100 cows, 6 yearling bulls:100 cows, and 58 calves:100 cows were observed. Results from the 1985 and 1987 surveys are difficult to compare because of small sample sizes and different survey methods; however, both surveys indicated poor yearling recruitment. Haggstrom (1986) suggested that poor calf and yearling survivals observed in 1985 might be due to predation by a large pack of wolves known to frequent the area. The 1987 bull:cow ratio was below our objective of 30 bulls:100 cows.

A small portion of the Dune Lake burn was surveyed for the first time in 1987. The preponderance of bulls suggested that harvests have not been excessive; 16 of 31 were bulls (6 yearlings, 5 medium, 5 large). Only 2 of 13 cows had calves, and none had twins.

Within the DNP, biologists counted 268 moose during the 1987 survey of 217 mi^2 in the Eastern Park count area (Dalle-Molle 1987). Bull:cow ratios declined from 44:100 in 1986 to 34:100 in 1987. The calf:cow ratio increased from 18:100 to 23:100, the second-highest one since 1974. Conversely, the 1987 yearling bull:cow ratio of 3:100 was the second-lowest one recorded for that area since 1974. Caution is necessary in interpreting these results because of varying survey techniques used throughout this period.

Within Subunit 20F, sex and age composition surveys have been attempted periodically since 1975. In 1975 reconnaissance flights were made over the riparian areas of Hess Creek, the Ray River, and the Big Salt River in a Cessna 185 to gather data on moose distribution and abundance. No substantial concentrations of moose were found, and no further surveys were planned. In 1981 a more intensive and systematic reconnaissance search was made in the Hess Creek drainage upstream from the Dalton Highway, but again very few moose were observed. In 1981 and 1982 subsequent composition surveys were conducted in one of the few areas that concentrations of moose had been seen (i.e., the divide between the Tolovana River and Hess Creek). In 1983 attempts were also made to survey the lower Tozitna River and upper Big Salt River. In all 3 years, however, numbers of moose observed and the area sampled were too small for meaningful interpretation of the data.

Distribution and Movements:

Between 1984 and 1988, stratification surveys of over 6,000 mi^2 (i.e., about 33% of Subunits 20C and 20F) confirmed the impression of overall low-density moose populations in these subunits. Seventy-three percent of the area stratified in Subunits 20C and 20F have had low moose densities, 21% had medium densities, and only 6% had high densities (Table 2). The range of density estimates for each strata were calculated by multiplying the observed density ($moose/mi^2$) times a correction factor of 2.5-3.7. This correction factor was calculated from other Interior surveys where the number of moose observed during stratification was compared with the number of moose observed during a subsequent survey (DuBois 1985a, b). With these correction factors, density estimates ranged from 0.01 to 0.16, 0.20 to 1.20, and 1.64 to 3.58 $moose/mi^2$ in the low-, medium-, and high-density strata, respectively. Of the 1,064 mi^2 stratified in the upper Tozitna River drainage in 1988, 64% had low, 33% had medium, and 3% had high moose densities. We did not estimate the density from data in this stratification, because the correction factors of 2.5 and 3.7 may not be appropriate. Within DNP, the Eastern Park area continues to have by far the highest density of moose; i.e., 1.4 $moose/mi^2$ in 1986 (Meier 1986).

Moose may be distributed differently during postrutting surveys than during the hunting season. For instance, there is indirect evidence that many moose in the Minchumina TCA in November were probably on the Muddy River drainage during September (Haggstrom 1986). Within DNP, 1986 surveys indicated a prevalence of bulls in the northwestern foothills of the Alaska Range and a relative scarcity of bulls in the flats to the north, which suggested an interchange of moose between these 2 areas (Meier 1986). However, according to data from radio-collared moose, most of the Eastern Park area moose are residents; only a few have ventured to the Toklat, Stampede, or Yanert areas (J. Dalle-Molle, pers. commun.). More data are necessary to determine movements and distribution of moose.

Generally moose are most abundant where willows are plentiful, such as in recently burned areas and riparian zones. Areas with medium or high densities of moose in Subunit 20C included the burn in the hills north of Minchumina and southwest of Wien Lake, the foothills of the Alaska Range in southwestern Subunit 20C, the lower Kantishna River along the eastern floodplain, the low-shrub area near Black Bear Lake, the northern subunit along the Tanana River, and possibly the burn near Dune Lake. In Subunit 20F, the highest densities of moose observed 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

Season and Bag Limit:

The open season for resident and nonresident hunters in Subunit 20C is 1-15 September. The open season for subsistence hunters is 1-20 September. The bag limit is 1 bull; however, white-phased or partial albino (more than 50% white) moose may not be taken. The open season for resident and nonresident hunters in Subunit 20F is 1-15 September. The open seasons for subsistence hunters are 1-15 September and 1-10 December. The bag limit is 1 bull.

Human-induced Mortality:

Most moose were harvested along waterways, roads, or close to villages. The reported harvest was relatively light, compared with the number of moose in the subunits (i.e., 3-4% of the estimated population), although unreported harvest may be substantial in both subunits. The level of harvest in some areas may be adversely impacting local subpopulations, particularly if moose remain in easily accessible areas throughout the year.

Subunit 20C

In 1988, 114 moose were killed by 267 hunters during 1,701 days of hunting. This hunting pressure was higher than the 1984-87 mean of 92 moose (range = 82-110) harvested by 256 (range = 203-302) hunters (Fig. 1). This increased success rate indicated that the elimination of the last 5 days of the season in 1988 was probably not responsible for the lowered success rate that year.

Thirty-five percent of the 1988 harvest came from the Kantishna River drainage (including 14% from Lake Minchumina), and 34% came from the Nenana River drainage within approximately 15 miles of the Parks Highway (Table 4). The number of moose hunters was much higher along the Parks Highway than in the Kantishna River drainage. Most harvested bulls had antler spreads between 30.0 and 39.9 inches (34%) or 50+ inches (31%) (Table 5). Yearlings (i.e., antlers <30 inches) composed 12% of the harvest.

There were 28 mortalities caused by moose-train collisions between milepost 327 and 371. Between November and April, trains killed 18 moose, 10 between Windy and Carlo. Although moose died in collisions with motor vehicle along the 60 miles of Richardson Highway in Subunit 20C, none of these records were located.

In June 1989, 2 bull moose were killed in Subunit 20C by residents of Tanana for the Nuchalawoyya Potlatch. In the spring of 1989 the Board of Game authorized the Department to issue a permit to the village of Tanana for the harvesting of up to 3 moose for this potlatch; the 3rd moose was harvested in Subunit 20F.

Subunit 20F

The 1988 reported harvest in Subunit 20F (31 moose) was 35% higher than the 1983-87 mean of 23 (range = 15-34) (Fig. 1). Most moose were harvested from drainages near the communities of Tanana and Manley Hot Springs and from Hess Creek (Table 4). Other than 1 moose taken in June for the Nuchalawoyya potlatch, no other mortalities were recorded.

The number of moose hunters in 1988 (98) was similar to the 1983-87 mean of 104 hunters. The hunter success rate in 1988 (32%) was the highest since the creation of the subunit in 1981. Hess Creek had by far the most hunters, because of access from the Dalton Highway and Yukon River Bridge.

Distribution of antler sizes among harvested bulls suggested the population is not being overharvested. The 1988 harvest included 41% bulls with ≥50-inch antlers and 10% yearlings (<30-inch antlers) (Table 5).

Hunter Residency and Success. During 1988, 94% of the 272 moose hunters with known residency were residents (Table 6). In Subunit 20C, 35% of the hunters were local residents (i.e., Clear, Healy, Lake Minchumina, Manley Hot Springs, Nenana, or Tanana), and they accounted for 42% of the harvest. In Subunit 20F, only 21% of the hunters were local residents (i.e., Tanana or Manley Hot Springs), and they accounted for 32% of the moose harvested.

Harvest Chronology. Data were summarized on a weekly basis; they did not indicate any consistent trend for either subunit. Chronology data will be summarized as daily totals to yield more meaningful results. No moose were reported harvested during the late season in Subunit 20F.

Transport Methods. Boats were the most common mode of transportation for moose hunters in both subunits. In 1988 boats were used by 44% and 57% of the moose hunters in Subunits 20C and 20F, respectively (Table 7).

Numerous lakes and gravel bars also provide airplane access. In Subunit 20F, relatively few hunters used aircraft (7% of hunters reporting transportation type since 1984); however, they usually had higher success rates than hunters using other types of transportation. In recent years, local residents have proposed creating a controlled-use area in the vicinity of Fish Lake (Subunit 20F) to prohibit the use of aircraft by moose hunters. However, such restrictions are inconsistent providing the greatest sustained opportunity to hunt and do not appear necessary at this time.

Natural Mortality:

Predation by wolves and bears accounted for most natural mortality of moose; however, our data on predator populations in most of these areas have been limited primarily to harvest data. In Subunit 20C, 4-12 wolves, 4-20 black bears, and 3-5 grizzly bears were reported harvested annually during the last 5 years. In Subunit 20F, 2-7 wolves, 6-12 black bears, and zero to 2 grizzly bears have been reported harvested annually during the last 5 years. Current NPS studies of wolf movements in and adjacent to DNP will increase our knowledge of predator-prey relationships in these areas. In addition to predation, another substantial cause of moose mortality in DNP was injuries related to rutting behavior (V. VanBallenberghe, pers. commun.).

Habitat

Habitat probably does not limit growth of the low-density moose population in either subunit. Although much of the area includes mature black spruce and birch-aspen stands that provide little available browse, suitable habitat is available in riparian and subalpine areas. Moose habitat could be enhanced by allowing natural fires to alter plant succession. In Subunit 20C, a patchwork of burns of various ages has also created favorable moose habitat (e.g., 1981 Dune Lake fire was 171,000 acres). In Subunit 20F, some riparian areas along major drainages and adjacent hillsides appear to be excellent moose habitat.

Game Board Actions and Emergency Orders

The Board of Game made several regulatory changes effective 1 July 1987. The opportunity for subsistence harvest of moose in Subunit 20F was increased by excluding nonsubsistence hunters from the late season and by changing the late season from 1-10 November to 1-10 December to allow for more reliable access. The Subunit 20C resident/nonresident season was shortened by 5 days. In response to a proposal from the Clear-Healy Advisory Committee, the Board of Game also prohibited moose hunters in Subunit 20C from shooting moose that were white-phased or partially albino (more than 50% white) to protect moose with this rare coloration.

In the spring of 1989 the Board passed a proposal from the village of Tanana to allow harvesting up to 3 moose per regulatory year for the Nuchalawoyya Potlatch. With this subsistence permit, the village is required to report to the Department the sex of the moose and location of harvest within 5 days.

CONCLUSIONS AND RECOMMENDATIONS

Moose hunting in DNP is prohibited for nonconsumptive, scientific, or educational uses. Within the remainder of these subunits, a 15-day hunting season provides opportunities for resident and nonresident hunters to harvest moose. Subsistence hunters have more liberal seasons, and the village of Tanana is permitted to take up to 3 moose for their Nuchalawoyya Potlatch.

To establish population objectives for moose in Subunits 20C and 20F by 1992, the dynamics of these populations should be better understood. Significant progress has been made toward reviewing the available data so that gaps in our knowledge can be identified. Important data needs include estimates of densities, mortalities, and recruitment.

Progress toward estimating moose densities in key areas of Subunits 20C and 20F has been slow. Widespread low densities will continue to require time-consuming, expensive surveys to gather adequate sample sizes, if traditional survey methods are used. In the past we have intensively surveyed relatively small areas to derive precise estimates of moose density. During the next reporting period we will explore the feasibility and desirability of establishing a less-precise density estimate for a larger area using less intensive surveys. This broader picture from revised survey techniques may better meet our management needs. This survey is scheduled for the fall of 1991.

The influence of mortality on moose population dynamics can best be understood with accurate estimates of harvest by humans and other predators. To obtain these estimates, I recommend that during the next few years we also (1) assess hunting pressures and reporting rates by monitoring hunter distribution, access, and success; (2) increase harvest reporting rates and decrease illegal take of cows by improving communication with local residents via public meetings, informal visits, or by letter; and (3) conduct an aerial wolf survey to gather data on predator populations in Subunits 20C and 20F.

Although growth of moose populations in most portions of Subunits 20C and 20F does not appear to be limited by food, I also recommend that we enhance moose habitat by allowing natural fires to alter vegetation. No changes in seasons or bag limits are recommended at this time.

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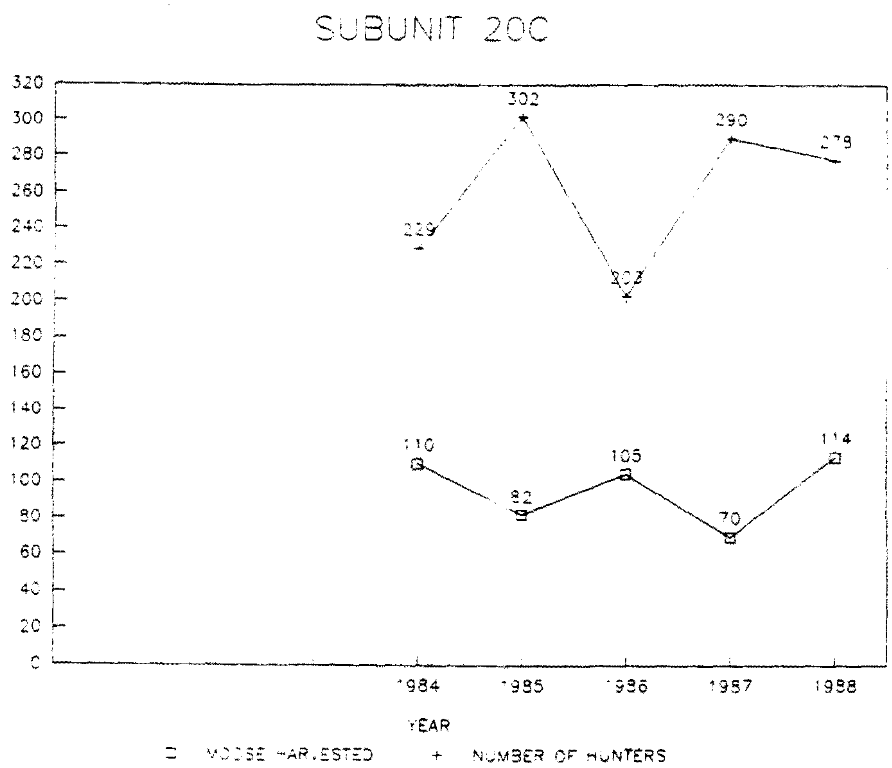

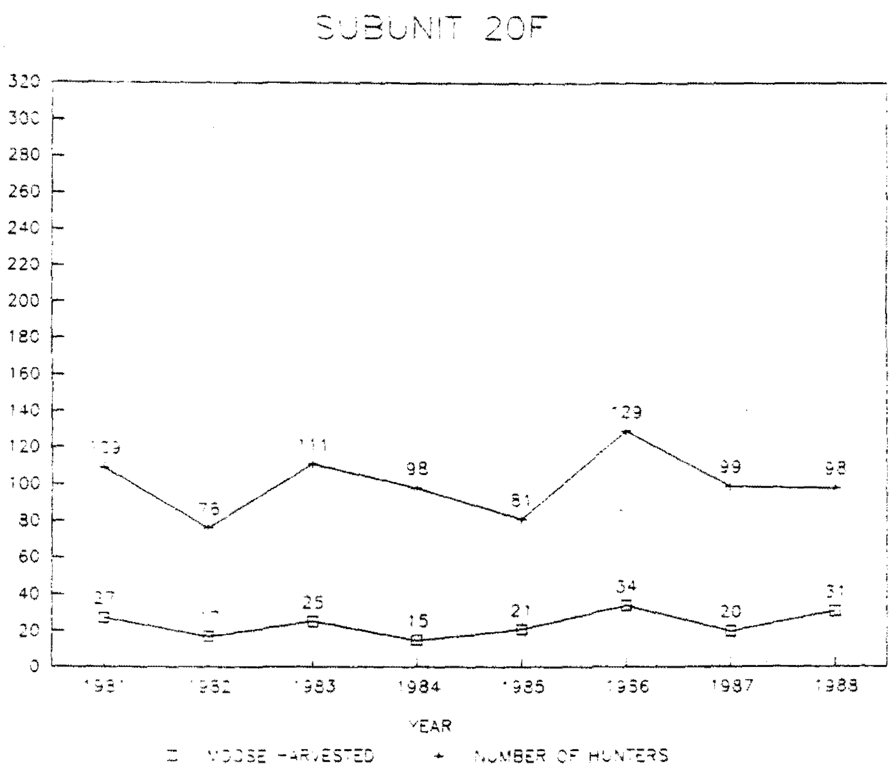

Fig. 1. Reported moose harvest and number of hunters in Subunits 20C and 20F, 1981-88. (Subunit 20C data prior to 1984 has been omitted because of boundary changes).

Table 1. Moose composition surveys in Subunit 20C, 1984-88 and Subunit 20F, 1975-88.

		Bulls			Cows/calves				Area	
Area	Date	Sm.	Med.	Lg.	w/o	w/1	w/2	n	(mi^2)	Comments
Subunit 20C										
Lower Kantishna	22 Nov 85	1	5	5	13	4	0	32	37	
Lower Kantishna	29 Nov 87	1	4	1	13	11	2	47	147	
Minchumina	25-27 Nov 85	9	25	14	35	14	3	120	94	
Minchumina	23 Nov 86	10	13	10	23	7	0	70	33	
Dune Lake	4 Dec 87	6	5	5	11	2	0	31	--	
Denali Natl. Park[a]	30-31 Oct 87	6	34	17	132	33	3	268[b]	217	
Subunit 20F										
Hess Creek	14 Feb 75[c]	--	--	--	--	--	--	10	--	9 adults, 1 calf
Upper Hess Creek	2 Dec 81	1	2	0	4	2	0	11	30	Very few moose seen
Upper Hess Creek	2 Nov 82	2	1	1	3	0	0	7	30	Inconclusive
Big Salt	14 Feb 75[c]	--	--	--	--	--	--	7	30	7 adults, no calves
Big Salt	7-10 Nov 83	0	2	0	3	2	0	9	47	Surveyed by BLM biologists
Tozitna River	1983	0	1	1	3	1	1	11	36	Surveyed by BLM biologists
Ray River mouth to Ray River Hot Springs	14 Feb 75[c]	--	--	--	--	--	--	6	--	Abundance of willow in lower 10 mi, all 6 moose seen here

[a] Data from previous surveys in Denali National Park also available.
[b] Includes 2 moose of unknown sex and age.
[c] Surveyed from a C-185 at 90-100 mph.

Table 2. Early winter distribution of moose in portions of Subunits 20C and 20F based on observed density during stratification flights, 1984-88.

Location	Year	Area stratified (mi^2)	% of area in strata[a]			Estimated density in strata[b]			Estimated no. moose
			Low	Medium	High	Low	Medium	High	
Lower Kantishna[c]	1984	654	77	23	0	0.01	0.20-0.30	n.a.[d]	38-55
Minchumina, including portions in DNP[e]	1984	3,294	80	14	5	0.05-0.07	0.52-0.77	2.34-3.46	795-1,177
NW Subunit 20C[f]	1985	149	68	23	9	0.07-0.11	0.51-0.75	1.64-2.43	48-70
Lower Tozitna/ Tanana River[f]	1985	873	57	30	14	0.11-0.16	0.81-1.20	2.42-3.58	553-818
Upper Tozitna	1988	1,064	64	33	3	Density not estimated			
Total		6,034	73	21	6				

[a] Low, medium, and high designations are assigned independently for each area. Thus, density estimates (moose/mi^2) for each stratum differ among areas.

[b] Observed density (moose/mi^2) times a correction factor of 2.5-3.7. This correction factor was calculated from other Interior Alaska moose population estimation surveys where the number of moose seen during stratification was compared with the number of moose seen during a subsequent survey.

[c] DuBois (1985b).

[d] Only 2 strata used.

[e] DuBois (1985a).

[f] This is a portion of Osborne's (1985) 1,414 mi^2 stratification that included portions of Subunits 20C, 20F, 21B, and 21C.

Table 3. Moose hunting seasons for Subunits 20C and 20F, 1983-88.[a]

Year	20C	20F
1983	1-20 Sep	1-15 Sep
1984	1-20 Sep	1-15 Sep 1-10 Nov
1985	1-20 Sep	1-15 Sep 1-10 Nov[b]
1986	1-20 Sep	1-15 Sep 1-10 Nov[c]
1987, 1988	1-15 Sep[d, e] 1-20 Sep[b, e]	1-15 Sep 1-10 Dec[b]

[a] Seasons apply to all hunters unless noted and bag limit was 1 bull for all years.

[b] Subsistence hunters only.

[c] Subsistence and residents hunters only.

[d] Resident and nonresident hunters only.

[e] White-phased or partial albino (more than 50% white) moose may not be taken.

Table 4. Distribution of reported moose harvest and hunting pressure in Subunits 20C and 20F, 1984-88.

	Regulatory year									
	1984[a]		1985[a]		1986[a]		1987		1988	
Drainage	Hunters	Harvest	Hunters	Harvest	Hunters	Harvest	Hunters	Harvest	Hunters	Harvest
<u>20C</u>										
Tanana River		9		6		13	12	4	32	16
Chitanana River		0		2		2	5	1	3	3
Cosna River		1		1		3	9	5	9	4
Zitziana River		3		2		5	10	4	13	6
Kantishna River (except Lake Minchumina)		36		31		28	60	16	69	24
Lake Minchumina		17		13		17	20	9	13	16
Nenana (includes Teklanika and Savage River)		42		26		36	134	23	108	39
Unknown		2		1		1	43	8	31	6
Total	229	110	302	82	203	105	290	70	278	114
<u>20F</u>										
Tozitna River		3		4		4	12	4	8	4
Yukon River (minor drainages)		0		4		6	15	7	25	8
Hess Creek		5		3		11	47	1	43	12
Tanana River		6		10		8	14	5	16	7
Ray River		0		0		0	4	1	3	0
Unknown		1		--		3	6	2	3	0
Total	98	15	81	21	129	31	98	20	98	31

[a] Hunting pressure by drainage not tabulated for these years.

Table 5. Antler size of moose harvested in Subunits 20C and 20F, 1984-88.

Year	Number of moose with antler size (inches)			
	<30	30.0-39.9	40.0-49.9	50+
20C				
1984	17	31	25	34
1985	14	21	19	25
1986	8	26	29	41
1987	8	25	6	23
1988	13	36	25	33
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

Table 6. Number of successful and unsuccessful moose hunters by Alaska residency, Subunits 20C and 20F, 1984-88.

Year	Successful hunters				Unsuccessful hunters				Total hunters
	Resident	Nonresident	Unspecified	Total	Resident	Nonresident	Unspecified	Total	
20C									
1984	105	4	1	110	182	5	2	189	299
1985	77	3	2	82	208	5	7	220	302
1986	98	3	4	105	196	4	3	203	308
1987	65	3	2	70	203	6	11	220	290
1988	84	6	24	114	114	8	42	164	278
20F									
1984	15	0	0	15	79	1	3	83	98
1985	18	3	0	21	56	2	2	60	81
1986	33	1	0	34	92	2	1	95	129
1987	19	0	1	20	69	3	7	79	99
1988	25	0	6	31	49	3	15	67	98

Table 7. Methods of transportation reported by moose hunters[a] in Subunits 20C and 20F, 1984-88.

Transport[b] mode	1984		1985		1986		1987		1988	
	S	U	S	U	S	U	S	U	S	U
20C										
Aircraft	35	41	27	33	29	26	19	30	26	26
Horse	4	3	2	4	1	4	1	6	2	3
Boat	32	65	26	60	35	66	30	56	50	58
3- or 4-wheeler, ORV	26	22	11	45	26	44	14	46	19	28
Highway vehicle	7	28	8	46	7	35	4	39	10	26
Total	104	159	74	188	98	175	68	177	107	141
20F										
Aircraft	3	4	4	3	3	1	3	4	2	3
Horse	0	0	0	0	1	0	0	0	0	0
Boat	10	32	13	19	13	46	6	41	17	30
3- or 4-wheeler, ORV	1	10	0	9	9	11	1	3	6	4
Highway vehicle	0	27	4	23	6	20	4	18	4	16
Total	14	73	21	54	32	78	14	66	29	53

[a] S = Successful, U = Unsuccessful.

[b] Excludes unknown transportation.

STUDY AREA

GAME MANAGEMENT UNIT: 20D (5,605 mi^2)

GEOGRAPHICAL DESCRIPTION: Central Tanana Valley near Delta Junction

BACKGROUND

Subunit 20D was created in 1971 from the portion of Subunit 20C south of the Tanana River between the Johnson and Delta Rivers. From 1962 to 1970, the moose hunting season in the area that is currently Subunit 20D consisted of a 70- to 72-day bull season and a 1- to 8-day antlerless moose season. Fifty-one to 74% of the harvest from 1964 to 1970 came from the highly accessible areas near Delta Junction (i.e., Clearwater Lake, Donnelly Dome, and the Delta farming area). However, several severe winters in the mid-1960's and early 1970's killed many moose throughout this subunit and other portions of Interior Alaska and set the stage for predation and hunting to compound and aggravate already widespread population declines. The moose hunting season was closed, because the depressed moose population could no longer support the harvest that would result from even the most restrictive seasons (McIlroy 1974). Recruitment of yearling moose to the population had remained poor, causing the continued bulls-only hunting to depress the bull:cow ratio to only 4:100 in the more accessible portions of the subunit.

Despite restrictions on hunting, the moose population in Subunit 20D continued to decline because of chronically high moose mortality related to other causes. In 1973 the moose population in the area south of the Tanana River and between the Johnson and Delta Rivers was estimated to number only 600. When limited moose hunting was resumed in 1974, it was conducted under a registration permit system designed to keep harvests minimal. The population decline in the western portion of the subunit was gradually reversed by wolf control efforts in adjacent Subunit 20A (1976-82) and in western Subunit 20D (1980-83), in combination with continued hunting restrictions and mild winters.

In 1978 Subunit 20D 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).

For convenience, Subunit 20D has been unofficially subdivided into 4 areas for moose management purposes: southwestern Subunit 20D, which includes the area south of the Tanana River from the Johnson River to the Delta River; southeastern Subunit 20D, which includes the area south of the Tanana River from the Robertson River to the Johnson River; northwestern Subunit 20D, which includes the area north of the Tanana River from Banner Creek to and including the Goodpaster River; and northeastern Subunit 20D, which includes the area north of the Tanana River and east of the Goodpaster River.

Table 1 lists moose hunting seasons in Subunit 20D since it was enlarged to its present size in 1981. Hunting opportunities were gradually expanded in southwestern Subunit 20D by first eliminating the registration permit requirement and then lengthening the season. Antler restrictions became necessary in 1988 to maintain hunting opportunities as well as an older age structure in the population. In the northern portion of Subunit 20D, hunting opportunities have been gradually curtailed by shortening the season to reduce harvest levels. In southeastern Subunit 20D, the seasons have been gradually increased. The DJMA remains closed to moose hunting, but this is because of local preferences rather than biological necessity.

POPULATION OBJECTIVES

To maintain a total population in Subunit 20D of 5,500-7,000 moose: 1,600-2,400 in southwestern Subunit 20D, 3,000 in the northern portions of Subunit 20D, and 900-1,600 in southeastern Subunit 20D.

To maintain an overall posthunting bull:cow ratio of 30:100.

To increase the age structure of bulls in southwestern Subunit 20D by 1993 so that at least 20% post-season bulls have antler spreads of 50 inches or larger.

METHODS

Aerial composition surveys were conducted in a Piper Super Cub at altitudes 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, look for additional moose, and estimate antler spread and the number of antler brow tines for bulls. Yearling bulls were identified by spiked or forked antlers or by a lack of brow development on palmated antlers. Nonyearling bulls with an antler spread less than 50 inches were classified as medium bulls. Bulls with an antler spread of 50 inches or more were classified as large bulls.

Density of moose and unbiased composition data were collected in trend count areas (TCA) that were subdivided into sample units (SU); each SU had a mean area of approximately 12 mi^2. One SU was surveyed at a time, with a search intensity of approximately 6-8 minutes/square mile. Estimates of sex and age composition were calculated after aerial contour surveys had been conducted in specified areas; however, this data may be biased because different segments of the moose population had varying observer sightability during the aerial surveys.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size and Trend:

Based on a population estimation survey conducted during November 1981 and subsequent reexamination of the stratification data, Johnson (1987) estimated that 1,900 moose existed south of the Tanana River (2,653 mi^2) during the early winter. A population estimate of 1,300 moose was derived for the rest of the subunit north of the Tanana River (2,952 mi^2), using similar extrapolations of stratification data. More accurate, precise estimates of population size were not available.

The estimated average moose density south of the Tanana River (0.7 moose/mi^2) was medium to high, relative to moose densities found elsewhere in Interior Alaska. Numbers were either stable or increasing. The opposite situation existed north of the Tanana River, where the estimated mean density (0.4 moose/mi^2) was medium to low and probably decreasing.

Moose density in the Donnelly TCA in southwestern Subunit 20D was 3.2 moose/mi^2 in 1988, similar to densities measured in 1986 and 1987 surveys (Table 2). The slight change noted may be due to changes in the survey area boundaries for 1988. In the Knob Ridge TCA in southeastern Subunit 20D, densities have also stayed fairly constant at about 2.0 moose/mi^2 since 1984 (Table 2).

North of the Tanana River, density information is only available from the Central Creek TCA, which is situated in a partially regrown burn and contains much better moose habitat than occurs in most of northern Subunit 20D. Thus, early winter moose densities in the Central Creek TCA have been higher than those typically found in this portion of the subunit. Observed density in 1988 was 2.4 moose/mi^2 (Table 2).

Population Composition:

Southwestern Subunit 20D. Data collected in the Donnelly TCA indicated that calf survival to 6 months of age increased for the third consecutive year (Table 2). Forty-seven calves:100 cows were observed, and calves composed 27% of the moose classified. Calf survival to 18 months of age continued to be fairly good, based on the proportion of yearling bulls observed during surveys after the hunting season (Fig. 1). Because many yearling bulls are harvested by hunters (Table 3), the observed ratios of yearling bulls:100 cows have underestimated the actual recruitment to yearlings more than in less heavily harvested areas. Twelve yearling bulls:100 cows were observed in 1988.

The ratio of 29 bulls:100 cows (Table 2) was slightly below the population objective of 30 bulls:100 cows. The proportion of bulls in the population has been declining for several years

(Fig. 1) because of increased hunting pressure caused by the increased popularity of three- and four-wheel all-terrain vehicles and improved access.

The good recruitment of bulls in recent years and hunter selectivity for large-antlered bulls were reflected in the antler spread data from the Donnelly TCA (Table 4). These data suggested a predominantly young but varied age structure among bull moose in southwestern Subunit 20D. Yearlings, medium-antlered, and large-antlered bulls composed 42%, 46%, and 12% of the bulls observed during aerial surveys in 1988, respectively. This is an improvement over 1987, when yearlings made up 49% of the bull segment and large bulls accounted for only 9% of the bulls observed.

Fifty-four percent of yearling bulls in the Donnelly TCA had spike-fork antlers and 39% of the medium bulls had 3 or more brow tines on at least 1 antler (Table 4). These bulls, along with all those in the large category, would have been legal to harvest under the antler restriction regulations in effect in southwestern Subunit 20D during 1988.

Southeastern Subunit 20D. Data were collected from the Knob Ridge (Table 2) and Robertson River (Table 5) survey areas. Calf survivals to 6 months of age continued to increase in both areas. Calf survivals were fair (26 calves:100 cows) in the Knob Ridge TCA and excellent (43 calves:100 cows) in the Robertson River survey area. Calves composed 15% and 23% of the moose observed in each area, respectively. Calf survivals to 18 months of age were fair; both areas had a ratio of 11 yearling bulls:100 cows.

Good bull:cow ratios were evident in both survey areas (42 and 45 bulls:100 cows, respectively), reflecting the considerably lower hunting pressure and harvest rates in this portion of the subunit (Figs. 2 and 3). Yearling bulls and large-antlered bulls each composed 27% and 25% of those observed in the Knob Ridge TCA (Table 4) and Robertson River, respectively. These data indicated a more evenly distributed age structure of bulls than that in southwestern Subunit 20D.

Northeastern Subunit 20D. Composition data were collected from the Billy Creek (Table 5) and Tower Bluffs survey areas during 1988. Only 17 moose were observed during the Tower Bluffs survey, so these data are not included.

Calf survival to 6 months of age continued to be poor in Billy Creek, with only 13 calves:100 cows in 1988. This was the lowest calf:cow ratio in this area since 1985. Calf survival to 18 months of age was also poor (4 yearling bulls:100 cows).

The overall bull:cow ratio continued to be high (93 bulls:100 cows) in Billy Creek, indicating that little hunting pressure had been directed at this segment of the Subunit 20D moose population. The chronically poor recruitment rates were also reflected in the old-age structure of these moose (Table 4). Yearling bulls made up only 5% of all bulls observed, whereas medium and large bulls made up 57% and 38% of all bulls, respectively. Of the 16 large bulls observed, five (31%) had antlers that were at least 60 inches wide.

Northwestern Subunit 20D. Composition data were collected from the Central Creek (Table 5) and the North Fork Goodpaster/Slate Creek (Table 5) survey areas. However, sample sizes continued to be small in the North Fork Goodpaster/Slate Creek survey and ratios calculated from the data could easily be misleading.

Calf survival to 6 months of age was poor (i.e., 13 calves:100 cows) in the Central Creek TCA. Initial calf survival may have been better (24 calves:100 cows) in the North Fork Goodpaster/Slate Creek area, but the small sample size may be misleading. Survivals of calves to 18 months of age were poor (i.e., 6 and 4 yearling bulls:100 cows, respectively) in both survey areas.

Bull:cow ratios were surprisingly low (i.e., 44 and 32 bulls:100 cows in the Central Creek and the North Fork Goodpaster/Slate Creek TCA's, respectively) for these relatively inaccessible areas, indicating that moose were probably harvested from this population as they migrate through the lower portions of the Goodpaster drainage. Yearling, medium-antlered, and large-antlered bulls composed 14%, 59%, and 27% of the bulls observed in the Central Creek TCA, respectively (Table 4).

Mortality

Season and Bag Limit:

The open season for all hunters in that portion of Subunit 20D lying west of the east bank of the Johnson River and south of the Tanana River, except the Delta Junction Management Area, is 1-15 September; the bag limit is 1 bull with spike-fork or 50-inch antlers. The open season for all hunters in that portion of Subunit 20D lying south of the north bank of the Tanana River and east of the east bank of the Johnson River is 1-20 September; the bag limit is 1 bull. There is no open season in that portion of Subunit 20D known as the Delta Junction Management Area. The open season for all hunters in the remainder of Subunit 20D is 1-10 September; the bag limit is 1 bull.

Human-induced Mortality:

One hundred seventy-three moose were killed because of human-related activities during this reporting period, including 126 reported by hunters, 20 reported deaths caused by collisions with vehicles, 13 known illegal harvests, 7 unknown illegal harvests, and 7 unreported collisions with trucks on the Alaska and Richardson Highways. Most of these mortalities occurred in southwestern Subunit 20D.

The annual human-induced mortality constituted about 5.4% of the estimated population of moose in the subunit. Legal hunting alone removed only an estimated 3.9% of the population.

The impact of human-caused deaths was slightly greater in the southern half of the subunit, because most of the legal harvest and the illegal kills occurred there. Annual human-induced mortality was about 6.3%; most of the increase was due to illegal activities or vehicle accidents. The legal harvest alone accounted for about 3.8% of the estimated moose population in the southern half of the subunit.

Five hundred fifty-five people reported hunting moose in Subunit 20D during 1988. The number of hunters has declined steadily since 1984 (Fig. 2). Until 1988 the increase in hunters in southwestern Subunit 20D was partially offset by the decline in hunters in northern Subunit 20D; however, the marked decrease (18%) in hunters in southwestern Subunit 20D because of the imposition of antler restrictions reversed the trend in that area, contributing to an even greater decline in the total number of hunters for the whole subunit. Evidently, people who had previously hunted in southwestern Subunit 20D were not simply displaced to other portions of the subunit. Hunting pressure in the southeastern portion of the subunit has remained fairly constant since 1983.

Hunters reported harvesting the same number of bull moose in 1988 as in 1987 (Fig. 3); however, the distribution of the harvest changed. Fewer moose were taken in southwestern Subunit 20D, and more moose were taken in southeastern Subunit 20D. The harvest in northern Subunit 20D remained about the same.

Southwestern Subunit 20D. Sixty moose were reported harvested in 1988 (Fig. 4). This was the second year that the reported harvest had declined since the recent high in 1986. Hunter participation dropped drastically, presumedly because of the new regulations restricting harvest to specified antler size classes. Those choosing to continue hunting in southwestern Subunit 20D were slightly more successful than those in 1987, perhaps because of the additional 5 days in which to hunt and relative abundance of legal bulls.

Based on the classification of 54 bulls in the Donnelly TCA to various antler size and brow tine categories, yearling bulls with spike or forked antlers, medium-sized bulls with 3 or more brow tines on at least 1 antler, and large bulls with antler spreads of 50 inches or larger composed 24%, 17%, and 13% of the bull segment of the population, respectively, after the fall 1988 hunting season (Table 4). These bulls represented what was left of the huntable segment of the population (i.e., after subtracting the legal harvest). Thus, only 46% or less of the bulls in the population were protected by the antler restrictions that had become effective in 1988.

The proportion of yearling bulls in the harvest declined 32% from 1987 to 1988 (Table 3), presumedly because of the imposition of antler restrictions for the fall 1988 hunt that protected roughly half of the yearling bulls. Concurrently, the proportion of large bulls in the harvest increased from 5% in 1987 to 37% in 1988 and the mean antler spread of the harvested moose increased from 33.9 to 41.8 inches. In this area, bull moose with 50-inch antler spreads averaged 6 years of age (Gasaway et al. 1987); some attained that size at an even earlier age.

Although a greater reduction in the harvest was expected, it appears that many hunters took advantage of the additional season length to seek out legal bull moose (Table 6). If hunters were willing to increase hunting effort to compensate for antler restrictions and up to 40% of the medium bulls were legally harvestable (i.e., 3 or more brow tines on at least 1 antler), a high level of harvest on medium-sized bulls will result. Therefore, the changes in bull age structure expected with antler restrictions will occur much more slowly than anticipated in southwestern Subunit 20D. With a season length of 15 days or longer, it appears that hunters in southwestern Subunit 20D could soon become fairly effective at keeping the bull segment of the population cropped down to animals younger than about 6 years. However, because about 50% of the yearling bulls and 60% of the medium bulls are protected by current antler restrictions, the mean age of the bulls will remain higher than if antler restrictions were not in place.

If we wish to more quickly shift the age structure to include more older bulls, further regulation changes may become necessary. Because only 6% of the medium-sized bulls had 4 brow tines on at least 1 antler, one solution would be to redefine large bulls as those with either 50-inch or larger antlers or 4 or more brow tines on at least 1 antler. This would significantly reduce the harvest of young bulls. Other alternatives could include shortening or closing the season or issuing permits; however, I do not consider either option necessary at the present time.

Most hunters I talked to during the 1988 hunting season were unhappy with the antler restriction regulations. Many were concerned that other hunters would unintentionally shoot bulls that did not meet the legal requirements and then leave them unsalvaged in the field. This apparently did not occur. No such incidents were reported by either hunters or officers of the Fish and Wildlife Protection Division (D. Bunselmeier, pers. commun.).

The current antler restriction regulations provide the following benefits for residents and visitors in southwestern Subunit 20D: (1) they prevent the bull segment of the moose population from being cropped back to the point where it only includes the annual recruitment of yearling bulls; (2) they ensure that, on average, larger bull moose will become available to view and hunt; and (3) they make it feasible to have longer hunting seasons, which should lead to more hunting opportunity, less crowding, less competition for moose, and, perhaps, hunting practices that are more acceptable to the majority of the hunters and nonhunters alike. A possible drawback of the current approach is that longer hunting seasons are not perceived as a benefit to those who do not like hunting and view it as a conflict with other outdoor pursuits.

Southeastern Subunit 20D. Both the harvest of moose and the number of hunters have remained low and relatively constant (Fig. 5). This probably occurred because of access restrictions in the Macomb Plateau Controlled Use Area that made moose hunting difficult in all areas, except along the Alaska Highway, the Tanana River, and the Robertson River. Hunters in this area had a 27% success rate.

Hunters appeared to select mature bulls; medium- and large-antlered bulls were represented in the harvest (Table 3) more frequently than they occurred in the population (Table 4). Antler spread averaged 46.1 inches, which was similar to that of the preceding year.

Northern Subunit 20D. The number of moose killed has remained fairly constant, despite a steady decline in the number of hunters from 1984 to 1988 (Fig. 6). Hunters had a 21% success rate. Despite a declining moose population, the harvest has remained constant because hunters are generally familiar with the area and efficient at harvesting moose. Migratory moose from the large population in southwestern Subunit 20D are also contributing significantly to the harvest.

Even though the harvests for 1987 and 1988 were essentially identical, the 1988 harvest included a greater proportion of large-antlered moose (Table 3). This brought the mean antler spread up to 38.4 inches in 1988. Yearling bulls composed 14% of the bulls observed in the Central Creek survey area in 1988 but only 5% of the bulls observed in the Billy Creek survey area (Table 4).

Hunter Residency. Fifty-one percent of the hunters in Subunit 20D during 1988 were local residents (Table 7). Nonlocal residents and nonresidents accounted for 34% and 7% of the hunters, respectively. The proportion of hunters who reside in Subunit 20D has remained essentially the same since 1983.

Hunter Effort. All successful hunters hunted a mean of 5.0 days during 1988, compared with a mean of 6.0 days for all unsuccessful hunters (Table 6). In southwestern Subunit 20D, hunter effort increased 0.2 days for successful hunters and 0.6 days for unsuccessful hunters. These increases were probably due to (1) the 5-day-longer hunting season in 1988 that gave hunters the opportunity to either hunt more often or longer and (2) the new antler restriction regulations for 1988 that may have forced hunters to search longer to find legal bull moose. Even though hunter effort increased in this area, it was still below average for the subunit.

Harvest Chronology. Fifty percent of the moose killed in Subunit 20D were taken by 8 September. An additional 40% were killed from 9 to 15 September. While the season closed on 10 September in northern Subunit 20D, it remained open in southeastern Subunit 20D until 20 September; 4% of the moose were killed from 15 to 20 September. Harvest dates were not reported for an additional 5%.

Transport Methods. Little change was evident from transportation means and success rates reported during 1987. Hunting characteristics were considerably different in the southern half of Subunit 20D because of road access. In southern Subunit 20D, most hunters used highway vehicles or some type of off-road vehicle. The only road access in the northern half of the subunit is where the Richardson Highway traverses the southwestern corner of the area. Consequently, most people who hunted in the northern portion of the subunit used boats for access (Table 8). Aircraft are infrequently used because few landing sites are available. Similar, but more pronounced, trends were evident in the data for successful hunters (Table 9).

Natural Mortality:

No estimates of natural mortality were calculated during 1988-89; however, predation by wolves, grizzly bears, and black bears was significant in Subunit 20D. Predation is limiting moose population growth in the northern half of Subunit 20D.

Habitat Assessment and Enhancement

Moose browse surveys were conducted near Ober Dome and Big Lake within the Donnelly TCA in southwestern Subunit 20D. Both areas support high moose densities (i.e., 5.0 and 3.0 moose/mi^2, respectively) during the early winter but only low-to-moderate densities during the summer.

Willows composed 75% of the plants at the Ober Dome site (Table 10). Balsam popular was the only other browse species present in any significant amount (24%). Although 92% of the willows received some use by moose, browsing levels were only moderate. Browsing was rated heavy on only 38% of all willows combined.

Willows, aspen, and dwarf birch were almost equally represented at the Big Lake site (Table 11). Almost half (43%) of the willows and virtually all of the aspen and birch had not been browsed by moose because these latter species were not prefered and moose densities were low enough to afford selectivity of preferred browse.

Game Board Actions and Emergency Orders

The Board of Game changed the open season and bag limit in southwestern Subunit 20D from 1 to 10 September and 1 bull moose (any size) to 1 to 15 September and 1 bull moose having either spike-fork antlers (1 or 2 tines on either antler), or an antler spread of 50 inches or more or with 3 or more brow tines on either side, respectively.

CONCLUSIONS AND RECOMMENDATIONS

Southwestern Subunit 20D is the most important moose hunting area in Subunit 20D. It receives the most hunting pressure and has the largest harvest of any area in Subunit 20D. The moose population is probably still growing, so the population objectives may have been met; however, another population estimation survey should be conducted to verify that. If population objectives have been met, browse surveys should be conducted to determine if the habitat will support additional moose; moreover, the public should have the opportunity to review the population objectives in the management plan.

Hunters responded to antler restrictions by increasing their hunting effort to compensate for having fewer legal bulls in the population. This was made possible by the longer season that accompanied the restrictions to certain antler size classes. Hunters killed a higher proportion of medium and large bulls than they did in 1987, presumably because part of the yearling bull segment was protected by the new regulations.

It appears that antler restrictions adopted in 1988 are not going to produce a rapid change in age distribution among bulls, because many medium-sized and therefore young bulls are legal to harvest under the present brow-tine requirement. However, it is probably not necessary to do more than reduce the total harvest, and existing regulations seem to be accomplishing that without greatly reducing the length of the season.

In northern Subunit 20D, the number of hunters has declined steadily since 1984 because of the imposition of a very short season and a continued decline in the moose numbers caused by predation. Measures to restore moose numbers to more moderate levels should be explored.

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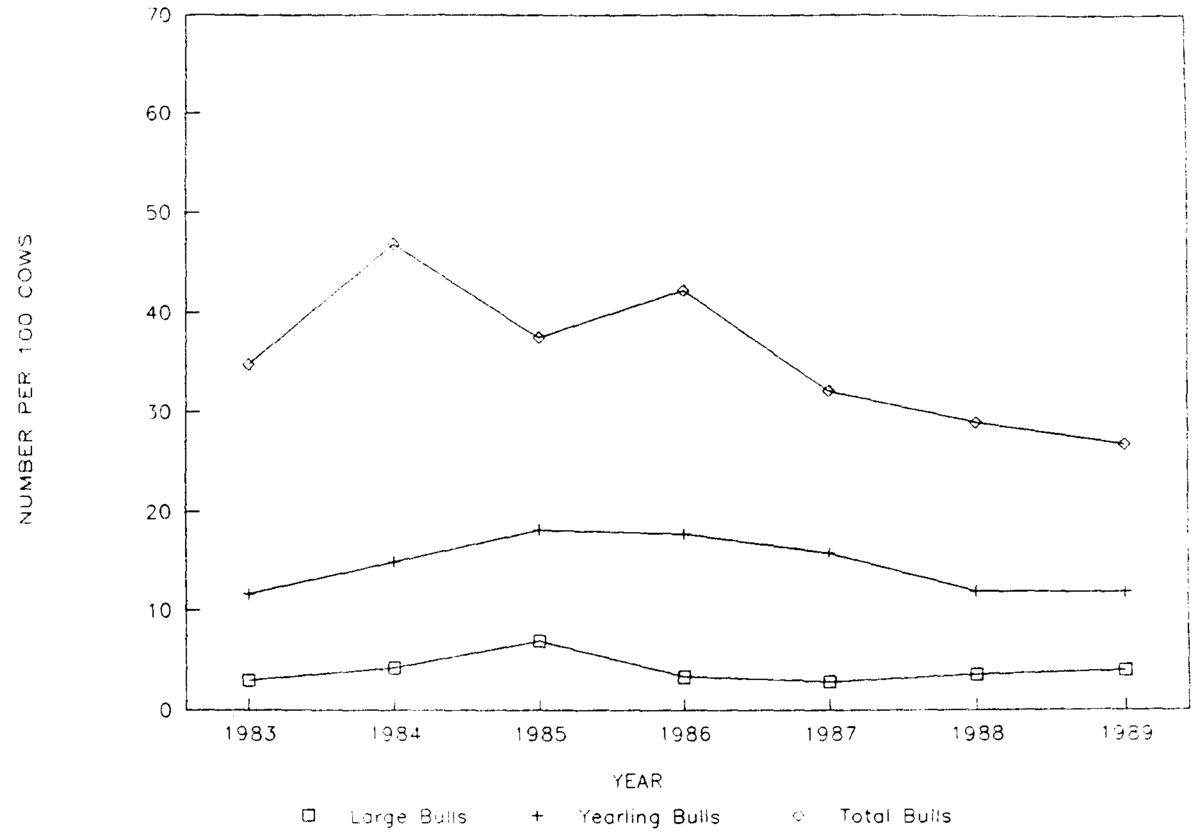

Fig. 1. Moose bull:cow ratios in southwestern Subunit 20D, 1983-89.

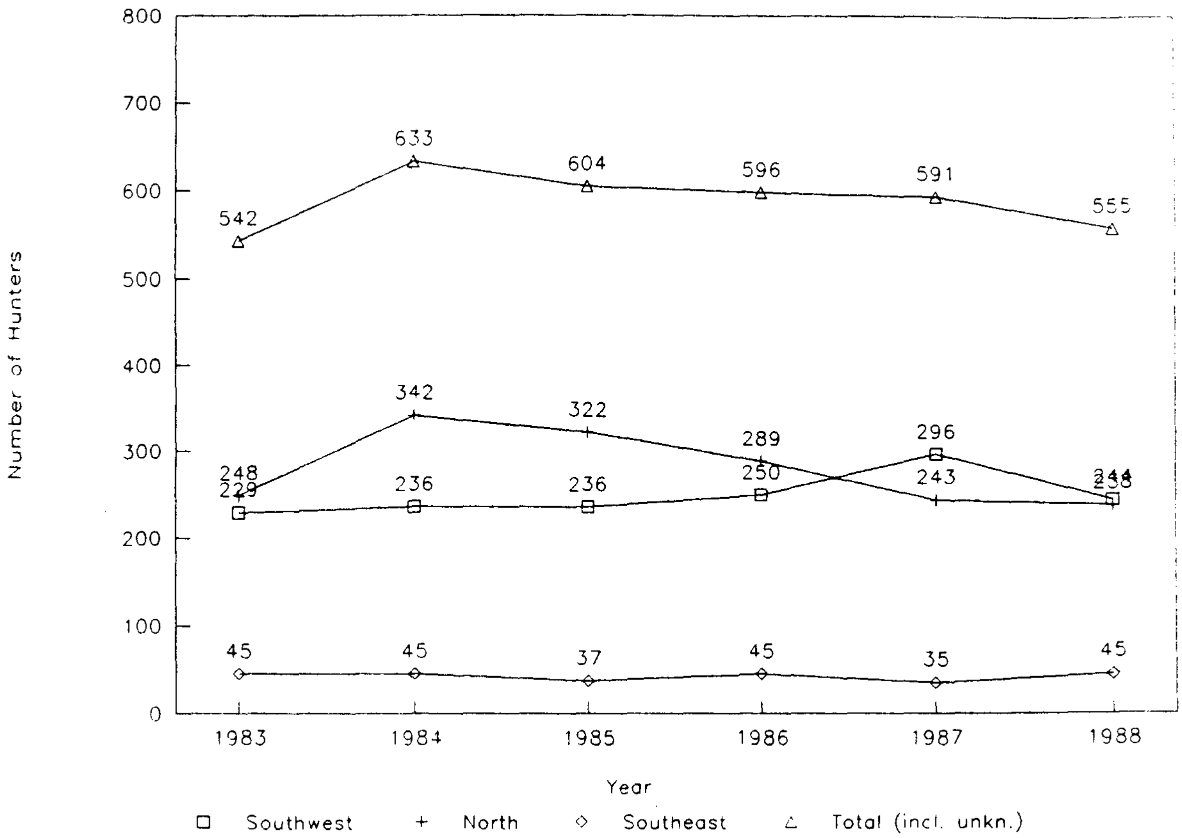

Fig. 2. Trends in the number of moose hunters in Subunit 20D, 1983-88.

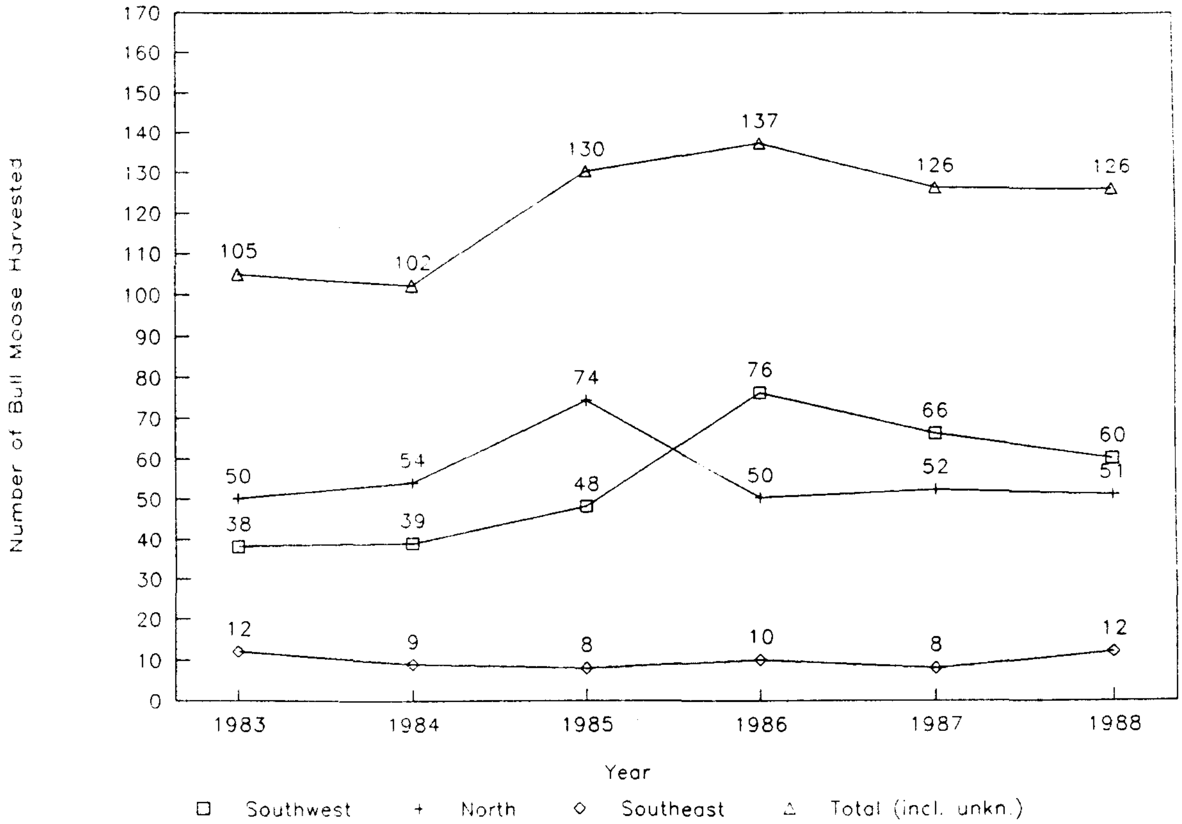

Fig. 3. Moose harvest trends in Subunit 20D, 1983-88.

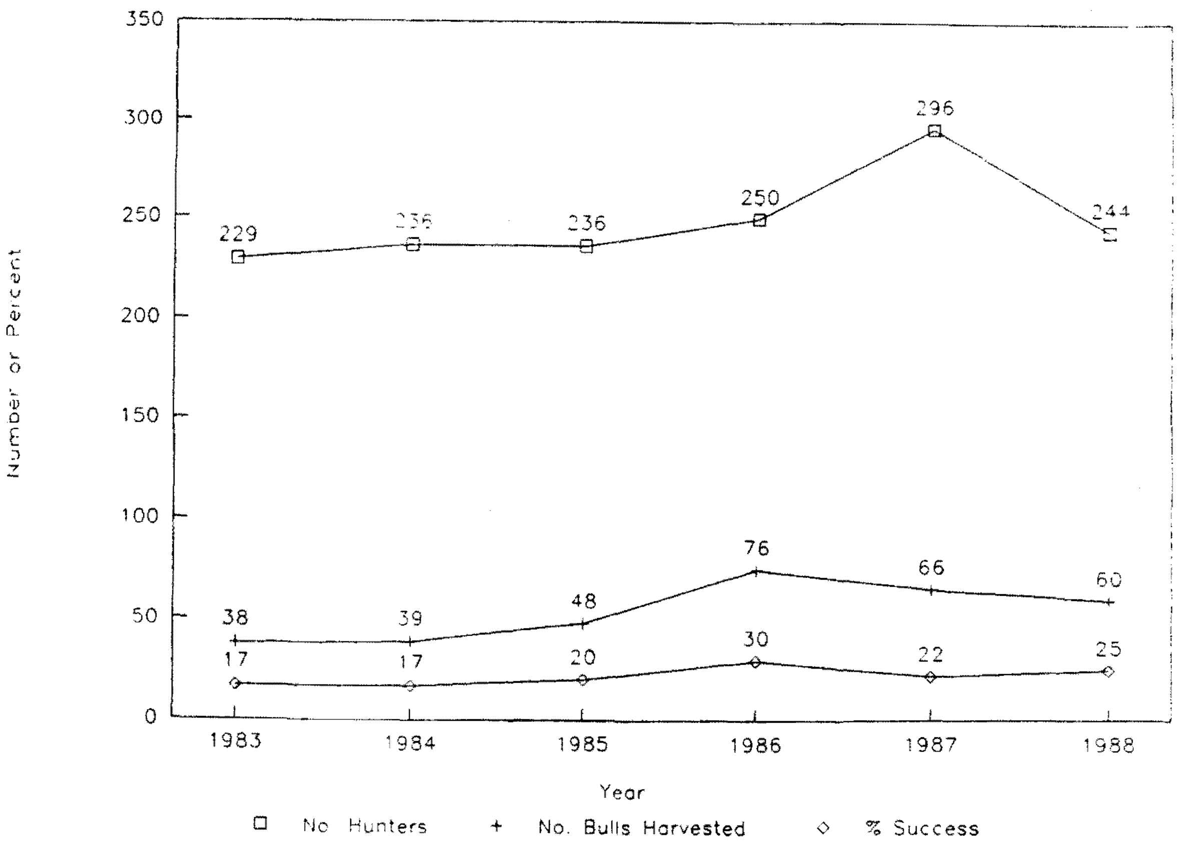

Fig. 4. Moose hunter and harvest statistics for southwestern Subunit 20D, 1983-88.

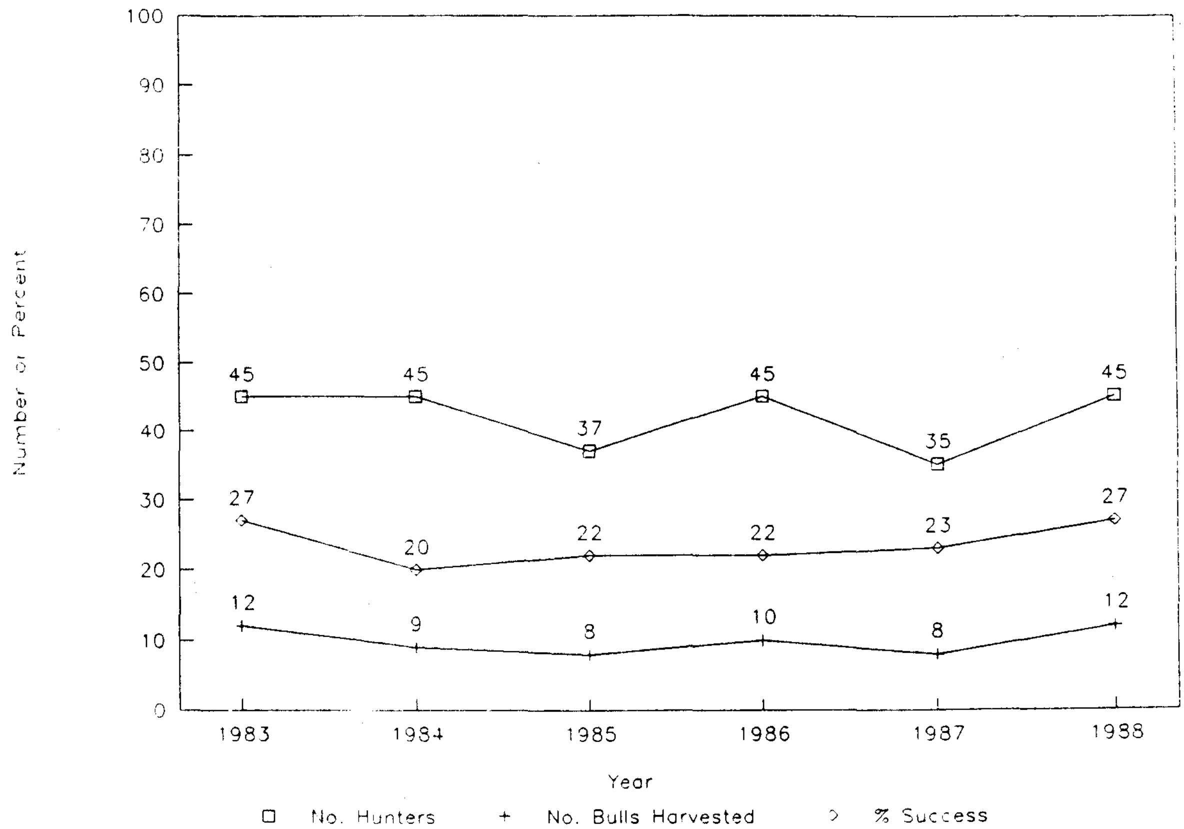

Fig. 5. Moose hunter and harvest statistics for southeastern Subunit 20D, 1983-88.

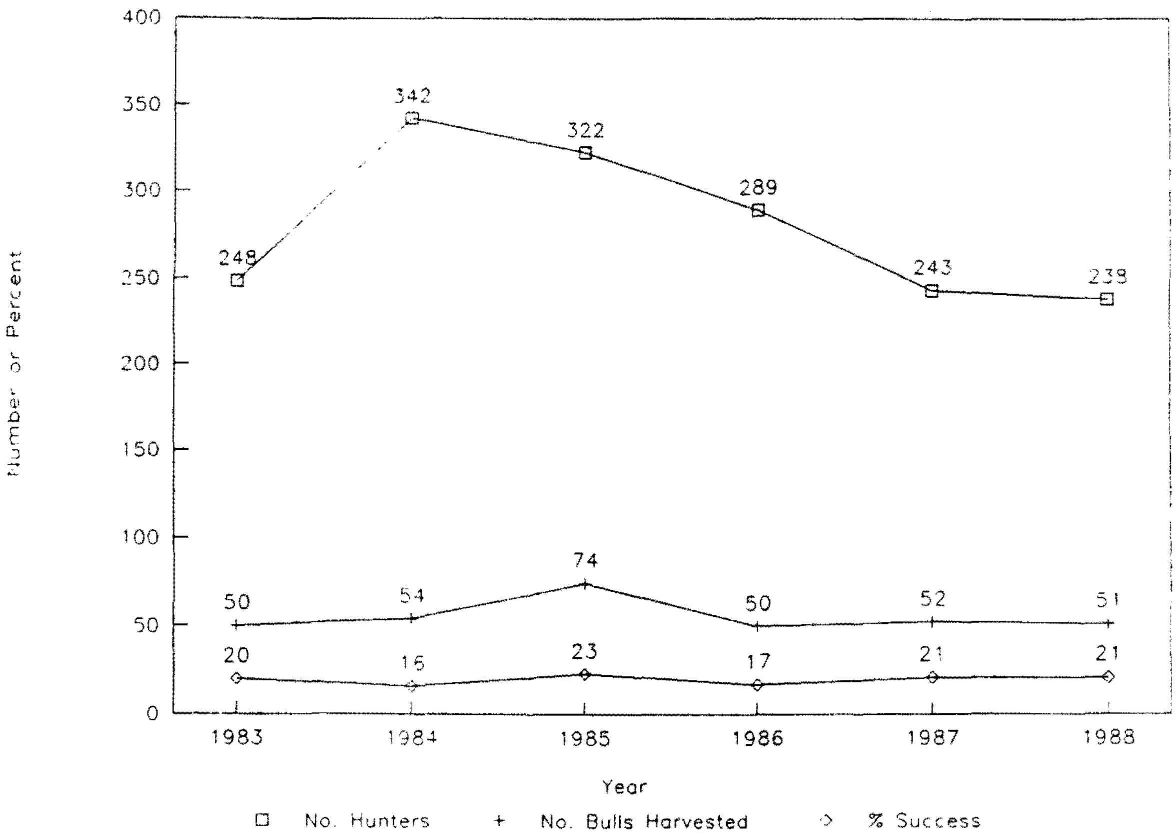

Fig. 6. Moose hunter and harvest statistics for northern Subunit 20D, 1983-88.

Table 1. Seasons,[a] bag limits[b], and other requirements pertaining to moose hunting in Subunit 20D, 1981-88.

Year	Portion of Subunit 20D		
	Southwestern[c,d]	Southeastern[e]	Northern[f]
1981	5-15 Sep[g]	1-15 Sep	5-15 Sep
1982	5-15 Sep[g]	5-15 Sep	5-15 Sep
1983	1-4 Sep	5-15 Sep	5-15 Sep
1984	1-6 Sep	1-20 Sep	1-15 Sep
1985	1-10 Sep	1-20 Sep	1-10 Sep
1986	1-10 Sep	1-20 Sep	1-10 Sep
1987	1-10 Sep	1-20 Sep	1-10 Sep
1988	1-15 Sep[h]	1-20 Sep	1-10 Sep

[a] The same seasons applied to resident, nonresident, and subsistence users.

[b] One bull unless otherwise noted.

[c] The area lying south of the Tanana River from the Johnson River to the Delta River.

[d] These regulations do not apply to the Delta Junction Management Area which is closed to moose hunting.

[e] The area lying south of the Tanana River from the Robertson River to the Johnson River.

[f] The area lying north of the Tanana River.

[g] Registration permit required.

[h] Bag limit was further restricted to 1 bull with either 1 or 2 tines on either antler (spike or fork), an antler spread of 50 inches or more, or 3 or more brow tines on either side.

Table 2. Sex and age composition and density of moose observed during trend area surveys in Subunit 20D, 1984-88.

Year	Total sample size	Total bulls: 100 cows	Yrlg bulls: 100 cows	% Yrlg bulls	Calves: 100 cows	% Calves	Moose/ mi^2
Donnelly Dome							
1984	217	41	13	7	41	23	-[a]
1985	131	42	18	10	34	19	-[a]
1986	353	30	12	7	40	24	3.4
1987	323	31	15	9	44	25	3.4
1988	343	29	12	7	47	27	3.2[b]
Knob Ridge							
1984	120	39	11	7	28	17	2.4
1985	102	61	11	6	18	10	1.8
1986	123	46	4	2	12	7	2.0
1987	No data						
1988	149	42	11	7	26	15	2.0
Central Creek							
1984	77	31	4	3	11	8	-[c]
1985	108	58	12	7	24	13	-[c]
1986	No data						
1987	No data						
1988	150	44	6	4	13	8	2.4[d]

[a] Data for 1984-85 is a pooling of the old Jarvis/Ober and Donnelly survey areas. The 2 areas were combined in 1986 to form the new Donnelly trend count area.

[b] Not comparable with 1986-87 data because of changes in the survey area boundaries.

[c] This area was surveyed with contour surveys in 1984-85. Search intensity was 1.7 and 3.0 min/mi^2, respectively. The 1984 survey covered 113 mi^2. The 1985 survey covered 62 mi^2 and covers the same area as the current trend count area.

[d] This is the first year this area was surveyed as a trend count area.

Table 3. Antler spread measurements of bull moose harvested from Subunit 20D, 1987-88.

Year	Harvest area	Antler spread category (inches) Yearling <30.0 No.	%[a]	Medium 30.0-49.9 No.	%	Large >50.0 No.	%	Unknown no.	Total known bull harvest	Mean antler spread (inches)
1987	Southwestern 20D	19	34	34	61	3	5	10	66	33.9
	Southeastern 20D	0	0	4	50	4	50	0	8	47.9
	Northern 20D	18	42	23	53	2	5	9	52	33.1
	Combined (all 20D)[b]	38	34	64	56	11	10	13	126	34.9
1988	Southwestern 20D	9	23	16	40	15	37	20	60	41.8
	Southeastern 20D	1	9	5	46	5	45	1	12	46.1
	Northern 20D	11	24	24	52	11	24	5	51	38.4
	Combined (all 20D)	24	23	48	46	32	31	22	126	40.3

[a] Measured as percent of the total harvest for each harvest area for which antler measurements were provided.

[b] May include some bulls for which antler measurements were provided, but location o kill could only be identified as Subunit 20D.

Table 4. Distribution[a] of bull moose observed during aerial surveys in Subunit 20D in October-November 1988 among various antler spread and brow tine categories.

Category	Donnelly		Knob Ridge		Central Cr.		Billy Cr.		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Yearlings (≤30"):										
Spike or forked antler	13	23	3	8	0	0	0	0	16	9
Palmated antler	11	19	7	19	1	2	2	5	21	12
Unidentified	0	0	0	0	5	12	0	0	5	3
Medium bulls:										
Class 1 (31.0-40.9")										
<3 brow tines	10	18	6	16	2	5	6	14	24	13
3 brow tines	5	9	4	11	0	0	1	2	10	6
≥4 brow tines	2	4	0	0	0	0	0	0	2	1
Class 2 (41.0-49.9")										
<3 brow tines	4	7	1	3	1	2	8	19	14	8
3 brow tines	2	4	0	0	0	0	3	7	5	3
≥4 brow tines	0	0	0	0	0	0	1	2	1	1
Unidentified	3	5	6	16	22	52	5	12	36	20
Large bulls (≥50.0"):										
<3 brow tines	2	4	2	5	0	0	1	2	7	4
3 brow tines	2	4	3	8	3	7	7	17	18	10
≥4 brow tines	3	5	4	11	4	10	6	14	19	11
Unidentified	0	0	1	3	4	10	2	5	7	4
All combined	57	100	37	100	42	100	42	100	178	100

[a] Percentages may not always total 100 due to rounding of individual values.

Table 5. Sex and age composition and relative abundance of moose observed during contour surveys in Subunit 20D, 1984-88.

Year	Total sample size	Total bulls: 100 cows	Yrlg bulls: 100 cows	% Yrlg bulls	Calves: 100 cows	% calves	Moose/ mi^2
Robertson River							
1984	98	54	17	10	12	7	25
1985	47[a]	91	14	6	23	11	20
1986	169	60	15	8	24	13	41
1987	No data						
1988	151	45	11	6	43	23	33
Billy Creek							
1985	120	109	15	7	17	8	18
1986	138	77	3	1	17	9	36
1987	No data						
1988	93	93	4	2	13	6	37
North Fork Goodpaster/Slate Creek							
1984	12	83	0	0	17	8	4
1985	25	54	15	8	38	20	10
1986	No data						
1987	No data						
1988	39	32	4	3	24	15	16

[a] Small sample size was due to low search time of 2.3 hours. Search time for other years ranged from 3.9 to 4.6 hours.

Table 6. Mean days hunted for successful and unsuccessful hunters in southwestern, southeastern, northwestern, and northeastern Subunit 20D from 1984 to 1988.

Year	Successful SW	SE	NW	NE	Total	Unsuccessful SW	SE	NW	NE	Total
1984	2.8	6.1	7.2	4.9	5.1	4.3	6.1	5.7	6.4	5.2
1985	4.6	6.7	4.1	5.2	4.6	4.4	5.0	6.1	6.9	5.3
1986	3.8	3.0	5.3	4.1	3.9	5.5	10.5	6.1	7.0	6.0
1987	4.4	7.3	4.8	3.9	4.7	5.3	7.5	6.7	6.5	6.1
1988	4.6	6.2	5.3	4.5	5.0	5.9	6.3	5.8	6.5	6.0

Table 7. Residency of people who hunted in Subunit 20D, 1983-88.

	Local[a]		Nonlocal[b]		Nonres.[c]		Unknown		Total	
Year	No.	%	No.	%	No.	%	No.	%	No.	%
1983	310	57	192	35	30	6	10	2	542	100
1984	343	54	272	43	19	3	1	0	635	100
1985	Data not compiled									
1986	Data not compiled									
1987	335	57	191	32	24	4	41	7	591	100
1988	285	51	190	34	40	7	40	7	555	100

[a] Residents of Subunit 20D.

[b] Other residents of Alaska.

[c] Not Alaskan residents.

Table 8. Transportation methods used by all hunters (successful and unsuccessful combined) in Subunit 20D, 1987 and 1988. Values in parentheses are the number of hunters in each category expressed as a percentage of the total hunters.

Year	Airplane	Horse	Boat	3- or 4-wheeler	Other ORVs	Highway vehicle	Unknown
Southern portion:							
1987	7 (2.1)	4 (1.2)	27 (8.2)	62 (18.8)	29 (8.8)	160 (48.6)	40 (12.2)
1988	10 (3.5)	9 (3.2)	18 (6.3)	47 (16.5)	40 (14.1)	128 (45.1)	32 (11.3)
Northern portion:							
1987	20 (9.0)	1 (0.4)	112 (50.2)	8 (3.6)	6 (2.7)	53 (23.8)	23 (10.3)
1988	17 (7.1)	7 (2.9)	129 (54.2)	6 (2.5)	9 (3.8)	51 (21.4)	19 (8.0)

Table 9. Transportation methods used by successful hunters in Subunit 20D, 1987 and 1988. Values in parentheses are the number of hunters in each category expressed as a percentage of the total successful hunters.

Year	Airplane	Horse	Boat	3- or 4-wheeler	Other ORVs	Highway vehicle	Unknown
Southern portion:							
1987	3 (4.1)	2 (2.7)	4 (5.5)	23 (31.5)	9 (12.3)	28 (38.4)	4 (5.5)
1988	6 (8.5)	2 (2.8)	2 (2.8)	21 (29.6)	9 (12.7)	26 (36.6)	5 (7.0)
Northern portion:							
1987	7 (14.0)	0 (0.0)	30 (60.0)	1 (2.0)	1 (2.0)	9 (18.0)	2 (4.0)
1988	5 (9.8)	1 (2.0)	28 (54.9)	2 (3.9)	2 (3.9)	9 (17.6)	4 (7.8)

Table 10. Browse availability and use by moose near Ober Dome in southwestern Subunit 20D as determined by ground transect surveys during April 1988.

Plant species	Percent occurrence in sample[a]	Mean distance apart[b] (ft)	Mean height (ft)	% plants browsed[c]			
				None	Low	Mod	High
Willows:							
Diamondleaf (*Salix pulchra*)	22	1.1	2.6	0	7	20	73
Halberd (*S. hastata*)	19	1.4	2.7	15	8	46	31
Grayleaf (*S. glauca*)	13	1.1	2.1	22	0	56	22
Richardson (*S. lanata*)	10	1.3	3.2	0	29	71	0
Feltleaf (*S. alaxensis*)	4	6.3	5.0	0	0	67	33
Barren-ground (*S. brachycarpa*)	1	1.0	1.0	100	0	0	0
Unknown	3	1.5	1.5	50	50	0	0
All combined	75	--	--	8	10	44	38
Other species:							
Aspen (*Populus tremuloides*)	24	5.4	4.8	38	25	31	6
Dwarf birch (*Betula glandulosa*)	1	1.0	1.0	100	0	0	0

[a] Sample size equals 67 plants.

[b] Average of the distances from each sampled plant to the nearest plant of the same species.

[c] None = no evidence of browsing on current annual growth, low = 1-24% use of annual growth, mod = 25-74% use of annual growth, and high = 75-100% use of annual growth.

Table 11. Browse availability and use by moose near Big Lake in southwestern Subunit 20D as determined by ground transect surveys during April 1988.

Plant species	Percent occurrence in sample[a]	Mean distance apart[b] (ft)	Mean height (ft)	% plants browsed[c]			
				None	Low	Mod	High
Willows:							
Richardson (*Salix lanata*)	10	2.9	2.2	50	30	0	20
Bebb (*S. bebbiana*)	9	2.8	2.4	56	33	0	11
Diamondleaf (*S. pulchra*)	4	1.5	2.3	0	25	25	50
Grayleaf (*S. glauca*)	2	2.5	2.0	50	0	50	0
Halberd (*S. hastata*)	2	4.5	2.0	0	0	50	50
Littletree (*S. arbusculoides*)	1	4.0	3.0	0	0	100	0
Unknown	2	1.5	2.0	100	0	0	0
All combined	30	--	--	43	23	13	20
Other species:							
Aspen (*Populus tremuloides*)	29	1.9	4.0	97	3	0	0
Dwarf birch (*Betula glandulosa*)	31	2.3	2.2	100	0	0	0

[a] Sample size equals 100 plants.

[b] Average of the distances from each sampled plant to the nearest plant of the same species.

[c] None = no evidence of browsing on current annual growth, low = 1-24% use of annual growth, mod = 25-74% use of annual growth, and high = 75-100% use of annual growth.

STUDY AREA

GAME MANAGEMENT UNIT: 20E (11,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Charley, Fortymile, and Ladue River drainages

BACKGROUND

Moose were noticeably abundant in this area during the mid-1960's. The moose population increased to at least 12,000 by 1965, as a result of a federal predator control program conducted from 1948 to 1959. It is likely that moose were far more abundant than that, but they had not been censused. Moose numbers declined rapidly from 1965 to 1976. Factors that may have contributed to the decline included severe winters in the mid-1960's and early 1970's and increasing numbers of wolves and grizzly bears following the end of predator control. Overhunting was considered not to have been an important factor in the decline, because annual harvests were small in relation to the moose population and largely restricted to the Taylor Highway corridor and the Mosquito Fork drainage. Concurrent moose population declines occurred in remote, unhunted areas as well as in hunted areas.

The Taylor Highway provided access for many moose hunters throughout the 1960's and the early 1970's. It was a popular hunting area for local hunters as well as hunters from Fairbanks and Southeast Alaska. Historically, hunter success rates there were about twice as great as current ones; harvests were greater also. Hunting of antlerless moose (i.e., largely limited to the Taylor Highway area) was halted in 1974, but the population decline continued unitwide. Moose hunting in Subunit 20E (then a portion of 20C) was prohibited in 1977.

The season remained closed until a short (1-10 September) bulls-only season was restored in 1982. State wolf control was conducted during the period 1981-83, and the fall wolf population was reduced by 49% as of the fall of 1982. Grizzly bear hunting regulations were also liberalized beginning in 1978 to increase the bear harvest.

Yearling recruitment and survival of calf moose have improved since reaching low points in 1976. The number of moose observed per hour of survey was low during the period 1976-80, but it has increased since that time, roughly reflecting population trend. Therefore, most indications are that moose have most likely increased in the wolf control area since 1980, albeit very slowly.

Since the moose season was restored in 1982, annual reported harvests of bull moose have increased. Nonresident hunters are not allowed to hunt in Subunit 20E, and hunter success for resident hunters has been approximately one-half that reported in 1970.

POPULATION OBJECTIVES

To maintain a posthunting sex ratio of at least 40 bulls:100 cows in the Charley River drainage.

To 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.

To 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.

To maintain a posthunting bull:cow ratio of at least 40 bulls:100 cows in all areas.

METHODS

Sex and age composition was estimated in November and December 1988 using aerial contour and transect surveys. All moose observed were classified as large bulls (antlers $\geq$50 inches), medium bulls (antlers larger than yearlings but <50 inches), small bulls (spike, cerviform, or palmate-antlered yearling bulls approximately 17 months old), cows without calves, cows with 1 calf, cows with 2 calves, lone calves, or unidentified moose. The same areas have been surveyed annually in a comparable manner. A census was conducted in southwestern Subunit 20E during October 1988 using techniques described by Gasaway et al. (1986).

Moose harvests were estimated from harvest reports. Except for maintaining restrictive moose hunting regulations and liberal grizzly bear regulations, no action was taken in 1988 to increase moose numbers.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size:

An estimated 2,000 to 3,000 moose inhabit Subunit 20E at a density of about 0.18-0.27 moose/mi^2 (70-105/1,000 km^2). A fall 1988 census conducted in a 2,973-mi^2 (7,700 km^2) area in southwestern Subunit 20E within the 1981-83 wolf control area resulted in a density estimate of about 0.4 moose/mi^2 (157/1,000 km^2, 90% CI = 127-188/1,000 km^2). Participants in the census believe that the actual density is probably toward the lower end of the confidence interval, or about 0.33 moose/mi^2 (127/1,000 km^2). A census of the same area in the fall of 1981 resulted in a point density estimate of about 0.23 moose/mi^2 (90/1,000 km^2), with a probable range of 0.18 to 0.27 moose/mi^2 (70 to 105/km^2). Participants in that effort believed that moose density in 1981 was probably in the upper half of the range.

I believe that moose numbers have increased by about 4% annually, or about a total of 50% since the fall of 1981. The moose population has been beneficially affected by wolf control and increased harvests of grizzly bears, based on the comparison of the 1981 and 1988 censuses and the increased yearling survival and moose observed per hour of survey during fall composition surveys since 1981. Moose numbers in areas experiencing no wolf control and only an increased level of grizzly bear harvests have not increased, indicating that reductions in bear and wolf predation or, perhaps, wolf predation alone were needed to allow for moose population growth from severely depressed densities. Even now, moose densities remain at extremely low levels, compared with the carrying-capacity potential.

Population Composition:

Fall moose composition surveys were conducted in Subunit 20E during the period 15-19 November 1988; 463 moose were classified during 15.6 survey hours (i.e., 30 moose/hr). Heavy, early snows (>22 in) precipitated early moose movements that reduced the number of moose in survey areas and, hence, the number observed per hour of survey. Additionally, 585 moose were classified during the census effort during the period 17-23 October 1988. Composition of all 1,048 moose classified are presented in Table 1.

There has been a slowly declining trend in the bull:cow ratios since 1984, although the ratio was still high (78 bulls:100 cows). Calf survival to 5 months remained low (26 calves:100 cows ≥2 years), but it has improved slightly during the past 5 years. Presumedly, higher harvests of grizzly bears and slowly widening ratios between numbers of all ungulates and ungulate predators were responsible. Yearlings ($\underline{n}$ = 138), estimated by doubling the number of yearling bulls observed, composed nearly 15% of all adults ($\underline{n}$ = 931). If adult mortality can be maintained at less than 10%, continued slow growth may occur in southern Subunit 20E.

Six hundred ninety-four moose were classified during 19 survey hours during November and December (Table 1). While the bull:cow ratio of 79:100 is still good, it has declined slightly for 2 consecutive years. The proportion of yearling bulls in the samples has also declined somewhat since 1985. The changes in both the sex ratio and the proportion of yearlings in the herd have been slight but directional, and they may reflect slowly increasing bull harvests from 1982 through 1987 and a concurrent increase in wolf numbers since the wolf control efforts were halted in the fall of 1983. It is important to maintain a high proportion of males as buffer prey to females in moose populations heavily impacted by wolf predation (William Gasaway, pers. commun.).

Survival of calves to 5 months during the past 2 years has been the highest recorded since 1971; although it is still quite low (Table 1), it probably resulted from increased harvests of grizzly bears since 1981. Most grizzly bear predation on calf moose occurs within the first few weeks of life; however, recent management efforts to improve early calf survival have been negated by increased overwinter loss of calves to wolf predation. Boertje et al. (1987) concluded that moose in Subunit 20E were large, healthy, and productive (130 calves:100 cows $\geq$2 years and a 40-50% twinning rate), but that predation on calves by bears during the summer and wolves year-round was limiting growth of this depressed population. Composition data suggest this was still the case.

Distribution and Movements:

Moose were well distributed throughout Subunit 20E. While resident moose remained in the Mosquito Flats area, most others made seasonal movements between lowland summer habitat and upland rutting areas, where they remained until winter conditions caused them to move back to lower elevations. In the fall of 1988, early deep snowfall (>22 inches) caused moose to move to lower elevations earlier than in previous years.

Mortality

Season and Bag Limit:

The open season for subsistence and resident hunters in that portion of Subunit 20E draining into the Yukon River within Alaska upstream from and including the Charley River drainage is 5 to 25 September; the bag limit is 1 bull. The open season for subsistence and resident hunters in the remainder of Subunit 20E is 1-10 September; the bag limit is 1 bull. There is no open season for nonresident hunters in Subunit 20E.

Human-induced Mortality:

Total reported harvest in Subunit 20E during the fall 1988 season was 57 bulls (Table 2), or about 2% of the estimated population. This was the greatest reported harvest in the last 7 years. Increased numbers of hunters, many of whom were also seeking caribou, contributed to the slight increase in harvest and decrease in success during 1988. Regulatory changes affecting caribou hunters in Subunit 20E are expected to reduce the number of hunters and, subsequently, the harvest of moose in the fall of 1989.

The Yukon River serves as the boundary between Subunits 20E and 25B. Prior to 1984 the season throughout Subunit 20E was 1-10 September; however, most of the harvest along the Yukon River occurred after that date. According to reports by residents of Eagle, harvests of moose in Subunit 20E were either reported falsely to Subunit 25B or not reported at all. In 1985 this reporting problem was largely corrected when the season in northern Subunit 20E was aligned with the season in Subunit 25B.

Of the 57 moose harvested, 11 (19%) were taken along the Yukon and Charley Rivers ($\underline{n}$ = 8 and 3, respectively) and 46 (81%) were taken in the remainder of the unit. The Mosquito Fork drainage received the greatest harvest; 18 bulls were taken there. The Dennison Fork and West Fork drainages contributed 10 bulls, as did the Middle Fork.

Although hunting pressure has increased in Subunit 20E (Table 2), hunter density was very low, except along the Taylor Highway. Moose hunting pressure incidental to caribou hunting is expected to decline in the fall of 1989 because of the new permit system for caribou hunting.

The mean antler spread of bulls taken in Subunit 20E was 46.2 inches, 3 inches less than 1987. Six bulls (11%) were judged to have been yearlings (antlers <30 inches), 23 (42%) were 2-4 years old (antler spread 30.0-49.99 inches), and 26 (47%) were mature bulls (antler spread ≥50 inches). Nine bulls (16%) were taken that had antler spreads ≥60 inches, and three (5%) had antler spreads >65 inches. Antler spreads were estimated for 408 bulls observed during posthunting aerial surveys, suggesting a similar age composition to that of harvested bulls (17% yearlings; 44% 2- to 4-year-olds; 39% 5 years or older). There does appear to be hunter selectivity for larger bulls.

Hunter Residency and Success. Nonresident hunters have been prohibited from hunting moose in Subunit 20E since 1984, even though the number of moose harvested by nonresidents during 1982 and 1983 was insignificant. Two bulls were taken illegally by nonresidents during the 1988-89 reporting period. Of the 57 bulls harvested, 14 (25%) were taken by residents of Unit 12 and Subunit 20E but only four of those were taken by residents of Chicken and Eagle. Nonlocal residents reported taking 36 moose in Subunit 20E. Of these, two were from Delta, eight were from Southeast Alaska, 10 were from Southcentral Alaska, and 13 were from Fairbanks. Residency was not specified by 5 successful hunters.

Hunter success was only 17% overall; 344 hunters reported (Table 2), representing a 30% increase over the 265 moose hunters reporting in 1987. Although success has ranged from 17% to 22% since 1982, unsuccessful hunters are less likely to report than successful hunters, biasing rates on the high side. Fifty-eight hunters from Unit 12 and Subunit 20E experienced a 24% rate of hunter success, probably because of their familiarity with moose distribution and movements in this area. Achievement of the 35% success rate (i.e., population objective) will probably not occur until moose densities significantly increase.

Harvest Chronology. The moose hunting seasons in Subunit 20E are so short that analysis of harvest chronology is of limited value. The harvest date or the 56 moose taken during the season are as follows: 27 (48%) 1-6 September, 18 (32%) 7-13 September, seven (13%) 14-20 September, and two (4%) 20-25 September. One moose was reported taken in December, long after the hunting season had closed.

Transport Methods. Most hunters used highway vehicles (102), followed by three- or four-wheelers (74), boats (48), aircraft (46), and ORV's (23), and unspecified (48). As expected, hunters using aircraft experienced a relatively high rate of success (33%), followed by those using ORV's (26%), boats (16%), and three- or four-wheelers (12%). One of 2 hunters on horseback also took a bull. Hunters using highway vehicles had the lowest rate of success (11%). Hunter success for those using three- or four-wheelers has remained lower than expected.

Hunters using aircraft for access accounted for 29% of the harvest, followed by hunters using highway vehicles (22%), ORV's (12%), three- or four-wheelers (18%), and boats (16%). Transport means were not reported by 11% of successful hunters.

Hunters who used transport methods to reach areas away from the Taylor Highway generally experienced greater success than those who did not. Many subsistence hunters lack the means to hunt far from their highway vehicles. While there is some resentment among subsistence hunters toward hunters who can afford to use aircraft, there is virtually no actual competition for moose. Aircraft-borne hunters hunt moose generally unavailable to most subsistence hunters, who hunt along the Taylor Highway corridor. Most competition for moose between local and nonlocal hunters occurs near the Taylor Highway.

Natural Mortality:

Predation by wolves and grizzly bears is the greatest source of mortality for moose in Subunit 20E. Grizzly bears and wolves prey upon both calves and adults to such an extent that they are controlling growth of this depleted, low-density moose population. In relation to the moose population, both predator species are abundant in Subunit 20E.

Boertje et al. (1987) reported that predators were responsible for 34 (89%) of 38 adult moose deaths investigated. Other causes of death included antler wounds (2), drowning (1), and gunshot wounds (1). The minimum adult moose mortality was estimated to be at least 7%. This mortality rate may be greater now that the wolf population has increased.

Calf mortality was also extremely high. Boertje et al. (1985) reported 82% mortality among 33 neonates collared in the spring of 1984; most mortality occurred within 8 weeks of birth. Grizzly bears killed 52% of the calves, wolves killed 12-15%, and black bears killed 3%. Four calves (12%) drowned. It is important to remember that wolf control efforts had reduced wolf numbers by approximately 64% in the core study area by 1984. Because wolf numbers have increased since control ended, the percentage of calf moose killed by wolves was most likely higher.

Habitat Assessment and Enhancement

Most of Subunit 20E has potential moose habitat, except areas above elevations of about 4,000 feet. Over 2 decades of largely unnecessary fire suppression have produced an unnatural habitat mosaic, with more spruce forest and less brush land and deciduous forest than would have existed under a natural fire regime. Even so, the availability of browse far exceeds that necessary to support the current moose population. Of 2,820 browse plants examined during the mid-1980's, 86% had not been browsed during the previous winter, and use of the current annual growth had been less than 5% (Boertje et al. 1985). Food availability is not currently limiting moose population growth in Subunit 20E, nor is it expected to do so in the near future, given the present low rates of moose population increase.

Implementation of the Alaska Interagency Fire Management Plan is expected to restore a near-natural wildfire regime to over 60% of Subunit 20E. Unfortunately, a series of wet summers and/or insufficient occurrence of lightning strikes during dry conditions has produced few fire starts since 1984, when the plan went into effect. Under the plan, much state and federal land was accorded only limited fire protection, because values requiring a higher level of protection were largely absent. However, nearly all land selected by Native corporations was accorded modified or full-suppression status. The habitat in these areas of higher fire protection will continue to degrade, to the detriment of moose and other wildlife species that fare best in a fire-shaped environment. Additionally, recent actions on the part of federal and state fire suppression organizations have resulted in the suppression of some fires that, under terms of the plan, should not have been suppressed.

Game Board Actions and Emergency Orders

Moose hunting regulations were not changed in Subunit 20E during this reporting period; however, during the November 1987 meeting the Board of Game prohibited the taking of wolves by the land-and-shoot method. This restriction, which greatly reduced the harvest of wolves during the winter of 1988-89, further disadvantaged the already depleted moose population.

CONCLUSIONS AND RECOMMENDATIONS

After several years of intensive research into factors limiting moose in Subunit 20E and extensive survey-inventory efforts, it can only be concluded that predation is limiting growth of this low-density moose population. Strategic goals and specific population management objectives are not being met and cannot be met until predation is reduced sufficiently to allow the moose population to grow at a moderate 10% annual growth rate. A larger and more productive moose population will be necessary to meet the needs of humans as well as predators and scavengers in this ecosystem.

Liberalized hunting regulations for grizzly bears have resulted in increased bear harvests since 1981. Calf survivals to 5 months have increased during the last 3 years to 27, 24, and 26 calves:100 cows $\geq$2 years. However, because wolf numbers have increased since the early 1980's, wolves are believed responsible for the continued low observed rates of yearling recruitment. The recent action taken by the Alaska Board of Game has had the effect of further reducing annual harvests of wolves by the public, thereby potentially aggravating this situation.

Annual harvests of bull moose have been maintained at less than 3% of the estimated moose population, but given the extent of predation, even this level of harvest is affecting the sex ratio. At the very least, I recommend restoration of same-day-airborne taking of wolves in Subunit 20E, maintenance of liberal bear hunting regulations, and conservative moose hunting regulations. Furthermore, I recommend a program to significantly reduce wolf predation on moose to augment the benefits to calf survival that are apparently resulting from reduction of the grizzly bear population.

Federal and state land managers with responsibilities for managing wildlife habitat on their lands should be persuaded to resist attempts by the fire suppression organizations to fight most fires. Continued degradation of habitat diversity and quality will result as long as naturally ignited wildfires continue to be suppressed.

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Table 1. Moose sex and age ratios, Subunit 20E, 1984-88.

Year	Males: 100 females	Yrlg males: 100 females	Yrlg male % in herd	Calves:100 cows ≥2 yrs	Calf % in herd	Twins:100 cows w/ calf	Moose/ hour	Total moose
1984	68	12	6	11	12	0	22	383
1985	86	15	7	19	8	4	29	613
1986	80	12	6	27	18	7	29	701
1987	79	9	5	24	11	6	37	694
1988[a]	78	13	7	26	11	5	30	1,048
Mean	78	12	6	21	12	4	29	

[a] Heavy early snowfall precipitated early moose movements which reduced moose/hr observed. Sample includes 585 moose classified during the census.

Table 2. Reported and estimated moose harvest, number of hunters, and hunter success in Subunit 20E, 1984-88.

Year	Reported harvest M	F	Unk	Total	Estimated harvest Unreported[a]	Poaching[b]	Total	Total reporting hunters	Success[c] (%)
1984	29	0	0	29[d]	3-6	5-15	37-50	151	19
1985	49	0	0	49[e]	4-7	5-15	58-71	225	22
1986	46	0	0	46	4-7	5-15	55-68	233	20
1987	52	0	2	54	6-10[f]	5-15	65-79	265	20
1988	56	0	1	57	4-7	5-15	66-79	344	17
Mean				47				244	20

[a] Unreported take during the hunting season.

[b] Out-of-season take.

[c] Among reporting hunters.

[d] Yukon corridor harvest not included.

[e] Season along Yukon River lengthened; reporting improved.

[f] Confusing wording in the regulations resulted in some moose being killed after the season had closed.

STUDY AREA

GAME MANAGEMENT UNIT: 21A and 21E (23,673 mi^2)

GEOGRAPHICAL DESCRIPTION: Upper Nowitna River, Innoko River, and Yukon river between Paimiut and Blackburn Rivers

BACKGROUND

Anecdotal information implies that moose were a relative rarity in these subunits until after the turn of the century; however, moose densities in parts of the area are probably higher now than ever before. Over the past 5 or 6 decades, local residents have become dependent upon the moose resource. The major factors influencing moose abundance in Subunits 21A and 21E include predation, hunting, and spring flooding. Overbrowsing is not a serious concern, despite locally heavy winter browsing in riparian areas along the Yukon and Innoko Rivers.

Wolf numbers are moderate to high, and their effects on local moose populations are significant. Brown bears are also present, but they account for only a small amount of predation mortality. Black bears are seasonally numerous, especially in Subunit 21E, but the amount of predation attributable to them is unknown. High water levels in late spring may also account for calf mortality during some years, although the extent of that mortality is unknown.

Several villages are located in Subunit 21E, and most hunters live in the subunit. Moose meat is an important part of the diet for local residents, who use boats for access to their hunting areas. Most hunters in Subunit 21A do not live there; typically, these hunters want to harvest large-antlered bulls and use aircraft to gain access. Subunit 21A provides considerable recreational opportunities for hunters willing to travel to remote areas.

Research is presently being conducted cooperatively by the U.S. Fish and Wildlife Service-Innoko National Wildlife Refuge (FWS), U.S. Bureau of Land Management (BLM), and the Alaska Department of Fish and Game (ADF&G) to gather data on moose movements, parturition, and survival. During early spring 1986, 24 moose were radio-collared in Subunit 21E. In 1988 an additional 36 moose were radio-collared in Subunit 21A.

During early winter 1987, an attempt was made to conduct a population estimation survey (Gasaway et al. 1986) of moose on 2,200 mi^2 of the Paradise Controlled Use Area in Subunit 21E between the Yukon and Innoko Rivers. Although biologists were unable to complete the survey, 1,711 mi^2 were successfully stratified and 18 sample units (SU) were completed before the survey was halted. This effort indicated that moose densities were low, medium, and high in 64%, 32%, and 4% of the area, respectively. Observed densities ranged from zero to 12.5 moose/mi^2; 832 moose were classified during the survey attempt.

In February 1988 a moose composition survey was conducted in approximately 30 mi^2 of the Paradise Controlled Use Area between Great Paimiut Island and Carlo Island. Three hundred eight moose were classified.

POPULATION OBJECTIVES

To delineate moose survey areas in both subunits suitable for use in obtaining annual information on population status and trend.

To maintain a population in Subunit 21A capable of sustaining a reported harvest of at least 150 bull moose with an average antler spread measurement in excess of 48 inches.

To maintain a population in Subunit 21E capable of sustaining a reported harvest of at least 125 moose that includes some reasonable opportunity to take cow moose.

To maintain a reported hunter success rate of at least 50% in both subunits.

To encourage the FWS, BLM, and Alaska Department of Natural Resources (ADNR) 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 Plans, so that fire can fulfill its natural role of maintaining young, highly productive, and diverse habitats.

To increase compliance with the requirement to use harvest tickets and reports.

METHODS

Standard aerial survey techniques were used to monitor moose population dynamics in Subunits 21A and 21E; these included occasional stratification flights, annual composition or trend surveys in established count areas, and occasional population estimation surveys. Standard radiotelemetry techniques were used to obtain information on moose mortality and movement. Hunting mortality and distribution were monitored through harvest tickets 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:

There is not enough information on moose distribution and abundance in Subunit 21A to produce a population estimate. In Subunit 21E, there was a minimum of 3,000 moose, based on extrapolation of stratification and sampling data from an attempted population estimation survey in the early winter of 1987. However, since the survey was not completed, there is no statistical justification for this estimate.

A population estimation survey planned for a 1,100-mi^2 portion of the Innoko National Wildlife Refuge was not completed during this reporting period because of weather constraints. This survey will be rescheduled for early winter 1989.

Population Composition:

In Subunit 21A, composition surveys were conducted in eastern portions of the Innoko River drainage, where snow cover was adequate (Table 1). Moose densities in the selected survey areas were relatively low. No historical comparisons were made because of the variable timing of prior surveys. No surveys were conducted in Subunit 21E because of inclement weather.

Distribution and Movements:

The FWS-Innoko Refuge staff continued to sporadically monitor the radio-collared moose in Subunits 21A and 21E during this reporting period. Information received to date indicated that most adult moose were migratory over relatively short distances. However, bulls remained away from riparian zones during summer, fall, and early winter until snow depths pushed them down to lower elevations.

Mortality

Season and Bag Limit:

The open seasons for subsistence and resident hunters in Subunit 21A are 5-30 September and 1-30 November. The open season for nonresident hunters is 5-30 September. The bag limit is 1 bull. The open seasons for subsistence and resident hunters in Subunit 21E are 5-25 September and 1-10 February. The bag limit is 1 moose; however, antlerless moose may be taken only from 1-10 February. The open season for nonresident hunters is 5-25 September; the bag limit is 1 bull.

Human-induced Mortality:

The reported harvest of 167 moose from Subunit 21A during the reporting period is the highest on record (Table 2). Linear regression of the harvest as a function of time showed that harvests have increased significantly since 1980 ($r = 0.8206$, $\underline{P} \leq 0.02$, 6 df). I believe this increase reflects an actual increase in harvest, rather than an increase in reporting. Hunter success rates have remained relatively stable.

In Subunit 21E, the reported harvest of 150 moose was higher than harvests of the previous 5 years (Table 3). Linear regression of harvest as a function of time showed that harvests have increased significantly since 1979 ($r = 0.8149$, $\underline{P} \leq 0.01$, 7 df). Success rates have remained relatively stable.

Local compliance with the harvest ticket reporting requirement remained poor. The illegal and unreported harvest of moose in Subunit 21E continued to be extremely high. Residents of Grayling, Anvik, Shageluk, and Holy Cross harvest a minimum of 75-100 moose annually, but only 11 harvest tickets were returned during the 1988-89 season. I suspect that the actual moose harvest in the subunit is at least twice that which was reported.

Hunter Residency and Success. Nonresidents and residents who reside in locations other than Units 18, 19, and 21 continued to account for the majority of the harvest (82%) in Subunit 21A (Table 4). During 1988 residents of Unit 21 reported taking only 4 moose (2.4%) from the area. Residents of Unit 18 accounted for 10.8% (18 moose) of the reported take. The residencies of hunters using Subunit 21A during 1988 were not substantially different from those of previous years.

In Subunit 21E, subsistence use of moose by residents of Unit 21 and Unit 18 accounted for the majority of the reported harvest (Table 5). In 1988 most hunters (49.2%) were from rural locations in Unit 18. As with previous years, nonresidents accounted for a very small percentage (8.4%) of the hunters in Subunit 21E.

Harvest Chronology. During 1988 most (97%) of the reported harvest in Subunit 21A occurred during the 25-day September season. Only 2 moose were killed during the November hunt.

In Subunit 21E, 130 of 150 (87%) of the reported harvest occurred in September. An additional 14 moose (13%) were taken in February. The number of hunters involved in the 10-day February subsistence hunt was substantially less in 1987 because only residents of the subunit and Russian Mission were eligible to participate.

Transport Methods. In Subunit 21A, aircraft were used by approximately 61% of the hunters. Boats were used by an additional 25%, most of whom traveled up the Innoko River into the subunit to hunt. Conversely, 73% of the reporting hunters in Subunit 21E used boats for access. This difference was due to the proximity of hunting areas to the majority of the users, good boat access to most of the subunit, and a prohibition on the use of aircraft for moose hunting in the Paradise Controlled Use Area. Snowmachine use composed 5.2% of the total because of the 10-day February subsistence season.

Natural Mortality:

No new information was available to suggest a change in the 1987 estimates of 166 and 86 wolves in Subunits 21A and 21E, respectively. There were 21 packs in Subunit 21A and 10 packs in Subunit 21E. These moderate-to-high wolf densities, coupled with a relative scarcity of alternate prey species, undoubtedly affected moose numbers.

Water levels were moderate during spring 1988. Very little, if any, neonatal mortality occurred.

Natural wildfires burned at least 20,000 acres near the Innoko River near Cripple Landing during the summer of 1988. This burning is expected to result in increased availability of young, high-quality, and highly palatable browse for moose.

Game Board Actions and Emergency Orders

The Game Board eliminated the February season for moose in Subunit 21E during their spring 1989 meeting. No other regulatory changes were enacted that will affect the 1989-90 seasons.

CONCLUSIONS AND RECOMMENDATIONS

Moose populations appear to be doing well in both Subunits 21A and 21E. The mean antler sizes of harvested bulls and hunter success rates have remained relatively high, despite a long-term increase in the harvest. Therefore, at this time I would not recommend any changes in the existing regulations.

The most important management problem in Subunit 21E and, to a lesser extent, Subunit 21A is noncompliance with the harvest reporting requirement. Educational efforts to emphasize the importance of harvest tickets should continue in the villages of Grayling, Anvik, Shageluk, and Holy Cross. Enforcement of the reporting requirement should be increased. The Alaska Department of Public Safety, Division of Fish and Wildlife Protection, should be encouraged to continue their enforcement programs along the Innoko River during the moose hunting seasons.

I believe the moose population in Subunit 21E is larger than the population objective specified. If planned population estimation surveys confirm this conclusion, the population objective should be reevaluated. I see no justification for attempting to curtail the growth of the population.

Cooperative arrangements with the FWS and the BLM should continue. Valuable information concerning moose densities, movements, natality, and mortality rates is being collected at reasonable costs because of joint projects with these agencies.

The Department should reiterate its continued support for the existing interagency fire management plans. We need to continue emphasizing the need and benefits of wildfires, in terms of moose browse enhancement.

Recently passed legislation will make it possible to document efforts and harvest levels among hunters using outfitters. I hope to evaluate this information for Subunit 21A during the next reporting period.

Although some standardized moose composition and trend areas were established during the fall of 1988, additional areas are needed. Standardized survey areas or routes should be outlined and data collected annually until population trends have been established.

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Table 1. Moose population indices calculated from aerial survey data from Subunit 21A, early winter 1988.

Area	Bulls: 100 cows	Calves: 100 cows	% Calves	n	Moose/ hour
Upper Innoko - Ophir	66.7	40.0	19.4	31	11.8
Upper Innoko - Fourmile	237.5	12.5	3.6	28	9.9
North Fork Innoko River	52.3	40.9	21.2	85	77.3
Total	77.6	37.3	17.4	144	26.0

Table 2. Annual reported moose harvests in Subunits 21A and 21E, 1984-88.

Year	Males	Females	Total
Subunit 21A			
1984	136	0	136
1985	120	0	120
1986	126	0	126
1987	146	0	146
1988	167	0	167
Subunit 21E			
1984	133	0	133
1985	100	8	108
1986	101	11	112
1987	105	6	111
1988	139	6	150

Table 3. Reported residency of moose hunters in Subunits 21A and 21E during the 1988-89 regulatory year.

	Successful	Unsuccessful	Total	% of Total
Subunit 21A				
Unit 21 residents	3	1	4	1.7
Unit 18 residents	16	2	18	7.7
Unit 19 residents	13	3	16	6.8
Other Alaska residents	60	30	90	38.5
Nonresidents	57	24	81	34.6
Unknown residency	18	7	25	10.7
Total	167	67	234	100.0
Subunit 21E				
Unit 21 residents	10	1	11	5.8
Unit 18 residents	74	20	94	49.2
Unit 19 residents	0	0	0	0.0
Other Alaskan residents	14	7	21	11.0
Nonresidents	12	4	16	8.4
Unknown residency	40	9	49	25.6
Total	150	41	191	100.0

STUDY AREA

GAME MANAGEMENT UNIT: 21B (4,600 mi^2)

GEOGRAPHICAL DESCRIPTION: Lower Nowitna River and Yukon River between Melozitna and Tozitna Rivers

BACKGROUND

Moose were fairly abundant when gold seekers converged on the area in the early 1900's. The town of Ruby had a population of 10,000 people during the 1910 gold rush, and many moose were hunted to supply the townsfolk with meat. The area was believed to have supported a large moose population from the early 1900's to late 1970's. Several severe winters in the late 1960's and early 1970's initiated widespread declines in moose populations throughout the Interior.

Historically, naturally occurring wildfires have been a major force affecting the productivity and diversity of moose habitat in this area. A major portion of the area was burned by large fires prior to the 1950's, when effective fire suppression substantially altered this fire regime. The Tanana-Minchumina Fire Plan (1982) provided the mechanism for returning to a natural fire regime in most of this area by allowing some fires to burn with minimal interference.

The Nowitna River (Novi) drainage to the east of Ruby is the main hunting area for residents of Ruby, Tanana, and to a lesser extent, Galena. It is also a popular hunting area for Fairbanks residents who use boats and aircraft for access. Because of its long history of use by both local and nonlocal hunters, this area has been the focus of much of the management effort in Subunit 21B over the years.

Aerial moose surveys during the period 1977-79 suggested that moose numbers were declining in the Novi. Wolves were abundant, compared with the number of moose available, and predation by wolves was responsible for the decline in moose numbers. Thus a wolf control program was approved to augment the existing harvest by hunters and trappers. The total harvest from the drainage during the 3 years of the program amounted to 61 wolves: 11 in 1978-79; 27 in 1979-80; and 23 in 1980-81 (ADF&G 1983). Part of Subunit 21A was included.

Restrictions were also placed on hunters while the wolf control program was in effect. A registration permit system was enacted, aircraft were prohibited, and the season was shortened to 10 days. In addition, a hunter check station was operated at the mouth of the river from 1979 to 1983.

A population estimation survey 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 prior data were of poorer quality, it was not possible to ascertain whether the increase in the moose population was due to reductions in the wolf population and restrictions on hunting or an artifact of the survey data.

When wolf control was suspended in 1981, the aircraft restrictions and permit requirement were dropped. Since 1981 hunters have had a 20-day season and a bag limit of 1 bull moose. Harvest reports indicated the number of hunters using the Novi has remained stable, the harvest averaging 49 bulls over the last 10 years.

In 1986 an estimated 783 ± 191 moose were in a 1,556-mi^2 portion of the lower Novi; survey techniques were similar to those employed in 1980. By performing the population estimation calculations on a subset of the original 1980 data that corresponded to the 1986 area of interest, we estimated that the same area in 1980 contained 1,390 ± 373 moose. The assumption was made that these 2 population estimation surveys were comparable. The 2 estimates were then compared with a two-tailed Student's $\underline{t}$-test and found to be significantly different at the 95% confidence level. This analysis indicated that a decline in moose numbers had occurred during the interval between the 2 surveys. The magnitude of the decline may have been as high as 44% over the 6-year period.

Calf survival to 6 months of age was thought to have been good to excellent in most years, as indicated by the calf:cow ratio. In contrast, overwinter survivals of calves were poor during the early 1980's, when the population had been declining. Yearling bulls composed only 3-5% of the moose surveyed from 1983 to 1986.

Low temperatures, deep snow, and crusting ice created severe conditions for moose in Subunit 21B during the winter of 1989. During January the temperature remained at -60°F or lower for almost 3 weeks; minus 80°F was recorded in Galena. Warmer temperatures and rain during February created a 2-inch ice crust on top of the 3.5- to 4.0-foot snow pack. The deep snow and ice crust curtailed movement, except were the snow had been packed.

Spring flooding during May 1989 was also severe. Melting of the deep-winter snow pack caused extensive local flooding, and a large ice jam at Kokrines on the Yukon River caused flooding up to 6 miles from the river bed at depths estimated up to 12-15 feet.

Besides the lower portion of the Novi drainage, Subunit 21B included the area east of the Ruby-Poorman Road, the banks of the Yukon River from Ruby to Tanana, the Blind River, and the Boney River. These areas produced from 36% to 46% of the reported harvest.

POPULATION OBJECTIVES

To increase the overall moose population in Subunit 21B to 4,000-4,500 by 1995.

The Floodplain Areas of the Yukon and Novi Rivers (400 mi^2)

To maintain or increase November moose densities to 2.5-4.0 moose per mi^2.

To maintain an average annual harvest of 40 moose from the desired population of 1,000-1,600 moose.

To determine the extent and sources of moose calf mortality from May 1988 through May 1990.

Remainder of the Novi Drainage in Subunit 21B (2,200 mi^2)

To maintain or increase November moose densities to 0.5 moose per mi^2.

To maintain an average annual harvest of 20 moose from the desired population of 1,100-1,300 moose.

Remainder of Unit (2,300 mi^2)

To maintain or increase November moose densities to 0.5 moose per mi^2.

To maintain a minimum annual harvest of 30 moose from the desired population of 1,600-1,700 moose.

METHODS

Population status and trend were monitored by conducting aerial surveys from a Piper PA-18 or equivalent aircraft in the early winter (mid-October to mid-December) in established trend areas. Each trend area contains contiguous survey units of approximately 12 mi^2 each to facilitate search effort and data recording. A search effort of 4 min/mi^2 or greater was attempted to maintain reasonably high sightability and thereby reduce survey bias.

Hunting mortalities were monitored by moose harvest reports and a hunter check station staff who collected information on hunter residencies, moose ages, and antler sizes. Predation mortalities were monitored by interviewing wolf trappers and conducting a wolf (USFWS) and moose calf mortality studies.

Calves used in the mortality study were captured by hand. A helicopter usually remained in the air hovering between the capture personnel and the cow while the calf was being handled. A radio transmitter sewn into an elastic-bandage material of the collar was placed on the neck of each calf. Calves were sexed and then left unattended to give the cows time to re-bond. Bond separation and calf handling time ranged from 20 seconds to 2 minutes. For purposes of data analysis, mortality among calves that did not re-bond or were influenced by our activities were assumed to be capture related.

Browse availability and use were determined by conducting standardized line transects at desired locations in the subunit. Data were collected for browse species that were closest to sampling points located at 5-step intervals. Use of the annual growth was estimated by visually categorizing the level of browsing into 1 of 3 categories: low (up to 25% browsed), medium (25-75% browsed), and high (greater than 75% browsed). Availability was determined by frequency of occurrence of each species along the transect and the distance to the nearest neighbor of the same species at each sampling point.

RESULTS AND DISCUSSION

Population Status and Trend

High moose densities (i.e., 2.0-4.0 moose/mi^2) existed in favorable habitat along the Nowitna River floodplain and immediately adjacent to the Yukon River. Densities were low to moderate (0.2-0.9 moose/mi^2) away from the river. Based on the results of the population estimation surveys, moose numbers decreased in the lower Novi sometime between 1980 and 1986. Although this conclusion is based on a statistically significant change in the population estimates, this trend can also be demonstrated by comparing the stratification results from the 2 surveys. In 1980, 42 survey units (531 mi^2) were classed as low density, compared with 82 survey units (1,018 mi^2) in 1986. Similarly, the number of medium-density survey units decreased from 56 (713 mi^2) to 35 (448 mi^2) and the number of high-density survey units decreased from 23 (312 mi^2) to seven (88 mi^2).

Moose density data collected from established trend areas along the lower Novi suggested that the population was stable or slowly increasing (Table 1). It may have already begun to increase at the time of the second population estimation survey in 1986. The density of total observed moose has steadily increased because of the yearly presence of large calf cohorts after 1985. To approximate what was happening to the breeding population, the calf and yearling component was eliminated from the moose/mi^2 index. The cow moose/mi^2 index likewise removed calves from the analysis, but left in the yearling cows. Both the latter 2 indices showed a lag in the suggested increase in density because of poor survival of 1985 calves.

Population Size:

There are from 1,750 to 2,850 moose in the subunit.

Population Composition:

Composition data was available from aerial surveys conducted by staff of the U.S. Fish and Wildlife Service (USFWS) in established trend areas on the Nowitna National Wildlife Refuge (Tables 1, 2). The 1988 results indicated that bull:cow ratios were good, calf:cow ratios excellent, and overwinter survival of calves to yearling age improved. The occurrence of twin calves among moose observed in these early winter surveys has also increased. A population with these attributes can be reasonably expected to grow. The fact that the bull:cow ratio has been increasing suggested that recruitment was adequate for the population to increase.

The twinning rates among cows with calves observed during May 1988 and May 1989 were 48% and 58%, respectively. In addition, 42% of all cows observed in May 1989 had calves by 25 May.

Distribution and Movements:

Early winter surveys indicated that moose were numerous along the floodplains of the Nowitna and Yukon Rivers. The riparian areas contained extensive willow browse species, which are the preferred for moose.

The relocations of calves collared for the calf mortality study have provided information on the seasonal distribution of cow moose accompanied by calves. The majority of the cows associated with this study spent most of their summer months around open grass and brush meadows on the floodplain, but away from the river. In October they moved to the riparian areas. Most of the yearlings returned to their riparian natal areas in early May 1989.

The Yukon River flooded the riparian areas in late May 1989, causing moose to temporarily move to upland black spruce areas away from the river. The collared calves, now yearlings, moved back to their natal areas as the flood waters subsided.

A cow that swam the Yukon River twice during summer 1988 with her calf wintered to the north of the Yukon on the 3,000-foot hills separating the Yukon River from the Melozitna River. Because of ice jammed along the edge of the Yukon River the cow and the yearling were unable to return to the natal area, staying on the north bank until July 1989. One other cow on the south side left the floodplain area of the Novi and wintered in the surrounding 2,000-foot hills.

<u>Mortality</u>

Season and Bag Limits:

The season in Subunit 21B is 5-25 September; the bag limit is 1 bull.

Human-induced Mortality:

The reported harvest has remained fairly stable, averaging 95 moose annually over the past 5 years (Table 3). The unreported harvests were 5 and 10 moose in the Ruby and Tanana areas, respectively. The Nowitna drainage has produced from 54% to 64% of the subunit's harvest during the last 5 years.

For the first time since 1981 a continuously operated moose hunter check station was located at the mouth of the Novi (in cooperation with the USFWS) to interview hunters using boats. The results (Table 4) indicate that the majority of hunters came from the Fairbanks area. Prior to 1980 more Yukon River village hunters visited the Novi in pursuit of moose. The increase in moose populations in Subunit 21D has changed hunting patterns, and more Ruby and Galena residents have been hunting within Subunit 21D.

<u>Hunter Residency and Transportation Methods</u>. Based on harvest reports, the majority (58%) of the hunters were nonlocal residents. Twenty-three percent of the hunters resided in Ruby, Tanana, and Galena; 10% of the hunters were nonresidents, reflecting a 250% increase over that for the previous year. Residency was unspecified for 13% of the hunters.

Because of easy river access, 67% of the hunters used boats. Another 10% used aircraft, 8% hunted via vehicles on the Ruby-Poorman Road, and 14% were not specified.

Natural Mortality:

A moose calf mortality study commenced on the lower portion of the Novi during May 1988, in cooperation with the USFWS (Loranger and Osborne 1988). From 22 to 24 May 1988, 41 calves (range = 6 to 48 hours old) were captured and fitted with radio collars. From 25 to 27 May 1988, 5 new calves were fitted with collars from calves that had died of either natural or capture-related causes.

Five (11%) of the 46 calves handled during the collaring effort died from capture-related causes. The 46 calves handled represented the offspring of 27 cows. Forty-eight percent of the cows with calves had twins. One collared calf died from stress. Another died from starvation brought on by abandonment. Two more drowned while trying to follow the cow across a marsh. Another became separated from its twin and cow and was subsequently killed by a black bear.

We began the mortality study phase with 41 bonded cow-calf pairs. By 30 June 1988 black bears had killed 11 calves and wolves had killed 2 calves, representing a 32% loss over the 49-day period. We found that when one of a set of twins was killed, the cow and the remaining calf would leave the immediate area for a week or two. Then they would return. There was only 1 instance in which both members of a set of twins were killed at the same time.

Eighteen of the 41 calves died within 6 months after birth because of natural causes other than predation; 61% of the deaths occurred during the first 4 weeks. When the interval after birth was extended to 8 weeks, it included 89% of the total losses due to causes other than predation.

Predators killed an additional 17 calves. Eighty-eight percent of the calf predation was by black bears. Grizzly bears and wolves killed just 1 calf each.

Some interesting observations were made. A dead calf with a black bear bite on its neck was found in a pond. We presume that it had escaped to the pond where it had either drowned or died from its wounds. We found the other twin dead 1 mile away from the pond. It may have been killed by the same bear.

Another set of twins became separated 10 days after collaring. The cow and 1 twin moved 2 miles away, and the orphan remained in the original area. The orphaned calf appeared to do well during the first 11 days, despite having been weaned at 10 days and being in the vicinity of 2 black bears; on the 12th day it was killed by wolves.

Six radio transmitters fell off the collars during September 1988, after wearing through the elastic-bandage material. On 2 October 1988 we darted all the remaining calves to replace the collars, and 2 new calves were collared to bring the sample size up to 19 calves. The mortality from 2 October 1988 until 15 May 1989 was 9 calves (47%). Five were killed by wolves, two died of winter poverty and starvation, and two were drowned during spring breakup and subsequent flooding; both of the drowned calves had taken refuge on high ground that was later covered as the flood waters rose even higher.

Forty-nine additional calves were radio-collared during May 1989; 48 calves remained bonded with their cows. Mortality was higher than in 1988. Thirteen (27%) had died by 1 June 1989; by 30 June 1989 the calf mortality had increased to 26 (52%), exceeding the total loss experienced by the 1988 cohort for the whole year. Black bears accounted for 77% of the losses to predators. Wolves and grizzly bears accounted for additional 15% and 8% losses, respectively.

This study has increased our understanding of natural factors affecting calf mortality in Subunit 21B. Although predation has long been suspected as the primary factor limiting the moose population over the long term, this study demonstrated the magnitude of the annual loss of calves to wolf and bear predation, the importance of black bear predation on calves, and how predation rates can increase when natural factors make moose more vulnerable. It now appears that calves are more predisposed to predation during years of flooding and that very few, if any, drown. Previously, I had assumed that winter poverty in cows, flooding, and mosquitos had been responsible for the occasional year when calf survival appeared extremely poor, based on the presence of few calves in November surveys. This last occurred in 1985, following another spring of heavy flooding. While these factors may still be considered the ultimate cause for the increase in calf mortality, it now appears that predators actually killed the calves.

One possible reason for the increase in predation rates during years of heavy flooding may be that it concentrates the predators and moose in the remaining unflooded areas. Stress and chronic hypothermia may also make calves more susceptible to predation. The increased amount of standing water may lead to greater concentrations of mosquitos, causing calves to become more restless, and in turn, attracting more predators. Flooding may also temporarily increase the dependence of bears on calves as a food source by covering normally emergent vegetation under several feet of water.

Wolves and bears were numerous in Subunit 21B, and harvests were low. No good estimate is available for the size of the bear populations, because of the difficulties inherent in assessing their numbers. There are about 80-90 wolves in 13-16 packs, suggesting about 20-30 moose per wolf in the subunit. This ratio of moose to wolves is usually not sufficient by itself to cause moose numbers to decline (Gasaway et al. 1983); however, when mortality from other factors, such as bear predation is high, the combined effect can precipitate a decline in moose numbers.

Habitat Assessment

Browse transects to assess winter use of willows and other species by moose were conducted by the USFWS in April 1988. Fifty-two percent of the 352 Salix pulchra plants examined had little or no use, 24% had moderate use, and 24% had high use. Sixteen percent of the 313 S. alaxensis plants examined had little or no use, 33% had moderate use, and 51% had high use. Similar results were obtained from browse transect surveys conducted in April 1987. These data indicated that browse availability was not limiting the moose population in the subunit.

The flood in May 1989 reversed succession along a 100-mile stretch of the Yukon River through the scouring action of the ice. The ice knocked down trees and flattened willows up to 200 feet from the river. On the floodplain areas adjacent to the ice jam at Kokrines, bog grass mats were floated out of the lakes where they had been accumulating. These mats were then deposited in the woods when the water receded. Any ice that had been present on lakes and sloughs was carried away by the current, flattening trees on the down current side of the lakes in the process.

Game Board Actions and Emergency Orders

During the past 5 years the seasons and bag limits have remained the same. The only action the Board of Game has taken was to make a subsistence priority determination for moose in 1987, based upon USFWS resource use maps and Division of Subsistence maps of local use. The Ruby Fish and Game Advisory Committee submitted a petition in 1987 asking the Board to take action to halt the decline of the moose population within the subunit; however, the Board took no action on the petition.

CONCLUSIONS AND RECOMMENDATIONS

Historical moose survey records for the Nowitna River area are scant and often not easily comparable because of the wide variation in survey techniques applied over the years. The most comprehensive and valid data came from the 1980 and 1986 population estimation surveys and the 1985-88 surveys of permanent trend areas. Statistical comparison of the 2 surveys suggested that the population had declined during the early 1980's. More recently, trend area data suggested that the population is recovering from the earlier decline.

Predation was the primary cause of the decline. Predators remained abundant and continued to be the primary factor controlling moose abundance within the constraints placed on the population by habitat considerations. Data from the calf mortality study suggested that unusually severe natural conditions, such as flooding, can exacerbate the effect of predation on the moose population. We can expect extremely poor calf survivals in those years in which spring flooding has been severe. The effect of these cohort failures on population trend will depend on the frequency of occurrence and the maintenance of reasonably good survival of both calves and adults in intervening years.

The bull:cow ratio was still good and may even be increasing. The steady harvest of about 49 bulls does not appear to be adversely impacting the availability of bulls for hunting, except in some localized situations.

The seasons should remain the same; however, efforts should be made to increase the harvest of predators.

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Table 1. Observed moose densities and sex and age ratios from aerial survey of comparable portions of established trend areas in Subunit 21B, 1985-88.

Year	Area[a] (mi^2)	Search effort (min/mi^2)	Sample size	Total moose/ mi^2	Adult[b] moose/ mi^2	Cow[c] moose/ mi^2	Yearling Bulls: 100 cows	Total bulls: 100 cows	Calves: 100 cows	Twins: 100 cows w/calves
1985	78	5.1	128	1.65	1.48	1.18	36	5	3	0
1986	81	4.5	168	2.08	1.44	1.14	39	7	43	11
1987	77	4.9	229	2.98	1.82	1.48	46	11	55	11
1988	77	5.6	267	3.48	2.15	1.87	48	17	38	15

[a] Consists of survey units 7, 29, 30, 35, 41, and 42 in each year.

[b] All moose greater than or equal to 18 months old.

[c] All female moose other than calves.

Table 2. Sex and age ratios from all moose observed during aerial survey of established trend areas in Subunit 21B, 1983-88.

Year	Area (mi^2)	Search effort (min/mi^2)	Sample size	Total Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Twins: 100 cows w/calves
1983	118	4.8	205	38	9	46	9
1984	No surveys						
1985	146	4.9	225	24	5	5	0
1986	188	4.6	326	33	6	43	5
1987	196	4.5	446	41	13	53	13
1988	147	5.0	407	36	14	41	16

Table 3. Annual moose harvest in Subunit 21B, 1983-88.

Year	Ruby Road	Novi/ Sulatna River	Yukon River	Unreported harvest	Total harvest
1983	11	49	17	15	92
1984	16	52	28	15	112
1985	6	37	22	15	79
1986	9	51	19	15	94
1987	9	45	28	15	97
1988	10	57	35	15	117

Table 4. Residency and success of moose hunters checked at the Nowitna River hunter check station in Subunit 21B, 1979-88.

Year	Yukon R. Villages		Fairbanks		Other Alaskan		Non-resident		Unknown		Total	
	N[a]	n[b]	N	n	N	n	N	n	N	n	N	n
1979	68	12	108	40	14	5	11	4	0	0	201	61
1980[c]	26	5	49	33	6	1	4	2	0	0	85	41
1981	46	5	67	42	15	3	10	5	0	0	138	55
1982-87	No data											
1988	33	9	103	35	25	7	8	5	9	0	178	56

[a] Total number of hunters.

[b] Number of successful hunters.

[c] Hunt by registration permit; no aircraft use allowed this year only.

STUDY AREA

GAME MANAGEMENT UNIT: 21C (3,650 mi^2)

GEOGRAPHICAL DESCRIPTION: Dulbi River above Cottonwood Creek and Melozitna River above Grayling Creek

BACKGROUND

The first survey was conducted in Subunit 21C in November 1980; 21 moose were observed. A trend count survey was conducted by Bureau of Land Management biologists at Sithdondit Creek near the headwaters of the Melozitna River in November 1983. Randomly selected survey units (SU's) were counted during a population estimate in November 1987. Those data were not sufficient to infer population trend, but they did indicate that numbers were generally low.

The terrain is mountainous; peaks are 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.

The harvests have ranged from 15 to 30 moose 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.

POPULATION OBJECTIVES

To increase the moose population to 2,500-3,000 in the Melozitna River drainage to increase hunting opportunities.

To maintain the moose population of 550-750 in the Dulbi River drainage to maintain hunting opportunities.

METHODS

The Dulbi River portion of the subunit was included in a population estimation survey that was conducted in Subunit 21D. No other surveys were conducted. Hunting mortalities were monitored through moose harvest reports, and predation was monitored by interviews with wolf trappers.

RESULTS AND DISCUSSION

Population Status and Trend

Moose densities are generally low. The population trend is unknown.

Population Size:

During November 1987 a population estimation survey was conducted in the Dulbi River drainage by biologists from the Alaska Department of Fish and Game, the U.S. Fish and Wildlife Service, and the Bureau of Land Management. The 865-mi^2 area was divided into 69 SU's; 28 (348 mi^2) were classified as low density, and 41 (517 mi^2) were classified as medium density. The estimated population was 544 to 720 moose.

An adequate estimate of population size for the whole subunit can not be made until either a census or a stratification survey has been completed in the Melozitna River section. A stratification survey is planned for November 1990.

Population Composition:

Composition data are available from 8 SU's (101 mi^2) that were searched in the Dulbi River portion during the population estimation survey in November 1987. Composition data indicated good bull:cow and calf:cow ratios (Table 1); however, the ratio of yearling bulls:100 cows was low.

Mortality

Season and Bag Limit:

The open season for all hunters is 5-25 September; the bag limit is 1 bull.

Human-induced Mortality:

The harvest has been stable, ranging from 25 to 30 moose annually for the past 10 years (Table 2). In 1982 an airplane was seized by Division of Fish and Wildlife Protection Staff following a violation of the same-day-airborne regulation. There was a reduction in the moose harvest that year and in subsequent years, suggesting that some hunters had been shooting moose on the same day that they had been airborne.

Hunter Residency and Transportation Methods. There is only 1 family residing within the subunit, and they usually shoot 1 moose each year. The remainder of the hunters were either nonlocal residents (16) or nonresidents (10). All hunters used aircraft for transport.

Natural Mortality:

There were at least 50 to 60 wolves in the subunit. Grizzly bear habitat is excellent; the estimated density was 1 per 40 mi^2. Moose and caribou are available as prey for wolves and grizzly bears. The Melozitna River also has a major salmon run. Predation is the main factor limiting moose numbers in the subunit.

Game Board Actions and Emergency Orders

The seasons and bag limits have remained the same during the past 5 years. A subsistence priority classification of the subunit was made in 1987, based on information from a subsistence survey conducted by U. S. Fish and Wildlife Service and the Subsistence Division of ADF&G. Residents of Subunits 21C, 21B, Tanana, and Galena were included.

CONCLUSIONS AND RECOMMENDATIONS

The 1987 population estimation survey in the Dulbi River drainage established a baseline population estimate. This was the first moose survey of the area ever, and it established that moose numbers fell within the range desired for management purposes.

The moose population in the Melozitna River drainage was low, and few people hunted in the drainage. An increase in moose numbers would benefit both hunters and the other predators that depend on them. However, better survey data are needed to aid management decisions. A stratification survey of the area should be conducted to ascertain moose distribution and relative abundance and determine areas for future trend surveys.

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Table 1. Summary of moose survey data from Subunit 21C, 1983-88.

Year	Bulls: 100 cows	Yrlg bulls: 100 cows	Calves: 100 cows	Percent calves	Moose/mi^2	Area mi^2	Sample size
1983	131	6	23	9	0.6	49.7	33
1984	No surveys						
1985	No surveys						
1986	No surveys						
1987	81	4	35	16	0.7	100.7	67
1988	No surveys						

Table 2. Annual moose harvest in Subunit 21C, 1983-88.

Year	Reported	Estimated unreported	Total
1983	16	0	16
1984	15	0	15
1985	18	0	18
1986	28	0	28
1987	29	0	29
1988	21	0	21

STUDY AREA

GAME MANAGEMENT UNIT: 21D (11,900 mi^2)

GEOGRAPHICAL DESCRIPTION: Yukon River from Blackburn to Ruby and Koyukuk River drainage below Dulbi Slough

BACKGROUND

Moose are a relatively new addition to the fauna of Subunit 21D. Local natives first reported seeing occasional tracks during winters in the 1930's. During the 1940's and early 1950's the numbers of moose and wolves slowly increased. Then, during the 1950's, federal wolf control and aerial shooting reduced the wolf population, causing a rapid expansion of the moose population during the late 1950's and through the 1960's. Statehood in 1959 brought an end to federal wolf control. Legal aerial shooting was stopped with the passage of the Airborne Hunting Act in 1972. Faced with an abundance of food, wolves once again became abundant. The moose population reached peak numbers about 1970 and then either stabilized or declined slightly in response to increased predation and hunting levels.

In 1979 the Koyukuk Controlled Use Area (KCUA) was established to reduce participation by hunters from outside the subunit by prohibiting the use of aircraft. However, by 1986 the number of hunters arriving by boat from outside the subunit equaled the number of hunters who previously accessed the area by aircraft.

Large (100,000-200,000 acres) fires during 1974 and 1977 in the uplands along the Koyukuk River improved the summer habitat in the subunit. Since 1980 trappers who have used aircraft to land near wolves have been able to consistently shoot enough wolves to stabilize predation on moose at a reduced level. The presence of numerous large lakes and rivers near moose winter concentration areas makes this a particularly effective trapping method.

Moose trend count areas (TCA's) established in the Three Day Slough and Yukon River floodplain areas have indicated an increasing density of moose. Initially, I thought the increase in density was due to better surveys, but a population estimation survey of the Kaiyuh Flats and the eastern drainages of 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.

There are 4 villages within the subunit (Kaltag, Nulato, Koyukuk, and Galena), and the residents of each village have traditional hunting areas. However, the areas used by Galena residents overlap those used by residents of some of the other villages because many of the Galena residents have larger boats and thus are able to travel farther. Although Huslia is only 30 miles from Subunit 21D, its residents rarely hunt within the subunit. Nonresidents and nonlocal residents mainly hunt the Koyukuk River between the Kateel River and the Unit 24 boundary, where competition with residents of Subunit 21D is not as likely to occur. Since 1981 the reported harvest has been about 200 moose annually; another 40 moose/year have been taken but not reported.

POPULATION OBJECTIVES

To maintain a population of at least 4,000 moose south and east of the river, including the Three Day Slough area.

To maintain an early winter density of at least 4.0 moose/mi^2 within the Three Day Slough floodplain.

To maintain a posthunting ratio of at least 30 bulls:100 cows in the population being monitored by the Three Day Slough trend count area.

To develop guidelines for maximum winter browse use within the Three Day Slough area.

To maintain a moose population level of 900-1,000 in the Kateel River drainage and to develop a population level for the Gisasa River by 1991.

To maintain an early winter density of at least 3.0 moose/mi^2 in floodplain areas along the Yukon River that are subject to both the September and February hunting seasons.

To develop a population level and density estimate by 1994 for the remainder of the subunit, including the Yukon and Nulato Rivers.

METHODS

Three types of aerial-survey techniques have been used to monitor the population dynamics of moose in Subunit 21D: stratification flights, trend surveys (annual), and population estimation surveys (5-year intervals). Browse utilization surveys were conducted on foot using standardized ADF&G transect methods. Radio-collared moose provided mortality and movement information.

Hunting mortality and distribution were monitored through harvest tickets and check stations. Local residents were encouraged to increase their harvest reporting. Predation was monitored by interviewing trappers, relocating radio-collared animals, and conducting track surveys.

RESULTS AND DISCUSSION

Population Status and Trend

Moose populations were healthy throughout most of the subunit, except in the Yuki River drainage. Moose densities were increasing in most areas.

Population Size:

Population estimation surveys were conducted during November 1987 on the Kaiyuh Flats and along the Koyukuk River north of Galena. Roughly two-thirds of the Kaiyuh Flats and one-half the Galena area were found to have low moose densities; i.e., 0.29 moose/mi^2 and 0.19 moose/mi^2, respectively. Data from the 1987 surveys suggested that the population in Subunit 21D numbered between 9,000 and 10,000 moose.

Population Composition:

Composition data were only obtained from the Three Day Slough trend area in 1988. The Dulbi River, Squirrel Creek, and Kaiyuh Slough trend count areas were not surveyed. Based on the 1988 data for the Three Day Slough and prior data from the other trend areas, the bull:cow ratios and calf survival indices seemed average to excellent (Table 1).

In past management reports, composition data have been presented with ratios and generalizations such as poor, good, and average. To better understand what the ratios mean within Unit 21 the following guides are used:

1. Usually the average posthunting bull:cow ratio is around 30-40 bulls:100 cows; 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 20's or less would be poor.

2. The percentage of yearling bulls within the herd is an indication of overwinter survival of calves. Generally, the yearling bull percentage is low. The average ranges from 4% to 8%, with anything less indicating poor recruitment and anything higher good recruitment.

3. The calf:cow ratio indicates the number of calves that have survived the summer, and it may infer population change. Typical parturition ratios in late May are 120 calves:100 cows. Five months later (November), average ratios are about 30-40 calves:100 cows. Black bears, grizzly bears, and wolves are the primary predators that reduce calf numbers. The average ratios can support winter predation and moderate hunting and maintain a stable population level. 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.

As can be seen in the historical trend area summaries (Table 1), oscillations occur more commonly in the calf:cow and yearling indices. The 1985 calf cohort was severely affected by flooding, deep snows, and perhaps, increased predation rates; however, in 1986 calf survival was better than average.

The posthunting bull:cow ratios for Three Day Slough reflected the heavy harvest of bulls from the area (Table 1). The yearling and calf numbers were about average for the area. The percentage of calves observed at one year and the percentage of yearlings observed the following year (Fig. 1) are positively correlated at the 90% level ($r = 0.8771$, 3 df).

The Squirrel Creek TCA had high bull:cow ratios in 1985 and 1987 (Table 5), despite hunting pressure from Koyukuk residents. The magnitude of the ratios was probably because the harvest included cow moose. The 1987 calf:cow ratio was very high for an Interior moose population. No survey was conducted in 1988.

The Kaiyuh Slough TCA is between the main hunting areas for Kaltag and Nulato. The bull:cow ratio (Table 1) was low in 1987 for unknown reasons. I had expected a higher ratio because the harvest included cow moose. No survey was conducted in 1988.

Distribution and Movements:

Information on moose distribution and movements in the Three Day Slough area has been obtained by monitoring 10 bull and 9 cow moose that had been radio-collared in October 1983. Most of these moose have remained in the floodplain area of Three Day Slough from late August until May each year. During May most moved 10 to 60 miles in either a northerly or southerly direction and then spent the summer months there before returning to the floodplain in the fall. Although moose movements are unknown in other portions of the subunit, local residents suspect that moose observed on the Kaiyuh Flats migrate seasonally.

Mortality

Season and Bag Limit:

The open seasons for subsistence hunters in Subunit 21D are 5-25 September and 1-5 February; the bag limit is 1 moose, although antlerless moose may be taken 21-25 September and 1-5 February. The open season for resident and nonresident hunters in Subunit 21D is 5-25 September. The bag limit is 1 bull.

Human-induced Mortality:

The reported harvest prior to 1981 was largely inaccurate, because many local residents either did not obtain licenses or failed to report their harvests. Educational and enforcement efforts have increased the reporting rate by local residents for the September hunt to 95% in Galena and 80% in Koyukuk and Nulato.

Hunters reported taking 251 moose during the 1988 season (Table 2); 248 of these were reported from the September season, and 13 were reported from the February season. With the possible exception of the Yuki River drainage, the moose populations in the subunit appear capable of sustaining current harvests.

The establishment of a hunter check station on the Koyukuk River has enabled me to accurately determine the number of hunters using the river and to inform residents of the reporting requirements. The number of hunters using the Koyukuk River has been increasing (Table 3). Use by local residents did not change much from 1987 to 1988, the 2 years for which check station data are comparable; however, their share of the total use dropped from 57% to 53%. This increase in hunting pressure has been a cause of concern among local residents, because it could eventually decrease their hunting success through increased competition, reduction in numbers of legal moose, or passage of more restrictive regulations.

In 1988, 82 of the hunters checked were from Galena, 45 were from Koyukuk, 29 were from Nulato, and one each were from Ruby and Kaltag. Only slight changes were noted in the numbers of hunters originating from Galena, Koyukuk, and Nulato in 1988, compared with 1987.

Most hunters who do not live in the area want to harvest bulls with antler spreads of at least 50 inches. Usually, about one-fourth to one-third of the bulls observed in the Three Day Slough TCA have antler spreads this large (Table 4). On average, 60% of the bulls checked on the Koyukuk River in September have had antler spreads of at least 50 inches.

Hunter Residency and Transportation Methods. Slightly more than half of the hunters checked through the Koyukuk River check station in 1987 and 1988 were residents of the subunit. The number of hunters who traveled to the Koyukuk River from areas outside Subunit 21D increased by 125% in 1988 (Table 3).

Boats were the main hunting method used. Rivers form the major transportation corridors in the area, and part of the area is closed to the use of aircraft for hunting purposes. Snowmachines were the main transportation method during the winter hunt.

Natural Mortality:

Subunit 21D has high populations of wolves and black bears. Grizzly bears are common in the upland areas of Nulato Hills and Kaiyuh Mountain. Wolves and grizzly bears prey heavily on both calf and adult moose. Black bears can be a substantial source of mortality for moose calves.

Bears, including grizzly bears where they are present, probably kill about 75% of the calves in Subunit 21D between parturition and October, because November calf:cow ratios rarely exceed 30-40 calves:100 cows. Where present, grizzly bears must also be considered a factor affecting the survival of adult moose. I have observed grizzly bears on moose kills every November at Three Day Slough. The extent of predation by grizzly bears is unknown.

The estimated wolf population is about 175-190 in 25-30 packs. This number of packs would probably kill 1,000 to 1,900 moose per year, based on an average kill rate of 1 moose every 3 to 6 days per pack during winter months (Gasaway et al. 1983). At this rate, wolves in Subunit 21D probably kill about 10-19% of the standing crop annually.

Deaths caused by drowning are fairly common in Subunit 21D, because 2 major rivers bisect the area. In November 1987 I observed a cow moose break through the ice into deep water and drown. Every year I receive from 5 to 10 reports of moose that had fallen through the ice.

The winter of 1988-89 was severe; temperatures were below -60°F for 3 weeks in January, including 1 day during which an extreme of -80°F was recorded. The cold did not appear to adversely affect the moose in the short term; i.e., one were found dead immediately after the cold spell.

Snow depth was only slightly deeper than average during the winter of 1988-89; however, the cold spell was followed by rain, resulting in an ice crust 2 inches thick on the snow surface. This crust restricted moose movements. Reports of moose dead from starvation were received during the next 2 months; most of the dead moose were calves.

Game Board Actions and Emergency Orders

The September season in Subunit 21D has remained the same for the past 6 years; however, changes were made in 1987 to restrict the hunting of antlerless moose to residents who qualified as subsistence hunters.

The Board of Game has been refining the winter hunt with the assistance of the Middle Yukon Fish and Game Advisory Committee over the past 6 years. The winter hunt resumed in 1981, after being suspended for 3 years. The hunt initially had a duration of 10 days; it was extended to 30 days and then later cut back to 10 days.

For 4 years the winter hunt was administered as a registration hunt, with a 5-day shorter season in the portion of the subunit upstream from Bear Creek. In 1987 the registration permit requirement was deleted, the hunting period downstream from Bear Creek was reduced by 5 days, and participation was restricted to only those hunters who qualified as subsistence hunters.

Four Emergency Orders (EO's) have been issued during the past 5 years, all dealing with the February hunting season. In 1985 the hunt was canceled because of extremely low calf:cow ratios observed during early winter surveys. Cancellation was believed necessary to keep the total harvest from exceeding recruitment.

In 1988 and 1989 EO's were issued to prohibit hunting within a half mile of the Yukon River to protect cow and calf moose that concentrate in the riparian habitat. This protection had been unintentionally lost when the permit requirement was deleted in 1987. In March 1989 the hunting regulations were amended to include the half-mile closure.

In 1989 an EO was also issued to extend the February season by 3 days, because of extreme weather conditions at the start of the hunt. Hunters would have had to endure extremely cold temperatures to take advantage of the first 3 days of the 5-day season. I informed them that the season would be extended and that they should not risk hunting in the extreme cold.

The purpose of all these changes has been to produce a midwinter hunt to meet local subsistence 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 subsistence harvest of 40 moose annually.

CONCLUSIONS AND RECOMMENDATIONS

Moose are numerous in the riparian lowlands of Subunit 21D. I currently estimate that there are 9,000 to 10,000 moose in the subunit. The populations were stable and appeared capable of supporting current levels of predation and harvest.

The population estimate is higher than the population objective, which was based on subjective estimates of population size. The population estimation survey in 1987 allowed me to refine the estimate. However, further liberalization of the seasons or bag limits is not recommended, since natural predation remains very high.

LITERATURE CITED

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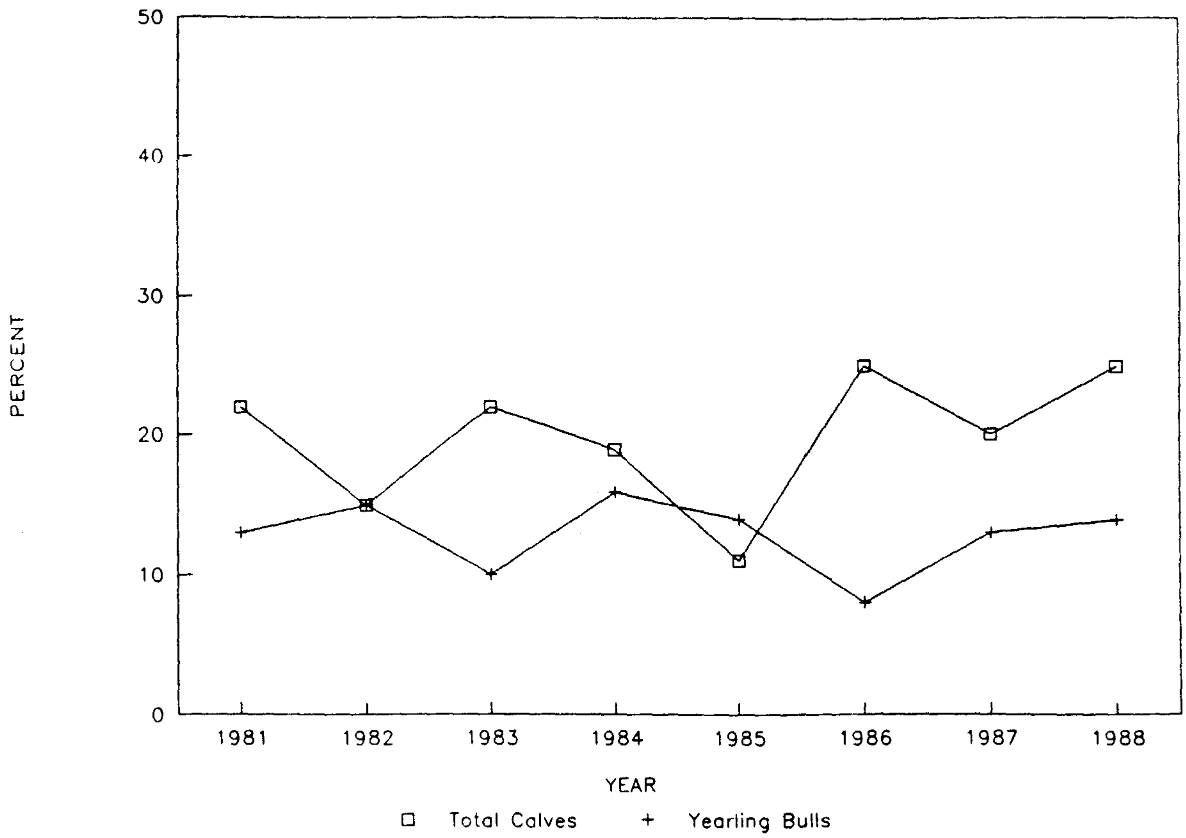

Figure 1. Occurrence of calves and yearling bulls among moose observed during November in the Three Day Slough TCA, Subunit 21D.

Table 1. Summary of moose survey data from Subunit 21D, 1983-88.

Area	Year	Bulls: 100 cows	Yrlg bull %	Calves: 100 cows	% calves	Moose/ mi^2	Area (mi^2)	Sample size
<u>Population Estimation Surveys</u>								
Kaiyuh	1987	55	8	49	24	1.6	460.3	731
Galena	1987	37	7	41	23	4.0	617.8	2,505
<u>Trend Areas</u>								
Three Day Slough	1983	31	5	37	22	6.2	84.8	530
	1984	30	8	31	19	5.7	57.8	332
	1985	39	7	17	11	5.9	83.3	501
	1986	39	4	45	25	7.9	83.3	660
	1987	33	7	34	20	8.8	127.7	1,128
	1988	33	7	45	25	9.9	83.3	832
Dulbi River	1983	39	4	29	17	5.1	57.1	230
	1984	36	2	44	24	5.3	42.1	184
	1985	No surveys						
	1986	No surveys						
	1987	55	8	44	22	7.3	38.9	283
	1988	No surveys						
Squirrel Creek	1983	58	7	35	18	3.7	37.3	137
	1984	No surveys						
	1985	78	16	11	6	3.5	52.6	185
	1986	No surveys						
	1987	76	8	67	27	3.4	38.4	131
	1988	No surveys						
Kaiyuh Slough	1983	74	10	59	25	1.6	39.8	
	1984	No surveys						
	1985	54	10	8	5	1.5	51.0	78
	1986	No surveys						
	1987	28	4	33	20	1.9	38.9	74
	1988	No surveys						

Table 2. Annual moose harvest from Subunit 21D, 1983-88.

Year	Reported Bulls	Reported Cows	Reported Unk	Estimated Unreported	Nonresident	Total
1983	136	8		40	7	184
1984	171	27		40	15	238
1985	139	18	2	40	19	199
1986	152	21		40	20	213
1987	185	19	1	40	20	245
1988	229	20	2	40	27	291

Table 3. Number of moose hunters by residency class checked through the Koyukuk River Check Station, Subunit 21D, 1983-88.[a]

Year	Residents of Subunit 21D	Other Alaskan residents	Nonresident	Total hunters
1983	132[b]	29	3	164
1984	92[b]	67	9	168
1985	117	74	4	195
1986	140[b]	80	9	229
1987	151[c]	92	21	264
1988	158[c]	121	20	299

[a] Checking in and out is not mandatory and compliance was lower during the first year, 1983.

[b] Counts every trip made by hunter.

[c] Hunters counted only once.

Table 4. Comparison of harvest and survey information from the Koyukuk River, Subunit 21D, 1981-88.

Year	Total bulls harvested[a]	Check station data[b] Number measured	% large bulls[c]	Survey data[d] % large bulls[c]	Total bulls: 100 cows
1981	61	--	--	27	31
1982	74	30	66	26	47
1983	85	42	69	27	31
1984	116	74	59	14	30
1985	81	49	57	22	39
1986	90	78	58	33	39
1987	138	109	57	23	33
1988	172	149	61	33	33

[a] From harvest reports received for the September season only.

[b] From check station on the lower Koyukuk during the September season.

[c] 50 inch or greater antler spread.

[d] November surveys of the Three Day Slough trend count area.

STUDY AREA

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 onto the Seward Peninsula during the mid- to late 1930's; by the late 1960's they had successfully expanded into much of the unit's suitable habitat. Although moose numbers continued to increase at substantial rates during the 1970's and early 1980's, they have leveled off or declined slightly in some areas.

Demand for moose, primarily by recreational and subsistence hunters residing in Unit 22, is high. Gravel roads and navigable rivers provide hunters with easy access to suitable moose habitat. Annual recorded harvest from 1969 to 1988 (Table 1) ranges from 44 (1972) to 408 (1986).

POPULATION OBJECTIVES

To maintain and/or increase viable moose populations consistent with environmental conditions, legal mandates, and public desires.

METHODS

Aerial surveys were conducted during March 1989 in selected drainages to evaluate population trend and short yearling recruitment. Using methods developed by Gasaway et al. (1986), a census was also conducted in a portion of Subunit 22A during March. The census data were used to provide estimates of density and short yearling recruitment. Harvest data were summarized from harvest reports returned by hunters.

RESULTS AND DISCUSSION

Population Status and Trend

Although the moose populations in Subunits 22A, 22C, and 22E appear to have increased in recent years, densities were low, compared with Subunits 22B and 22D. The factors (i.e., habitat, natural predation, overharvesting, or poor recruitment) restricting herd growth have not been determined. Densities in Subunits 22B and 22D have increased dramatically since the mid-

1970's, and they were near or above the carrying capacity of the winter range in some portions of these subunits. Calf survival, particularly in those areas of high moose concentrations, appeared to be declining.

Population Size:

Reliable data on the total number of moose residing in Unit 22 are not available. Censuses conducted in portions of Subunits 22B and 22D during March 1987 and 1988 yielded counts of 1,894 and 2,892 moose, respectively. A census conducted during March 1989 in a portion of the Unalakleet drainage (Subunit 22A) resulted in a population estimate of 325 moose; previous population estimates for Unit 22 ranged from 3,200 to 4,200 (Grauvogel 1986). Based on information obtained during recent censuses and surveys, a minimum of 7,000 moose currently reside in Unit 22.

Population Composition:

Composition data for Unit 22 are limited because inclement weather during fall and spring prevented completion of as many surveys as planned. During March 1989, 51.4 hours of aerial surveys were conducted in Subunit 22A (Table 2). Because the number of moose observed per hour year (Table 2) was significantly higher than in any other year, it is possible that the record snow fall may have caused a higher number of moose to congregate in riparian areas. The estimated percentage of calves in the Subunit 22A census area was 16.1%.

Mortality

Season and Bag Limit:

The open seasons for subsistence and resident hunters in Subunit 22A is 1 August to 30 September and 1 to 31 December; the bag limit is 1 bull. The open season for subsistence, resident, and nonresident hunters in Subunit 22B is 1 August to 31 January. The bag limit is 1 moose; however, antlerless moose may be taken by registration permit only from 1 to 31 December. The open season for all hunters in Subunit 22C is 1 to 14 September; the bag limit is 1 bull. The open season for all hunters in Subunit 22D for drainages into the north side of Port Clarence, the north side of Grantley Harbor, and the north side of Imuruk Basin, excluding the Kuzitrin, Pilgrim, and Kougarok River drainages is 1 August to 31 January. The bag limit is 1 moose; however, antlerless moose may be taken by registration permit only from 15 September to 31 December. Only antlered moose may be taken 1-31 January. The open season for all hunters in the remainder of Subunit 22D is 1 August to 31 December. The bag limit is 1 moose; however, antlerless moose may be taken by registration permit only from 1 to 31 December. The open season for all hunters in Subunit 22E is 1 August to 31 March. The bag limit is 1 moose; however, antlerless moose may be taken by registration permit only from 15 September to 31 March. The taking of calves and cows accompanied by calves is prohibited throughout Unit 22.

Human-induced Mortality:

The reported harvest (Tables 1 & 2) during the reporting period was 375 moose (332 males, 36 females, and 7 unspecifieds. Subunits 22B (45%) and 22D (31%) accounted for the majority of the harvest (Table 3).

Illegal and/or unreported harvests remained a problem in Unit 22. While some local residents either failed to acquire harvest tickets or killed moose out of season, it is difficult to estimate the magnitude of this illegal harvest; however, it ranged from 10% to 20% of the reported harvest. The estimated annual moose harvest, including illegal and/or unreported harvests, ranged from 413 to 451 moose.

Hunter Residency and Success. Residents of Unit 22 accounted for 75% of the harvest; residents of Nome acconted for 56% of the harvest. Other nonlocal residents and nonresidents accounted for 14% and 10% of the reported harvest, respectively. The residency status of the remaining 1% is unknown. Hunter success during the reporting period was 50%, considerably higher than the 20-year average of 42%.

During the reporting period, 203 antlerless permits were issued to prospective hunters (Table 4). Forty-seven permittees were successful in harvesting moose (11 males, 36 females). Subunit 22B accounted for 12 moose; Subunit 22D West, 7 moose; Subunit 22D East, 20 moose; and Subunit 22E, 8 moose.

Harvest Chronology. Much of the reported harvest (61%) occurred during September and October, when access to suitable habitat from roads and rivers is most favorable (Table 5). These 2 months also represented the time when most of the hunter effort occurred.

Transport Methods. Transport methods used by most successful hunters have not significantly changed from those of past years. Highway vehicles, boats equipped with jet units, and snow machines continued to account for approximately 70% of the unit's annual harvest (Table 6); however, ATV'S and off-road vehicles were more popular in some portions of the unit than in past years.

Natural Mortality:

Snow depths throughout this past winter were as deep or deeper than any recorded during the past 30 years. Moose were observed to be quite thin, particularly during the late winter and early spring. Although exact numbers are unknown, natural mortality was higher than those observed in past years. It is not known whether this winter's inclement weather had any effect on the spring 1989 calf production.

Although specific surveys to determine natural mortality rates among Seward Peninsula moose were not conducted, limited data were gathered from observations reported by local residents and Department staff engaged in other field activities. At least 15 dead moose were observed this spring by staff conducting moose surveys. Although several grizzly bears were observed feeding on moose carcasses during April and May, it is not known whether these moose were killed by the bears or died of natural causes. Numerous local residents reported seeing dead or very weak moose in Subunits 22B, 22C, and 22D.

Habitat Assessment

Some winter ranges in portions of Subunits 22B, 22C, 22D, and 22E have been heavily browsed in past years. Although lack of palatable browse has not yet been considered as a factor influencing moose mortality, it may soon be the case. Although the data and conclusions have not yet been published, several studies have been completed on moose-willow foraging relationships in the Kuzitrin River drainage in Subunit 22D. These data will be helpful in developing future long-range management strategies.

Many moose utilizing willowed riparian habitat in portions of Subunits 22B and 22D have demonstrated a tendency to move from riparian river bottoms in late March onto adjacent hillsides, where they apparently feed on sedges and dwarf willows. Moose inhabit these areas until spring thaws have reduced snow cover in adjacent valleys and ravines. It is not uncommon during this time to see "herds" of moose (e.g., +50) placidly grazing in these areas.

Game Board Actions and Emergency Orders

No Emergency Orders were enacted during the reporting period. At their spring meeting, the Board of Game took action on 3 regulatory proposals. The Board rejected a proposals to extend (1) the closure of the antlerless season in Subunit 22D and (2) the antlerless season in Subunit 22B. A proposal requesting elimination of the antlerless permit requirement and an earlier opening for the antlerless seasons in Subunits 22D and 22E was approved. The Board also reauthorized the antlerless moose seasons for 1989-90.

CONCLUSIONS AND RECOMMENDATIONS

Moose are clearly the most important big game species available in Unit 22, providing successful hunters with a substantial amount of protein annually as well as recreational opportunities (e.g., photography). The initialtion of a management plan for moose based on sound biological data and public input continues to be of the utmost importance. Unreported and illegal harvests remain a problem; public education programs and a visible enforcement effort must be maintained if we are to increase compliance with current regulations.

Although significant reductions in moose calf numbers are evident in some portions of the unit, the causes are unknown. A research program to determine the causes and effects of these mortalities is needed.

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Table 1. Historical moose harvest in Unit 22, 1969-88.

Regulatory year	Males	Females	Unknown sex	Total harvest	Hunters[a]	Percent success
1969	69	1	2	72	182	40
1970	70	0	1	71	139	51
1971	59	0	1	60	168	36
1972	44	0	0	44	99	44
1973	103	32	1	136	317	43
1974	149	72	1	222	479	46
1975	136	0	2	138	389	35
1976	186	51	3	240	611	39
1977	151	88	5	244	457	53
1978	198	97	2	297	596	50
1979	193	75	2	270	760	36
1980	156	71	1	228	492	46
1981	225	72	1	298	696	43
1982	244	100	0	344	904	38
1983	291	82	32	405	1292	31
1984	298	91	6	395	1086	36
1985	279	92	3	374	876	43
1986	306	101	1	408	892	46
1987	285	20	4	309	775	40
1988	332	36	7	375	748	50

[a] Minimum known number of hunters.

Table 2. Spring survey data for Unit 22, 1989.

Subunits	Adults	Cow calf	Cow calves	Total adults	Lone calves	Total calves	Total sample	% calves	Count time (hrs)	Moose per hr
22A	112	13	3	128	0	19	147	13%	20.0	7.4
22B	636	39	3	678	0	45	723	6%	11.1	65.1
22C	58	19	2	79	0	23	102	23%	2.3	44.3
22D	841	174	12	1027	0	198	1225	16%	8.0	153.1

Table 3. Historical harvest by subunit in Unit 22, 1983-88.

Year	22A			22B			22C			22D			22E			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U
1983-84	26	1	0	85	18	13	36	0	1	114	41	23	30	9	8	291	69	45
1984-85	21	0	1	85	30	1	16	0	1	147	47	0	29	13	1	298	90	4
1985-86	21	0	2	111	42	1	33	0	0	89	37	0	25	13	0	279	92	3
1986-87	27	0	0	97	45	1	32	0	0	133	44	0	17	12	0	306	101	1
1987-88	28	0	0	98	7	2	26	0	0	116	6	2	18	7	0	286	20	4
1988-89	28	0	1	106	8	4	41	0	1	145	22	1	12	6	0	332	36	7

Table 4. Antlerless permit summary by subunit in Unit 22, 1988-89.

Permit area	Permits issued	Did not hunt or report	Unsuccessful hunters	Successful hunters	Antlerless bulls	Cows
22B	49	7	30	12	4	8
22D West	73	8	58	7	1	6
22D East	52	1	31	20	4	16
22E	29	18	3	8	2	6
TOTALS	203	34	122	47	11	36

Table 5. Chronology of Unit 22 moose harvest, 1988-89.

Subunit	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Unk.	Totals
22A	6	15	--[a]	--	7	--	--	--	1	29
22B	14	45	20	11	8	13	--	--	7	118
22C	--	42	--	--	--	--	--	--	0	42
22D	28	69	32	19	14	2	--	--	4	168
22E	1	4	0	1	1	1	2	8	0	18
TOTALS	49	175	52	31	30	16	2	8	12	375

[a] Season closed

Table 6. Types of transportation used by successful and unsuccessful hunters in Unit 22 during 1988-89 moose season.

Subunit	Aircraft	Horse	Boat	3/4 wheelers	Snowmachine	Off-road vehicle	Highway vehicle	Unknown	Totals
22A	0	0	63	6	10	1	0	12	92
22B	17	0	46	16	28	10	44	16	177
22C	1	0	3	4	0	7	39	8	62
22D	16	1	67	34	13	16	118	37	302
22E	4	0	3	0	12	0	0	4	23
22Z	2	0	6	2	0	7	55	20	92
Totals	40	1	188	62	63	41	256	97	748

STUDY AREA

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

GEOGRAPHICAL DESCRIPTION: Western Brooks Range and Kotzebue Sound

BACKGROUND

Moose began colonizing this region only 30 or 40 years ago; therefore, few traditions governing the subsistence harvest and utilization of moose are evident in the local indigenous Inupiat culture. Even so, moose currently rank second only to caribou as a source of red meat for most residents of Unit 23. Moose are also avidly sought by local, nonlocal, and nonresident recreational hunters.

POPULATION OBJECTIVES

To maintain a healthy, viable population of moose for consumptive and nonconsumptive uses.

METHODS

Aerial moose surveys have been conducted in established trend count areas since 1986. For the purposes of this report, survey data collected prior to 1986 during the same approximate time of year near trend count areas are included with data from later trend surveys established after 1986. Each trend count area includes all major habitat types characteristically used by moose. During the reporting period, a Piper PA-18 aircraft and one observer were used for all trend counts. The U.S. Fish & Wildlife Service (USFWS) assisted with the Tagagawik trend count, and the National Park Service (NPS) participated in the middle Noatak and Nimiuktuk trend counts.

Fall surveys were conducted between 6 ans 29 November to determine population trend as well as the proportions of calves and bulls in the population. Yearling bulls (i.e., spike or fork antlers), medium bulls (i.e., antler width <50 in), and large bulls (i.e., antler width ≥50 in.) bulls were categorized. The Wulik, Nimiuktuk, middle Noatak (including portions of Wrench Creek and the Kelly River), and Tagagawik River trend count areas were surveyed.

Although spring surveys also reflected population trend, they were conducted primarily to determine recruitment of calves (short yearlings) into the population. Between 3 and 28 April 1989 spring surveys were conducted in the lower Kobuk and lower Noatak trend count areas, and a new trend count area was established on the upper Kobuk River between the villages of Kobuk and Shungnak.

Harvest information was summarized from harvest reports submitted by hunters. Interviews with local hunters indicated that a substantial number of moose were harvested but not reported. Some local residents have estimated that only 10% of the actual harvest is reported; therefore, additional harvest information was derived from reports and comments submitted by local hunters.

RESULTS AND DISCUSSION

Population Status and Trend

No estimate of moose population size has been made for Unit 23. Anecdotal information indicated that the moose population has increased steadily in size since becoming established in Unit 23.

Quantitative estimates of moose abundance derived from trend surveys showed no clear unitwide trend; however, individual count areas have been surveyed for only 1 to 5 years, and the time needed for determining trend may be insufficient (Tables 1-4). Because the lower Noatak and lower Kobuk River trend count areas have been surveyed for the longest period of time, they should provide the best information regarding temporal changes in moose abundance. The lower Noatak River has shown no identifiable trend in moose densities. In contrast, moose densities in the lower Kobuk River have steadily increased. During the next several years, surveys in the upper and lower Kobuk River trend count areas should indicate whether the mean 1986-89 density in the lower Noatak River (i.e., 2.7 moose/mi^2, SD = 0.03) approximates an upper limit for moose wintering in extensive riparian willow habitats.

Spatial differences in moose abundance were easier to discern from trend count data than temporal changes in abundance. Spring trend counts and, to a lesser degree, fall counts suggested that densities were lower on the northern Seward Peninsula than in the Kobuk or Noatak River drainages (Tables 1-4); however, this disagreed with reports of residents who have travelled widely in the unit (J. Bania and D. Thomas, pers. comm.). It may be that the Buckland River trend count area is situated at least partially outside of a prime wintering area for moose, and densities further west may be higher.

Population Composition:

The proportion of calves in the population during fall 1988 was high (range = 30-72 calves:100 cows) however, the incidence of twins was low (Tables 3 and 4). Opportunistic observations during the 1987-89 calving periods suggested that only approximately 10% of maternal females produced twins (W. Ballard, pers. commun.).

In 1989 the proportion of calves in the population during spring trend counts was similar to those of previous years (Tables 1 and 2). Because the heaviest mortality among winter-killed ungulates typically occurred during spring break-up, the mortality attributable to the severe winter of 1988-89 may not be apparent in survey data until the fall of 1989.

Bull:cow ratios in the fall of 1988 were also similar to those of previous years (Table 4). During September and October, numerous recreational hunters reported that significantly fewer large bulls were seen in the Kelly River/Wrench Creek area, especially near Kelly Bar, than in the last 5 years. Observers on 2 reconnaissance flights in that area failed to corroborate those reports. Likewise, the proportion of large bulls observed during the fall of 1988 in the middle Noatak River trend count area did not indicate that any change in population composition had occurred. Nevertheless, the number of moose hunters in this area has increased dramatically during the last 3 to 5 years, and the original report came from a long-term Kotzebue resident who has hunted this area for 17 years. Therefore, we should continue to monitor bull:cow ratios during late October and early November, after the majority of the recreational harvest has occurred, but before large numbers of overwintering moose have moved into the area.

Distribution and Movements:

During late summer and early fall, many moose inhabit the upper reaches of small riparian willow thickets. During the rut (September and October), bulls travel extensively until they locate one or more cows. 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, and cows with calves return to these areas by the time of the rut.

No specific home range or movement data have been collected for moose in Unit 23. We are considering initiating a moose telemetry study in the Noatak/Kelly River area to examine movements, habitat use, productivity, and mortality.

Mortality

Seasons and Bag Limits:

The open season for subsistence, resident, and nonresident hunters in that portion of Unit 23 on the Seward Peninsula west of and including the Buckland River drainage and that portion of the Noatak River drainage is 1 August to 31 March. The bag limit is 1 moose; however, antlerless moose may be taken only from 15 September to 31 March. The open season for all hunters in the remainder of Unit 23 is 1 August to 31 December. The bag limit is 1 moose; however, antlerless moose may be taken only from 15 September to 31 October.

Human-induced Mortality:

The 1988-89 harvest of 216 moose is the highest on record (Table 5). If only 14-24% of the harvest taken by local residents is normally reported (Quimby and James 1985), then the actual 1988-89 harvest by Unit 23 residents alone could number 246-268 moose. Bulls composed the majority of moose reported taken (201 bulls, 14 cows, and 1 unspecified). Most of the reported harvest (54%) came from the Noatak River drainage (Table 6). The distribution of the reported bull harvest among the antler size categories was different that reported previously; fewer bulls with antler widths less than 30 inches or greater than 60 inches were harvested in 1988-89 than in 1987-88, and a correspondingly higher proportion of bulls were taken with antler widths of 50-60 inches (Table 7). No change in mean antler width over time was evident among drainages or for the entire Unit (Table 8).

Hunter Residency and Success. Two hundred sixteen of 311 hunters (69%) reported harvesting moose in 1988-89 (Table 9). The highest hunter success rate occurred in the Noatak River drainage (Table 6).

The relatively low proportion of the harvest (16%) taken by local hunters in 1988-89 may reflect poor compliance with reporting requirements (Table 9), although caribou remained in close proximity to Kotzebue, Noatak, Noorvik, Selawik, and Buckland throughout the fall, winter, and early spring. Therefore, fewer moose may have been harvested in 1988-89, compared with harvests from previous years.

Harvest Chronology. Despite a relatively long hunting season, 88% of the reported harvest occurred between 17 August and 29 September (Table 10). Only 8 moose were harvested before 17 August, and 15 moose were taken after September. The harvest date was not reported for 4 moose. Local hunters rarely harvest mature bulls after the rut begins (i.e., roughly mid-September); however, females not accompanied by calves are taken throughout the season.

Some local residents want a bulls-only season in July to opportunistically kill moose they encounter while fishing. Also, residents of Kobuk River villages have indicated they would like the moose season extended through 31 March so that hunters could take moose during winter and early spring, when caribou are not accessible.

Transport Methods. Hunters using aircraft harvested 70% (151 moose) of the total reported harvest, substantially more than the 52% reported in 1987-88 (Table 11). Reports from local residents indicated that the number of aircraft observed in moose hunting areas in the Noatak River drainage has increased dramatically during the last 3 years. One hunter (0.5%) used a horse, 31 (14%) used boats, 10 (5%) used three-wheelers, and 12 (6%) used snow machines.

Natural Mortality:

No estimate of natural mortality has been made for moose in Unit 23. A wolf telemetry study currently being conducted in the Selawik River/Purcell Mountains area should provide some information concerning the significance of wolf predation on moose.

The winter of 1988-89 was one of the most severe in the last 50 years. Deep snow accumulated after late December, and January and February were characterized by extreme cold, high winds, and blizzards. Following the period of intense cold, record-high temperatures and freezing rain created crusted snow and ice-glazed ground. Many moose in the Igichuk Hills, Kiana Hills, western Baird Mountains, and lower Kobuk and Noatak Rivers were emaciated; large bulls were especially affected. Cooperators on the wolf telemetry study encountered numerous winter-killed moose in the Selawik Flats (W. Ballard, pers. commun.). Also, Department personnel observed more winter kills during the spring of 1989 than in the previous 4 years in the Noatak and Kobuk River drainages.

The Noatak River downriver of Noatak village flooded extensively in early June. Water levels had not risen to such an extent in over 40 years. Much of the Noatak River lowlands were submerged. Because this is an important moose calving area, a substantial number of moose calves may have died, although initial reports from Noatak residents indicated that this did not occur (P. Robb, pers. commun.). Surveys planned for the fall of 1989 should enable us to detect whether calf mortality in the spring of 1989 was higher than normal.

Habitat Assessment

Moose habitat has not been critically examined in Unit 23. Opportunistic observations by staff indicated that extensive "clubbing" and obvious browse lines occurred in some riparian willow areas. During February 1989, many moose were inhabiting headwater regions of small subalpine creeks that are typically abandoned in December, indicating a shortage of browse in lower riparian areas where moose usually overwinter. The extremely hard, windblown snow that characterized the latter half of the 1988-89 winter, however, may have provided moose easy access to these subalpine areas where deep snow usually excludes them.

Game Board Actions and Emergency Orders

In late January 1989 an Ambler resident contacted the Department and requested permission for the village to harvest several moose in response to an emergency situation. Caribou were far from the village, and an extended period of extreme cold had precluded long hunting trips and eliminated commercial flights carrying groceries into Ambler. The Department subsequently issued an Emergency Order opening the moose season from 1-3 February for a small area surrounding Ambler. In the 2 days required to promulgate the Emergency Order, the temperatures subsequently eased, and hunters were able to harvest caribou; therefore, no moose were taken during the emergency opening.

During March 1989 the Board of Game reauthorized the antlerless moose season in Unit 23, extending it from 1 September to 31 October in the Noatak River drainage and the northern Seward Peninsula; additionally, the harvesting of cows accompanied by calves was prohibited.

CONCLUSIONS AND RECOMMENDATIONS

It is clear that the Department needs to develop a moose management plan that will (1) recognize various demands on the moose resource, (2) establish management goals, (3) list management options, and (4) prioritize the criteria on which management decisions will be made.

Trend counts should remain a high priority during the spring and fall. Greater effort needs to be invested in assessing moose population status on the northern Seward Peninsula. If possible, the Buckland River trend count area should be surveyed each spring.

Intense hunting pressure in the Kelly and Noatak Rivers may require the Department to restrict the harvest of moose in this area, especially if the current proportion of large bulls is to be maintained. Although controlled use areas that restrict methods of hunter access benefit some wildlife populations and users, those restrictions frequently displace other hunters to surrounding areas. The Noatak Controlled Use Area in the upper Noatak canyon may have displaced hunters using aircraft and contributed to the increased use of the Kelly Bar area; NPS concessionaire permits may have had the same effect on the distribution of guiding activity. Potential impacts to other areas, users, and wildlife populations should be carefully considered before any type of exclusive-use area is established.

In the fall of 1988, the Alaska Supreme Court ruled that exclusive-use guide areas were unconstitutional. Because a stay of implementation retained established guide areas until 30 June 1989, the 1988-89 hunting season was not affected. According to the court decision, any guide registered to operate in a Game Management Unit could do so after 1 July 1989, even if he had not held an exclusive guide area in that unit before 1988. This could theoretically open the door for over 100 guides to begin operating in Unit 23. Although this is highly unlikely, the unit could experience a substantial increase in guiding activity as a result of this ruling. For the last 3 years, 5-7 guides have consistently operated in Unit 23. As an interim measure, the NPS will sell concessionaire permits only to guides who have held exclusive-use guiding areas within park or preserve boundaries, and the number of clients that can be guided will be limited. The state has appointed a 13-member task force to look into this matter. Depending upon the final outcome of this issue, the Department may need to regulate the harvest of moose by nonresident hunters in some areas through permit hunts.

Although we have little quantitative information on the size and status of the upper Kobuk River moose population, the limited data we do have and our opportunistic observations agree with reports from residents of Ambler, Shungnak, and Kobuk that moose are abundant in this area. We recommend that moose hunting seasons in the Kobuk River drainage be made consistent with those of the Noatak River drainage and northern Seward Peninsula.

Local compliance with harvest reporting requirements remains poor. Department personnel should continue to inform the public that accurate harvest information is needed for responsible management. Also, alternative methods of collecting harvest information should be explored.

The concept of transferrable bag limits has been discussed by Department personnel and the Board of Game, but it has never been implemented as a regulation. The issue of transferrable bag limits for moose has been frequently raised by unit residents. Many active hunters in villages hunt for extended families; the bag limit for caribou (i.e., 5 per day) allows an individual to hunt for himself as well as others, such as elders who cannot hunt. Village hunters and nonhunters alike have repeatedly suggested that the 1-moose-per-season bag limit does not adequately allow for traditional sharing of moose meat. A transferrable bag limit for subsistence hunting of moose should be considered in Unit 23, because with few exceptions, moose are abundant throughout the unit and can sustain an increased harvest. In addition, the large population size of the Western Arctic Caribou Herd should dampen the effects of a liberalized bag limit for moose, because caribou are the preferred species by most local residents. The Department could benefit from such a regulatory change through improved public relations and more accurate harvest information. Hunters are probably more likely to report harvested moose if they could do so without fear of self-incrimination.

In summary, I recommend that the Department: (1) develop a moose management plan for Unit 23; (2) place high priority on conducting spring and fall trend counts; (3) continue to monitor moose abundance and population composition in the vicinity of Kelly Bar, especially during September and October when hunting pressure is most intense; (4) work with the Upper and Lower Kobuk Advisory Committees to develop a proposal making moose regulations in the Kobuk River drainage consistent with the

Noatak River drainage and northern Seward Peninsula; (5) attempt to collect more accurate local harvest information by explaining to the public how harvest data is used and by exploring new techniques to collect harvest data; (6) work with advisory committees and the Arctic Regional Council to develop a proposal legalizing transferrable bag limits for subsistence moose hunters residing in Unit 23; and (7) develop a study plan for a moose telemetry investigation in the Noatak/Kelly River area to examine movements, mortality, productivity and habitat use.

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Table 1. Moose composition data from aerial spring trend counts, Unit 23, 1982-89.

Location (mi^2) and Date	Cows w/1 calf	Cows w/2 calves	Lone calves	Lone adults	Total calves	Total adults	Total
Upper Kobuk (25)							
4/3/89	15	1	1	26	18	42	60
Lower Kobuk (87)							
4/5/89	51	6	5	96	68	153	221
3/18/88	40	4	0	102	48	146	194
3/3-4/87	32	8	0	98	48	138	186
4/23/86	18	0	1	47	19	65	84
3/1/82	6	1	0	20	8	27	35
Lower Noatak (138)							
4/27-28/89	59	4	6	223	73	286	359
3/23-24/88	62	3	2	290	70	355	425
2/12-14/87	61	2	2	196	67	259	326
4/7-8/86	61	7	5	246	80	314	394

Table 1. Continued

Location (mi^2) and Date	Cows w/1 calf	Cows w/2 calves	Lone calves	Lone adults	Total calves	Total adults	Total
Buckland (131)							
3/31/88	1	0	0	18	1	19	20
4/20/87	5	1	0	15	7	21	28
3/6-7/86	14	1	0	79	16	94	110
Tagagawik (175)							
4/22/86	27	2	0	183	31	212	243

Table 2. Ratios for spring moose composition data, Unit 23, 1982-89.

Location (mi^2) and Date	Calves: 100 cows	% calves	% adults w/1 calf	% adults w/2 calves	Density ($moose/mi^2$)
Upper Kobuk (25)					
4/3/89	43	30	35.7	2.4	2.4
Lower Kobuk (87)					
4/5/89	39	28	32.1	3.8	2.5
3/18/88	33	25	27.4	2.7	2.2
3/3-4/87	35	26	23.2	5.8	2.1
4/23/86	29	23	27.7	0	1.0
3/1/82[a]	30	23	22.2	3.7	0.4
Lower Noatak (138)					
4/27-28/89	26	20	20.6	1.4	2.6
3/23-24/88	20	16	17.5	0.8	3.1
2/12-14/87	25	20	23.4	0.8	2.4
4/7-8/86	25	20	19.4	2.2	2.9

Table 2. Ratios for spring moose composition data, Unit 23, 1982-89. (continued)

Location (mi^2) and Date	Calves: 100 cows	% calves	% adults w/1 calf	% adults w/2 calves	Density ($moose/mi^2$)
Buckland (131)					
3/31/88	5	5	5.3	0	0.2
4/20/87	33	25	23.8	4.8	0.2
3/6-7/86	17	15	14.9	1.1	0.8
Tagagawik (175)					
4/22/86	15	13	12.7	0.9	1.4

Table 3. Moose composition data from fall aerial trend counts, Unit 23, 1984-88.

Location (mi^2) and Date	Males - Antler size				Females				Total calves	Total adults	Total
	sp-fk[a]	<50 in	≥50 in	Total	w/0 calf	w/1 calf	w/2 calves	Total			
Tagagawik (1975)											
11/23/88	36	43	29	108	134	42	6	182	54	290	344
11/9-10/87	19	33	32	84	145	59	4	208	67	292	359
11/22/86	13	31	21	65	99	35	9	143	53	208	261
Middle Noatak (252)											
11/28-29/88	17	29	28	74	108	53	4	165	61	239	300
11/11-15/87	3	13	19	35	42	51	4	96	59	131	190
11/23/86	16	14	21	51	76	37	3	116	43	167	210
Wulik (71)											
11/14/88	6	9	3	18	15	25	3	43	31	61	92
11/25/87	2	5	8	15	13	11	0	24	11	39	50
Nimiuktuk (94)											
11/ 6/88	3	5	11	19	17	12	1	30	14	49	63
11/24/87	3	18	13	34	39	12	1	52	14	86	100

Table 3. Continued

Location (mi^2) and Date	Males - Antler size: sp-fk[a]	<50 in	≥50 in	Total	Females: w/0 calf	w/1 calf	w/2 calves	Total	Total calves	Total adults	Total
Buckland (225)											
11/15/85	15	23	22	60	69	21	2	92	26	152	178
Inmachuk (417)[b]											
11/27/87	2	10	19	31	27	10	1	38	13	69	82
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 4. Continued

Location (mi^2) and Date	Bulls:100 cows, Antler size: sp-fk[a]	<50 in	≥50 in	Total	Calves: 100 cows	% of total calves	% cows w/1 calf	% cows w/2 calves	Density $moose/mi^2$
11/24/87	6	35	25	65	27	14	23.1	1.9	1.06
Buckland (225)									
11/15/85	16	25	24	65	28	15	22.8	2.2	0.79
Inmachuk (417)									
11/27/87	5	26	50	82	34	16	35.7	2.6	0.20
Upper Kobuk (976)[b]									
10/17-20/84	19	19	24	62	36	18	28.4	4.1	0.15

[a] Spike or fork antlers

[b] Not an established trend count area

Table 5. Annual reported moose harvest from Unit 23, 1978-89.[a]

Year	Male	Female	Unspecified	Total
1978-79	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
Total	1438	116	15	1569

[a]No data available for 1979-80.

Table 6. Location of moose killed by hunters in Unit 23, 1988-89.

Drainage	Males	Females	Unspecified	Total	% success
Noatak River	109	9	0	118	83
Kobuk River	56	3	0	59	57
Selawik River	17	0	0	17	53
Northern Seward Pen.	12	2	0	14	74
Kivalina/Wulik Rivers	6	0	0	6	60
Unspecified	2	0	0	2	67
Total	202	14	0	216	69

Table 7. Number and percentage of bull moose harvested in various antler width categories, Unit 23, 1985-89.

		Antler width categories (%)					
Season	<20"	20-<30"	30-<40"	40-<50"	50-<60"	<60"	Unknown[a]
1985-86	3 (3)	12 (11)	15 (14)	15 (14)	37 (34)	26 (24)	4
1986-87	1 (1)	8 (6)	28 (21)	29 (22)	49 (38)	15 (11)	9
1987-88	2 (1)	9 (5)	17 (10)	26 (15)	66 (38)	51 (30)	20
1988-89	1 (0.5)	4 (2)	24 (11)	35 (16)	82 (38)	41 (19)	23
Total	7 (1)	33 (6)	84 (14)	105 (18)	234 (39)	133 (22)	56

[a]Antler width not reported

Table 8. Mean antler widths, standard deviations (SD), and sample sizes (n) for moose by drainage and year, Unit 23, 1984-89.

Year	Noatak	Kobuk	Kivalina Wulik	Northern Seward Peninsula	Selawik	Total[a]
1984-85						
mean	49.4	46.1	35.0	46.6	45.0	47.8
SD	12.4	11.6		16.1	15.4	12.8
n	86	39	1	12	15	153
1985-86						
mean	50.1	42.0	49.3	30.0	49.3	48.3
SD	13.0	13.9	12.0		16.9	14.0
n	67	17	3	1	16	107[b]
1986-87						
mean	47.5	44.2		42.2	50.5	46.8
SD	11.6	9.7		9.4	13.2	11.3
n	78	29	0	8	12	130[b]
1987-88						
mean	53.4	47.2	50.5	44.1	52.0	51.4
SD	10.9	14.1	15.2	17.5	8.3	12.1
n	93	32	14	7	21	173[b]
1988-89						
mean	52.3	49.4	54.2	45.3	51.9	51.1
SD	9.8	10.0	12.6	17.0	10.6	10.6
n	102	56	6	11	17	193[b]

[a]All drainages combined

[b]Includes antler widths for additional moose taken in GMU 23 where drainage was not reported

Table 9. Hunter residency and success rate during 1988-89, Unit 23.

Residency	Successful	Unsuccessful	Total	% Success
Nonresident	94	29	123	76
Alaska resident (outside Unit 23)	58	38	96	60
Alaska resident (within Unit 23)	30	20	50	60
Unspecified	34	8	42	81
Total	216	95	311	69

Table 10. Chronology of 1988-89 moose harvest in Unit 23.

Week ending		Males	Females	Unspecified	Total
August	11	5	0	0	5
	18	3	0	0	3
	25	11	1	0	12
September	1	9	0	0	9
	8	38	1	0	39
	15	56	2	0	58
	22	49	4	0	53
	29	16	2	0	18
October	6	3	0	0	3
	13	1	0	0	1
	20	0	0	0	0
	27	0	0	0	0
November	3	1	0	0	1
	10	0	0	0	0
	17	1	0	0	1
	24	0	0	0	0
December	1	1	1	0	2
	8	0	0	0	0
	15	1	0	0	1
	22	0	0	0	0
January	5	1	0	0	1
March	16	1	0	0	0
	23	0	1	0	1
	30	1	2	0	3
Unknown		4	0	0	4

Table 11. Transportation means used by moose hunters in Unit 23, 1988-89.

Vehicle type	Successful	Unsuccessful	Total
Aircraft	151	53	204
Horse	1	0	1
Boat	31	28	59
Off-road vehicle	10	2	12
Snowmachine	12	1	13
Highway vehicle	0	1	1
Unknown	11	10	21
Total	216	95	311

STUDY AREA

GAME MANAGEMENT UNIT: 24 (24,150 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 1930's through the 1950's. Colonization was slow, until predator control efforts in the 1950's allowed rapid expansion of local populations, especially in the southern third of the unit. During the early 1970's the population reached a peak, and mortality started to exceed recruitment in some areas.

The habitat is excellent along most of the Koyukuk River lowlands, providing expansive areas of winter browse. Lightning-caused fire is a frequent event, and large areas of the uplands have been burned and are producing good moose browse. Browse availability is not limiting the size of the moose population at current moose densities.

Historical reported harvests during the past 25 years have ranged from 44 to 134, but they did not exceed 100 moose until 1980. The unreported harvests during this period ranged from 60 to 150 moose per year. Since 1980 the reported harvests have exceeded 100 moose, because more local residents have become aware of the reporting requirement, compliance with the reporting requirement has increased, and access to the subunit has become easier with the opening of the Dalton Highway.

MANAGEMENT OBJECTIVES

To manage a moose population at the current level of 3,000-4,000 in the area south of Hughes, including the Koyukuk Controlled Use Area.

To increase the moose population to 5,000-6,000 in the area from Hughes to Bettles, including the Kanuti Controlled Use Area and the South Fork drainage.

To increase the moose population north of Bettles, excluding the Gates of the Arctic National Park to 3,000-3,500.

To maintain the population in the Gates of the Arctic National Park at 1,300-1,500.

METHODS

Three types of aerial survey techniques were used to monitor the population dynamics of moose in Unit 24: (1) stratification flights, (2) composition and trend surveys (annual), and (3) population estimation surveys (5-year intervals). Browse utilization surveys were conducted on foot, using standardized ADF&G transect methods.

Hunting mortality and distribution were monitored through harvest tickets and check stations. Local residents were encouraged to report. Aerial wolf surveys and interviews with trappers were used to determine wolf distribution, abundance, and relative impact on moose populations.

RESULTS AND DISCUSSION

Population Status and Trend

Moose were numerous in the Koyukuk River lowlands in the southern third of the unit. The population was growing in the area around the village of Huslia. Elsewhere, moose numbers were stable.

Moose densities were low in the middle third of the unit, and the population is declining. This trend is due to over-hunting within the Kanuti Controlled Use Area and to predation.

Moose densities were moderate in the northern third of the unit, and moose numbers were stable in most areas; however, moose numbers may be slowly declining within the park.

Population Size:

In November 1988 a population estimation survey was conducted on 2,418 mi^2 in the southwestern part of the unit in the drainages of the Huslia and Nulitna Rivers. This survey included 588 mi^2 in the northern section of Subunit 21D. These data (Tables 1,2) produced a mean estimate of 1,898 $\pm$ 384 moose (90% probability level).

Data from prior years were used to estimate moose densities elsewhere in the southern portion of the unit. Trend count areas surveyed in 1985 revealed early winter densities of 3.1 to 4.6 moose/mi^2 along the Koyukuk River lowlands. Similar areas surveyed in adjacent Subunit 21D in 1987 found early winter densities of up to 9 moose/mi^2. These density estimates from established trend count areas were extrapolated to surrounding areas, based on the distribution of moose seen during stratification surveys.

Based on the results of the population estimation survey and the extrapolations of density estimates obtained during trend count surveys, about 4,000-5,000 moose were in the southern portion of Unit 24.

In the Kanuti National Wildlife Refuge (NWR) in the middle part of the unit, surveys of trend areas and a 1985 stratification survey suggested early winter densities of 0.3 to 1.0 moose/mi^2. In addition, stratification of 1,942 mi^2 of the South Fork Koyukuk River during October 1987 suggested densities ranging from 0.3 to 0.5 moose/mi^2. Based on the distribution of moose observed during the stratification surveys and the density estimates derived for each stratum, about 2,000-3,000 moose were in the middle portion of Unit 24.

In the northern part of the unit, stratification of 2,012 mi^2 within the Wild River, John River, and North Fork Koyukuk River drainages during October 1987 suggested densities ranging from 0.5 to 0.7 moose/mi^2. In the lower portions of the John River and Middle Fork Koyukuk River drainages, moose were not found above elevations of 4,000 feet, and in the Tinayguk and upper portion of the North Fork Koyukuk River moose were not found above elevations of 3,500 feet. Based on the distribution of moose seen during the stratification and the density estimates derived for each stratum, about 3,000-4,150 moose were in the northern portion of Unit 24, including approximately 1,500-2,000 moose within the Gates of the Arctic National Park. The population estimation survey of the Kanuti Controlled Use Area planned for late 1988 was postponed until 1989.

Population Composition:

Composition data were obtained from established trend count areas on the Kanuti NWR (Tables 3,4), a new trend count area near Coldfoot (Table 5), and during the Huslia River population estimation survey (Table 6). These data indicated poor recruitment in the central (Tables 3,4) and northern (Table 5) portions of the unit, high summer and winter mortality for calves. The high bull:cow ratios observed within the Kanuti NWR were misleading, because substantial numbers of cow moose were taken illegally. In the southern portion (Table 6), sex and age ratios indicated the population is probably expanding.

Mortality

Season and Bag Limits:

The hunting season and bag limit for the portion of the unit that includes the Gates of the Arctic National Park and the lands immediately adjacent to the park were different from 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 within the park, but all hunters could hunt outside the park boundaries. The bag limit was 1 moose, regardless of whether the hunter was inside or outside the park. In this area, residents could hunt antlered moose from 25 August through 25 September and from 1 through 10 March and antlerless moose from 21 through 25 September and from 1 through 10 March. Nonresidents could hunt antlered moose from 5 through 25 September and antlerless moose from 21 through 25 September.

In the remainder of Unit 24, the open season for all hunters was 25 August through 25 September, regardless of residency or subsistence status. The bag limit for all hunters was 1 bull moose.

Human-induced Mortality:

The hunting seasons in the unit are diverse, reflecting the various moose densities and consumptive-use patterns. The annual reported harvest since 1980 has ranged from 106 to 136 moose (Table 7). Most (96%) of the 137 moose reported during the 1988-89 regulatory year were harvested during the September portion of the hunting season. In addition, four were harvested during August, one during December in the Koyukuk Controlled Use Area, and one during March in the northern portion of the unit.

Illegal and unreported harvests by local residents continued to hamper Department efforts to manage moose. The actual harvest was about twice the reported harvest (Table 7). Moose harvested during the winter are rarely reported, even when the season is open. Neither Hughes nor Allakaket have license vendors, 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 attempting to obtain additional license vendors. Fortunately, most of the unreported harvest comes from the Koyukuk Controlled Use Area, which has a large enough moose population to support the additional harvest.

The estimated annual harvest by residents of Unit 24 is about 172 moose, according to Marcotte (1986), Marcotte and Haynes (1985), and my personal estimates. We estimate that the residents of Huslia, Hughes, Allakaket/Alatna, Bettles, and Wiseman harvested 84, 33, 35, 10, and 5 moose, respectively. An additional 5 moose were taken by residents of the unit who do not live in one of the villages.

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, except in 1985 when off-road vehicle restrictions were enforced (Table 4).

Natural Mortality:

A minimum of 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 has kept the moose population low throughout much of the unit.

Habitat Assessment

Winter moose browse within the Kanuti NWR was surveyed in April 1986, and a cursory survey has been conducted in the Koyukuk Controlled Use Area yearly since 1985. In the Kanuti NWR, winter browse is not a limiting factor to moose population growth. Survey data indicated that moose were only cropping 5-30% of the annual willow growth. Several large (300,000 acres) fires have burned in the middle portion of the unit. These areas are now in their most productive stage for moose browse.

In the Koyukuk Controlled Use Area almost every willow has signs of past moose browse, but no quantitative surveys have been conducted. The Koyukuk River is actively eroding its banks throughout most of the Controlled Use Area, and this action yearly creates hundreds of acres of willow regeneration on newly exposed sand bars.

Game Board Actions and Emergency Orders

During the last 5 years the game regulations have evolved from a simple 20-day season in September (plus a 10-day season during March in the Koyukuk Controlled Use Area) to a diverse system reflecting various moose densities and consumptive-use patterns.

In 1984 a 10-day season in December was added to the Koyukuk Controlled Use Area; the rest of the unit had the season starting date moved back to 25 August to allow the hunting of nonrutting bulls; a 10-day season in March was added to the Gates of the Arctic National Park; and a 25 August-31 December season was added to the upper John River for Anaktuvuk Pass residents.

In 1985 after objections from the National Park Service, the boundary of the hunt in the Gates of the Arctic National Park was modified to follow topographic features south of the park boundary, rather than the park boundary.

In 1988 the Board of Game changed the opening date in the upper John River area from 25 August to 1 August, thus aligning the season opening with Subunit 26A. This action was to assist the people of Anaktuvuk Pass in clarification of the seasons. The Koyukuk River Fish and Game Advisory Committee has proposed a winter season for the Kanuti Controlled Use Area for several years, but the Department has not favored the proposal because of the low numbers of moose in the area.

CONCLUSIONS AND RECOMMENDATIONS

The population objectives in the unit are being exceeded in the southern portion and within the Gates of the Arctic National Park. In the middle portion and the northern portion, excluding the Gates of the Arctic National Park, the moose population is half the desired level.

The habitat is excellent throughout much of the unit, with an abundance of either successional willow regrowth because of fire or new willow habitat in riparian locations related to topographic changes. The availability of browse 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 limiting factor on Unit 24 moose populations. Until management actions relieve the predation pressure, moose numbers will not increase in those areas where the population objectives have not been met.

Unit residents are meeting their wild food requirements, but reporting and licensing procedures are not being followed. More emphasis needs to be placed on education, enforcement, and the recruitment of license vendors. Hunting opportunities cannot be increased for people living outside the unit until moose numbers expand.

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Table 1. Stratification results from the Huslia River moose population estimation survey, November 1988.

	Units sampled	Moose seen	Area (mi^2)
Low density stratum	42	2	526.1
Medium density stratum	144	269	1,766.3
High density stratum	10	128	125.5
Total all strata	196	399	2,417.9

Table 2. Moose population estimation parameters for the Huslia River survey area, November 1988.

	Low Strata	Medium Strata	High Strata	Combined
Sample size (n)	8	24	10	42
Total stratum area	526.1	1,766.3	125.5	2,417.9
Total possible SU's	42	144	10	196
Observed density	0.38	0.71	3.2	0.77
Observed population estimate (T_O)	202	1254	408	1,864
Variance $V(T_O)$	12,488	33,928	0	46,416
Sightability correction factor				1.018
Corrected population estimate				1,898
C.I.% of population estimate 90% level				20.3%
Upper limit 90%				2,282
Lower limit 90%				1,514

Table 3. Sex and age ratios for data collected during moose surveys in Unit 24, 1984-88.

Year	Total moose	Total bulls: 100 cows	Yrlg. bulls: 100 cows	Yrlg. bulls % in herd	Calves: 100 cows	Calves: 100 cows >=2 yrs	Calf % in herd	Twins:100 cows with calf
Kanuti Canyon TCA[a,b]								
1984	44	46	11	7	11	12	7	0
1985	137	74	14	7	21	25	11	7
1986	57	174	37	12	26	42	9	25
1987	75	97	18	8	24	29	11	0
1988	101	118	8	3	41	44	16	23
Nolitna River TCA[b]								
1984	47	52	11	6	22	25	13	0
1985	61	104	36	16	14	22	7	0
1986	49	64	5	2	59	62	27	18
1987	112	69	29	14	35	49	17	6
1988	72	77	11	6	29	32	14	25
Coldfoot TCA								
1988	101	49	5	3	22	23	13	0
Huslia River population estimation survey[c]								
1988	658	78	24	11	42	56	12	19

[a] Trend count area

[b] Kanuti National Wildlife Refuge.

[c] Included 1,829 mi^2 in Unit 24 and 588 mi^2 in Subunit 21D.

Table 4. Annual moose harvest and Dalton Highway hunter success in Unit 24, 1983-88.

Year	Reported harvest	Estimated harvest	Total harvest	Dalton Highway Successful	Dalton Highway Unsuccessful
1983	120	117	237	26	26
1984	122	123	245	37	49
1985	114	127	241	28	70
1986	115	134	249	44	66
1987	136	123	259	42	39
1988	137	124	264	44	50

STUDY AREA

GAME MANAGEMENT UNIT: 25A, 25B, and 25D (49,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Upper Yukon River Valley

BACKGROUND

Moose habitat in the upper Yukon Valley varies from treeless tundra on the south slope of the Brooks Range in Subunit 25A to extensive wetlands on the Yukon Flats in Subunit 25D. Density is very low over most of the area, averaging about 0.1-0.3 moose/mi^2. The highest densities (1-2 moose/mi^2) are found in Subunit 25D near Mud Lakes, around the lower mouth of Birch Creek and along the lower reaches of the Porcupine and Black River drainages. Early winter concentrations are also found in Subunit 25A in the upper portions of the Sheenjek and Coleen River drainages.

Little is known about the history of moose populations in Unit 25. Systematic surveys were not conducted until the late 1970's, and intensive efforts were not begun until an area office was established in Fort Yukon in 1981. However, data that were obtained prior to 1983 were difficult to interpret, because few moose were found in the small survey areas. This interpretation problem was overcome when survey techniques were modified to accommodate the low moose densities and when radiotelemetry data (1983-87) for collared moose in the western portion of Subunit 25D became available.

For management purposes, Subunit 25D has been divided into western and eastern portions, which are referred to as 25D west and 25D east, respectively. The boundary between the two is near the center of the subunit and is described by a line along Birch Creek and the Hadweenzik River.

Composition surveys were last conducted in Subunits 25A, 25B, and 25D east in 1987. Moose populations in Subunit 25A were stable and able to sustain the existing harvests of bull moose. The moose population in Subunit 25B along the Yukon River was either stable or declining. The existing harvest is limited to bull moose and take is minimal. Calf survival has been poor and is probably due to bear and wolf predation. In Subunit 25D east, past levels of calf survival and yearling recruitment have been good. However, the population is not growing. There is a sizable illegal harvest of cow moose from this area.

Moose movement patterns have only been studied in Subunit 25D west. Preliminary analysis of data from 68 radio-collared moose relocated at weekly or monthly intervals between 1983 and 1987 revealed that approximately half were migratory. These moose spend spring and summer on the Yukon Flats and then move to the surrounding uplands for the fall and winter months. A final report is being prepared.

Very little is known about natural mortality among moose in most of the upper Yukon River Valley. The only exception is Subunit 25D west, where mortalities among radio-collared animals were investigated. Preliminary analysis of the data indicated that mortality rates were very low and that wolf predation was the primary cause of death among moose older than 6 months. A final report is being prepared.

Hunting access is difficult, because it is restricted primarily to aircraft, boats, snowmachines, and offroad vehicles. Highway vehicles can only be used on limited road systems around villages and on the Dalton Highway, which traverses small portions of the western edges of Subunits 25A and 25D. Most harvests in Subunit 25A are by recreational hunters seeking a high-quality wilderness experience. In Subunits 25B and 25D most of the harvest is by subsistence hunters who depend upon the moose population to feed their families.

POPULATION OBJECTIVES

Unit 25 overall:

To estimate subsistence needs and harvest levels by 1991 and educe the harvest of cows by 5-10% annually beginning in 1990 throughout Unit 25.

Subunit 25A:

To ensure that the mean annual antler spread of harvested bulls does not drop below 50 inches; maintain a posthunting sex ratio of at least 50 bulls:100 cows; and determine population size, composition, and distribution by 1991 in Subunit 25A.

To determine population size, composition, and distribution by 1991 in Subunit 25B.

Subunit 25D west:

To increase the population to 1,300 moose by 1990; present 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.

To determine population size, composition, and distribution by 1990; maintain a stable population of approximately 2,300 moose; and determine productivity, mortality, distribution, movement patterns, and habitat use by 1992 in Subunit 25D east.

METHODS

Aerial composition surveys were conducted in a Piper Super Cub at an altitude of approximately 500 feet above ground level and an airspeed of approximately 70 miles per hour. A low pass was flown over all moose to determine sex and age, look for additional moose, and estimate antler size of bulls. All moose habitat within established count areas was searched in a systematic manner at a search intensity of at least 4 min/mi^2. Data such as harvest size, hunter effort, antler size, and transportation methods were gathered from mandatory hunter harvest reports. Subsistence harvests of moose by Fort Yukon residents were estimated from a survey of 41 hunters within 39 households who did not use harvest tickets. Standard radio-telemetry techniques were used to monitor radio-collared moose.

RESULTS AND DISCUSSION

Population Status and Trend

The only new data available during this reporting period came from Subunit 25D west, supporting the previous conclusion that the population in this area was increasing (Table 1). Linear regression analysis of observed moose densities over time indicated a strong correlation with a positive slope ($r = 0.9166$, $\underline{P} \leq 0.05$, 3 df). In addition, indices to calf survival and yearling recruitment seemed sufficient for population growth.

Population Composition:

No surveys were conducted in Subunits 25A, 25B, and 25D east this year because of poor snow conditions. In Subunit 25D west, fall composition surveys were conducted in 3 trend areas as part of a cooperative effort between the ADF&G and the U.S. Fish and Wildlife Service (USFWS). Calves and yearlings composed 14% and 17%, respectively, of the population in 1988, compared with 13% calves and 8% yearlings in 1987; i.e., the lowest values in the last 5 years (Table 1).

Distribution and Movements:

Surviving radio-collared moose from the 1983-87 movement study in Subunit 25D west are still being monitored to document calf production and survival and calf use of recently burned habitat. It is too early to report on possible effects of the 1988 wildfires on moose movement patterns.

Mortality

Seasons and Bag Limits:

Seasons varied within the 3 subunits, but all shared a common bag limit of 1 bull. In Subunit 25A, the open season for all hunters was 5-25 September. Subunit 25B was divided into 2 parts. The portion within the Porcupine River drainage upstream from the Coleen River drainage had an open season for all hunters from 20 to 30 September. The open season within the remainder of Subunit 25B was 5-25 September for all hunters and 1-15 December for subsistence users and other residents. Subunit 25D was also divided into 2 parts. In the western portion a registration permit hunt was in effect with a quota of 35 bulls. Only residents of the permit area were eligible to hunt within it. Open season dates were 10-30 September, 1-10 December, and 18-28 February. In the eastern portion of Subunit 25D, the open season for all hunters was 10-20 September. The open seasons for subsistence hunters were 10-30 September and 1-10 December. These seasons and bag limits were unchanged from those of 1987.

Human-induced Mortality:

Reported moose harvests have changed little over the past 5 years in the upper Yukon River Valley (Table 2). The total reported harvest has varied from a low of 106 moose in 1985 to a high of 132 during 1986; 107 were taken in 1988.

Both the number of hunters and the reported harvest declined in Subunit 25D during 1988. The take in Subunit 25D east was similar to prior years, except for the 5-year high in 1987. Some of the harvest reduction in Subunit 25D may have been due to poor compliance with the registration permit hunt in the western portion of the subunit. Greater effort will be made in 1989 to ensure that hunters obtain permits before hunting and return them after hunting.

Subsistence hunters interviewed in Fort Yukon reported taking 35 bulls and 3 cows. This was an average of 1.12 moose per person and 1.20 moose per household. Total harvest by Fort Yukon residents, reported through harvest tickets and interviews, was 66 moose.

Unreported harvest by local villagers continued to be a chronic problem in the upper Yukon Valley. An estimated 100-200 moose of either sex are killed yearly, but not reported. This compares with a reported take of 15 to 28 bulls annually during the past 5 years.

The management objective to maintain larger antlered bulls in the harvest in Subunit 25A was met in 1988 (Table 3). The average antler size of reported bulls has varied only slightly over the past 5 years and seems stable at current harvest levels.

Hunter Residency and Success. Most hunters (86%) in Subunits 25A, 25B, and 25D were residents (Table 4); 63% of the resident hunters lived within Unit 25, and 67% of the hunters living in Unit 25 hunted in Subunit 25D east. The distribution of hunting effort by other residents was more equally spread among all 3 subunits. This pattern of use was similar to that of the previous 4 years.

Hunter success during 1987 was similar to previous years for most areas (Table 2). Hunter success changed most drastically in Subunit 25D west, where a substantial reduction in both the number of reported hunters and harvest occurred. The change in hunter success for this hunt was probably not real, since compliance with the permitting and reporting requirements was believed poorer than normal in 1987. Unsuccessful hunters are usually the first ones to forget to report in situations where compliance has been allowed to deteriorate.

Harvest Chronology. As in prior years, most moose (88%) were harvested during the first 3 weeks of September (Table 5). Hunters generally preferred to hunt early in the season, when weather conditions are usually more favorable and those hunting primarily to obtain meat prefer to take bulls before they are too far into the rut.

Transport Methods. According to harvest reports, most successful hunters (64%) in Subunit 25A used airplanes to get to their hunting areas (Table 6). In contrast, boats were used for access by 61% and 47% of the hunters in Subunit 25B and Subunit 25D east, respectively. These patterns appeared unchanged from previous years.

Similar information was not available for Subunit 25D west, because the permit reports used for the subsistence hunt in this area do not require hunters to report their transportation methods. However, because the villages are located on rivers and most people have boats, most hunters participating in this hunt probably used boats.

Game Board Actions and Emergency Orders

In 1984 in Subunit 25B the December season was extended 5 days to provide more hunting opportunity. In 1983 in Subunit 25D west, a registration permit hunt was created because moose densities were critically low and incapable of sustaining even the existing low harvest rates. Participation was limited by permit and the harvest was limited to only bull moose. In 1984 the single fall season was replaced with a month-long September season and 2 winter seasons to provide more hunting opportunity for local residents and to accommodate traditional hunting periods. In 1985 permit issuance was limited to only qualified Tier II applicants. In 1986 permit issuance was further restricted to just residents of the hunt area. A harvest quota was established to provide more direct control over the harvest. In 1985 in Subunit 25D east, a December subsistence season was added. In 1987 this subsistence season was extended 10 days to provide more opportunity to harvest bulls. The moose hunting regulations for Unit 25 were unchanged for regulatory year 1988.

CONCLUSIONS AND RECOMMENDATIONS

Good progress has been made toward achieving management goals and objectives for moose in the upper Yukon River Valley. In Subunit 25A the population is able to provide high-quality recreational hunting for large-antlered moose. Bulls continued to compose a high proportion of the population, and the antler spreads of those harvested continued to average over 50 inches. In Subunits 25B and 25D, progress has been made toward providing for subsistence use by providing additional hunting opportunities for local residents. Harvests were within sustainable levels and are meeting the minimum subsistence need.

In Subunit 25D west, harvest restrictions have protected the producing segment of the population and helped reduce total mortality below the annual recruitment level. Thus the population has grown and met the interim population objective for the area, new objectives need to be determined to guide management beyond the present point, because the number of moose in Subunit 25D west is not sufficient to permit either-sex hunting for subsistence use or hunting by nonlocals.

The unreported harvest of moose by residents of the upper Yukon River Valley is a chronic problem. Historically, local hunters have harvested game when it was needed. Consequently, many local hunters do not feel that the hunting seasons and bag limits apply to their subsistence activities. They also often do not see the need for the complex regulations now in place. Thus compliance with the regulations is poor and the reported harvest consistently misrepresents both the size and composition of the actual harvest. Additional efforts will be required to convince local hunters of the need to regulate the harvest through season and bag limit constraints. Regulatory accommodations to local subsistence needs and traditional-use patterns will enhance these efforts.

Most hunters interviewed in Fort Yukon want more time to hunt during the fall in Subunit 25D east, despite the recent extension of that season. Seasonal employment opportunities are sporadic and often preclude many people from hunting during the fall, which is the most desirable period. In addition, a longer fall hunting season may encourage people to take bulls rather than cows. The harvest of cows must be reduced, if the present harvest is to be sustained without causing the population to decline. I recommend the fall subsistence season for Subunit 25D east be lengthened from 10 to 30 September to 25 August through 5 October. I believe this will allow most subsistence needs to be met without substantially increasing the total harvest; it may even reduce the number of cows taken. I will continue to interview hunters in Fort Yukon and other villages in the upper Yukon Valley to supplement harvest reports.

Additional information is needed on mortality sources, productivity, movement patterns, distribution on and between seasonal ranges, and seasonal habitat use by moose in Subunit 25D east to adequately manage the moose population to meet human needs. The subsistence use of moose in Subunit 25D east is high, including the illegal harvest of cows. Calf:cow ratios observed during yearly trend counts are declining. I recommend the Department enter into a cooperative study with staff of the Yukon Flats National Wildlife Refuge (USFWS) to gather this information. This project should begin in October 1989 and be completed by 1992. In addition, I recommend refuge staff conduct stratification and trend surveys in Subunit 25D east and portions of Subunit 25B during the fall of 1989.

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Table 1. Density, herd composition, and sex and age indices for moose observed during early winter surveys in Unit 25[a], 1983-88.

Subunit	Year	Calves: 100 cows	Yearling bulls: 100 cows	Bulls: 100 cows	% of herd Calves	% of herd Yearlings	Sample size (n)	Observed density (N/mi^2)
25A	1987	35	8	79	16	8	179	NA
25B	1987	10	6	119	5	5	111	NA
25D west	1983	72	28	97	26	20	80	0.31
	1985	53	35	98	21	28	108	0.46
	1986	27	23	78	13	22	152	0.42
	1987	25	8	71	13	8	100	0.57
	1988	29	18	84	14	17	96	0.55
25D east	1984	44	12	76	20	11	226	NA
	1986	34	13	84	15	12	170	NA
	1987	27	18	81	13	17	225	NA

[a] Data for Subunit 25C are included in the Subunit 20B report.

Table 2. Total moose harvest, number of hunters, and percent success in Unit 25[a], 1984-88.

Subunit	Year	Total harvest	Number of hunters	Percent success
25A	1984	34	51	67
	1985	29	53	55
	1986	47	72	65
	1987	41	67	61
	1988	39	66	59
25B	1984	39	87	45
	1985	25	49	51
	1986	27	58	47
	1987	26	59	44
	1988	28	56	50
25D west	1984	16	47	34
	1985	20	41	49
	1986	15	46	32
	1987	13	29	49
	1988	8	13	62
25D east	1984	25	87	28
	1985	26	59	44
	1986	39	92	42
	1987	47	88	53
	1988	32	68	47

[a] Data for Subunit 25C are included in the Subunit 20B report.

Table 3. Total reported bull moose harvests, mean antler spreads, and percent distribution of the harvests among various antler size categories in Subunit 25A, 1984-88.

Regulatory year	Antler spread category (inches)								Total known bull harvest	Mean antler spread (inches)
	≤44.9	45.0-49.9	50.0-54.9	55.0-59.9	60.0-64.9	≥65.0	Unk	Total[a]		
1984	18	27	24	18	6	6	3	102	34	50
1985	21	14	17	24	24	0	0	100	29	51
1986	11	18	25	25	9	4	13	105	47	52
1987	17	12	12	34	12	5	7	99	41	51
1988	20	26	8	18	20	5	0	97	39	51

[a] Percentages do not always total 100 due to rounding error.

Table 4. Moose hunter residency and success in Unit 25[a], 1984-88.

	Successful					Unsuccessful				
Year	Unit 25 resident	Other Alaskan resident	Non-resident	Unk	Total	Unit 25 resident	Other Alaskan resident	Non-resident	Unk	Total
Subunit 25A										
1984	3	18	9	4	34	2	12	3	0	17
1985	2	12	14	1	29	3	13	6	2	24
1986	4	22	6	5	47	2	13	10	0	25
1987	4	16	18	3	41	4	14	3	5	26
1988	3	19	11	6	39	2	15	9	3	27
Subunit 25B										
1984	25	12	2	0	39	8	34	3	3	48
1985	7	11	2	5	25	1	19	4	0	24
1986	9	10	3	5	27	6	18	2	5	31
1987	9	10	1	6	26	5	19	6	3	33
1988	9	9	8	2	28	2	20	6	0	28
Subunit 25D east										
1984	15	7	3	0	25	38	21	3	0	62
1985	14	9	2	1	26	21	10	2	0	33
1986	23	10	1	5	39	29	22	1	1	53
1987	24	16	6	1	47	22	13	3	3	41
1988	18	5	4	5	32	19	8	4	5	36
Other[b]										
1984	1	0	0	0	1	2	2	0	0	4
1985	3	2	1	0	6	1	3	1	0	5
1986	1	2	1	0	4					
1987	2	0	0	0	2	1	8	1	0	10
1988	1	0	1	0	2	3	4	0	0	7

[a] Data are not available for Subunit 25D west. Data for Subunit 25C are included in the Subunit 20B report.
[b] Not identified to subunit level.

Table 5. Moose harvest chronology in Unit 25[a], 1984-88.

Subunit	Year	Week in September 1	2	3	4	5	Dec	Feb	Unk
25A	1984	0	14	8	9	0	--	--	3
	1985	5	13	6	3	1	--	--	1
	1986	15	20	6	5	0	--	--	1
	1987	5	14	14	7	0	--	--	1
	1988	4	21	12	1	0	0	0	1
25B	1984	0	1	14	9	7	3	--	5
	1985	1	8	4	5	2	3	--	2
	1986	2	6	14	2	0	0	--	3
	1987	2	5	10	5	1	2	--	1
	1988	1	11	12	1	0	1	0	1
25D west	1984	0	0	3	3	5	0	0	5
	1986	0	1	5	5	2	1	1	0
	1987	0	3	6	2	0	0	1	1
	1988	0	5	2	1	0	0	0	0
25D east	1984	0	1	13	7	0	2	--	2
	1985	0	12	9	1	0	0	--	4
	1986	0	22	12	1	0	3	--	1
	1987	0	9	24	6	0	3	--	3
	1988	0	15	10	1	1	4	0	1

[a] Data for Subunit 25C are included in the Subunit 20B report.

Table 6. Successful moose hunter transport methods in Unit 25[a], 1984-88.

Subunit	Year	Air-plane	Horse	Boat	3- or 4-Wheeler	Snow-machine	Offroad vehicle	Highway vehicle	Unk
25A	1984	20	2	5	0	0	0	3	4
	1985	17	6	3	0	0	0	1	2
	1986	34	8	4	0	0	0	0	1
	1987	25	5	7	0	0	0	1	3
	1988	25	2	8	0	0	0	2	2
25B	1984	9	0	26	0	2	0	0	2
	1985	5	0	16	0	2	0	0	2
	1986	8	0	17	0	0	0	0	2
	1987	7	0	17	0	1	0	0	1
	1988	8	0	17	0	1	0	0	2
25D east	1984	2	1	15	1	3	0	0	3
	1985	4	0	20	0	0	1	0	1
	1986	5	0	26	0	2	0	1	5
	1987	8	0	31	0	3	0	1	4
	1988	9	0	15	0	5	0	0	3

[a] Data are not available for Subunit 25D west. Data for Subunit 25C are included in the Subunit 20B report.

STUDY AREA

GAME MANAGEMENT UNIT: 26A (53,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Western North Slope

BACKGROUND

Moose have been present on the North Slope either sporadically or at low densities for many years; however, since about 1940 moose populations have increased in size and become well established in Subunit 26A. Although moose can be found throughout the subunit during the summer, they are confined to the riparian river corridors during the winter. The largest winter concentrations of moose are found in the inland portions of the Colville River drainage. 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, and 1984. A population estimate derived from a 1984 survey indicated that Subunit 26A contained 1,429-1,786 moose. The most recent surveys indicated that overwinter calf survival may be declining (Trent 1989).

POPULATION OBJECTIVES

To conduct spring trend counts annually to monitor short yearling recruitment.

To conduct fall surveys biennially to monitor sex composition trends.

To completely survey the population at 7-year intervals.

To manage the harvest for spatial and temporal separation of recreational and subsistence hunters.

To maintain for a hunter success rate of not less than 50%.

To establish a management plan and an upper harvest limit for moose.

METHODS

Late-winter trend surveys were conducted during late April in the Colville River drainage to determine population status and short yearling recruitment using Dehavilland Beaver and Piper Supercub aircraft. Harvest data were compiled from anecdotal information received from staff and the public and from harvest reports submitted by hunters.

RESULTS AND DISCUSSION

Population Status and Trend

Complete surveys conducted in 1977 and 1984 and annual trend surveys indicated that the moose population in the Colville River drainage was either stable or slightly increasing until 1987 (Trent 1989); however, during 1987, 1988, and 1989, the mean proportion of short yearlings observed during annual trend surveys (11%) has declined from the 5-year mean of 18% (Table 1). Although the causes of this decline are not known with certainty, Trent (1989) suspected that predation by grizzly bears and wolves may have played a significant role.

Population Composition:

In 1989, 630 adults and 69 short yearlings were observed during late-winter trend counts. The proportion of short yearlings observed (11%) was nearly identical to the proportion observed in 1988 (12%) and 1987 (10%), but substantially less than the mean of 18% observed during the previous 5 years.

Mortality

Season and Bag Limit:

The open season for subsistence hunters in Subunit 26A is 1 August to 31 December. The open season for resident and nonresident hunters is 1 September to 31 December. The bag limit for all hunters is 1 moose.

Human-induced Harvest

Harvest report data indicated that 57 moose (51 bulls and 6 cows) were harvested during the fall of 1988 in Subunit 26A (Table 2), lower than the 62 moose reported for fall 1987 but higher than the 52 moose reported for fall 1986. The number of additional moose killed but not reported in Subunit 26A is unknown. Trent (1989) estimated that 19 additional moose had been harvested but not reported in 1987. Although current data are lacking, I believe that the magnitude of the unreported harvest is probably at least equal to that for 1987.

Hunter Residency and Success. Of the 83 hunters who reported hunting in Subunit 26A, eight were local residents, 24 were nonlocal residents, 32 were nonresidents, 19 were unspecifieds (Table 3). Trent (1989) reported that the proportion of the harvest attributable to local residents has been increasing in recent years; it approached 40% during the fall 1987 season. During the 1988 season, only 8 out of 83 reporting hunters (10%) were local residents, representing a significant decline that was more attributable to a lower reporting rate than to an actual decrease. Our area biologist position at Barrow was vacant during most of the reporting period, and adequate attention was not given to maintenance of the licensing and harvest ticket systems as well as to hunter contacts in the field. The numbers of nonlocal residents (24) and nonresidents (32) were similar to those who reported hunting in Subunit 26A during the fall of 1987. Sixty-nine percent of the reporting hunters were successful in harvesting a moose during the fall of 1988 (Table 2), representing an increase from the 61% success rate observed during 1987 and nearly identical to the previous 5-year mean of 68%.

Harvest Chronology. Most of the harvest occurred during the first 2 weeks of September; 9% of the reported harvest was taken during August, 79% during the first 2 weeks of September, 9% during the remainder of September, and 3% was not specified. No moose were reported harvested during October, November, or December.

Transport Methods. Of the 79 hunters who reported transport means, 81% used aircraft and 18% used boats. One of the hunters did not specify the method used.

Game Board Actions and Emergency Orders

Only 1 regulatory change pertaining to moose in Subunit 26A was enacted by the Board of Game during the reporting period. Although antlerless moose may still be harvested, cows accompanied by calves may not be harvested during the upcoming 1989 season. No Emergency Orders were promulgated during the reporting period.

CONCLUSIONS AND RECOMMENDATIONS

The percentage of short yearlings observed during late-winter surveys has remained low for the third consecutive year; predation by bears and wolves may have been responsible. Although the number of individuals (83) who reportedly hunted in Subunit 26A was substantially lower than the record 118 hunters reported for 1987, it is still higher than those prior to 1986. Trent (1989) suggested that increasing hunting pressures and harvests as well as reduced recruitment have narrowed the safety margin between sustained yield and overall mortalities. If either calf mortalities or harvests increase significantly, the potential for overharvesting may be realized. Fall composition surveys are recommended to evaluate any changes that may be occurring in the bull segment of the population. In addition, a late-winter census of the Colville River population is recommended to verify whether the population is stable or has begun declining.

Efforts to establish license vendors in Subunit 26A should continue. Many individuals do not obtain licenses and harvest tickets before they go hunting. The quality of our harvest data is directly related to how well the license vendor and licensing systems are functioning, and continued efforts to maintain and improve the system are needed.

A moose management plan needs to be developed for Subunit 26A. This plan should recognize the characteristics of moose populations and the needs of moose hunters in those areas. Particular attention should be given to identifying and preserving the characteristics of moose hunting that are unique to the North Slope. In developing such a plan, it is vital to solicit meaningful public participation, especially from local residents. This management plan should discuss several specific objectives, including the spatial and temporal separation of subsistence hunters from recreational hunters and high success rates. The management plan should identify maximum allowable harvest guidelines.

It is also desirable to maintain a hunter contact and enforcement effort from 25 August to 15 September on the Colville River. These efforts should include the lower portions of the river near Nuiqsut as well as Umiat.

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

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Table 1. Colville River trend counts: Anaktuvuk River, Chandler River, and Colville River between Anaktuvuk and Killik Rivers, 1970, 1974-81, and 1983-89.

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

[a] Partial count because of incomplete snow cover and wide dispersal of moose.

Table 2. Reported hunter success in Unit 26A, 1983-88.

Year	Harvest	Sex			Hunters	Success rate (%)
		M	F	Unk		
1983	37	30	7	0	50	74
1984	50	42	7	1	66	76
1985	65	50	15	0	99	66
1986	52	46	6	0	80	65
1987	62	49	13	0	118[a]	61
1988	57	51	6	0	83	69

[a] 16 hunters did not report harvest.

Table 3. Residence of reporting hunters in Subunit 26A, 1983-88.

Year	North Slope (Unit 26) No.	(%)	Nonlocal Alaska resident No.	(%)	Nonresident No.	(%)	Total
1983	4	(9)	25	(56)	16	(35)	45
1984	12	(19)	42	(66)	10	(15)	64
1985	29	(30)	45	(46)	24	(24)	98
1986	29	(36)	33	(41)	18	(23)	80
1987	40	(40)	20	(20)	39	(40)	99
1988	8	(10)	24	(29)	32	(39)	83[a]

[a] Total includes 19 hunters (22%) whose residency is unknown.

STUDY AREA

GAME MANAGEMENT UNIT: 26B and 26C (26,000 mi^2)

GEOGRAPHICAL DESCRIPTION: North slope of the Brooks Range and arctic coastal plain east of the Itkillik River

BACKGROUND

Moose populations became established in Arctic Alaska during the late 1800's; however, they were rarely seen and did not become common until the early 1950's (LeResche et al. 1974). Wolf predation contributed to the slow expansion of these populations during this time. Extensive federal predator control efforts during the late 1940's and early 1950's relieved predation pressure and sparked population growth that continued until the early 1980's. Today, most moose are found in Subunit 26B and the western portion of Subunit 26C.

Moose in the eastern Arctic exist in a treeless tundra at the northern limit of their range. Year-round habitat is limited to narrow strips of riparian willow along the major rivers. The highest densities are probably found along the Canning, Kavik, and Shaviovik Rivers. Extrapolations from composition surveys and incidental observations suggest a stable population of approximately 1,200 moose; about 700 in Subunit 26B and 500 in Subunit 26C. No attempt has ever been made to accurately determine population size, and virtually nothing is known about their movements.

Composition surveys have been conducted by staff from the U.S. Fish and Wildlife Service (USFWS) and Arctic National Wildlife Refuge (ANWR) (Martin and Garner 1984, Weiler and Leidberg 1987, Mauer 1988). The Canning River has been surveyed almost annually since 1983. Drainages west of the Canning River were surveyed during 1986 and 1988.

The potential to produce and harvest large numbers of moose simply does not exist because of the limited availability of suitable habitat; however, much of the area is pristine Arctic tundra, and travel to it is expensive and often logistically difficult. The lack of access in most of Subunits 26B and 26C has concentrated the hunting pressure around the larger and better known aircraft landing sites. Concern over this potential problem has been voiced by transporters, guides, outfitters, and the ANWR staff. The presence of the Dalton Highway in central Subunit 26B provides unique opportunities for viewing and photography, but there is also the potential for impacting moose populations and quality of hunting experiences because of increased hunter access to the area.

The subsistence harvest of moose in Subunits 26B and 26C probably does not exceed 5-10 yearly. Kaktovik and Nuiqsut are the only subsistence communities in the area. Residents of Kaktovik rely on other species, because moose are not abundant in that part of Subunit 26C. Residents of Nuiqsut have ready access to moose on the Colville River, but because Nuiqsut is on the western boundary of Subunit 26B and most of the Colville drainage is in Subunit 26A, most of the harvest comes from Subunit 26A.

Increasing harvests by recreational hunters are a source of concern. Interest in the area has probably increased for 2 reasons: (1) access to moose populations in Subunit 26B dramatically improved when the Dalton Highway was opened for commercial use in 1978, hunting guides and outfitters established staging points along the road, and the general public invented an array of commercial reasons to use the highway and thereby circumvent restrictions and (2) additional hunters have been attracted into the area because wildlife resources in the Arctic National Wildlife Refuge (ANWR), which covers most of the eastern Arctic, have received national publicity as part of the controversy over oil development.

The only regulatory changes made over the last 5 years occurred in 1987, when the hunting season for most hunters was reduced to 1-30 September and the bag limit of 1 moose was further restricted to permit only the harvest of bulls. At the same time, the season for residents of Unit 26 who qualify as subsistence hunters was increased to 1 August through 31 December and the subsistence bag limit of 1 moose was retained without a bulls-only restriction.

Regulations for the Dalton Highway Management Area (DHMA) originally specified that hunting was not permitted within 5 miles of the Dalton Highway from the Yukon River bridge to the Prudhoe Bay Closed Area, except for the hunting of big and small game with bow and arrow. In 1987 the Board of Game prohibited motorized vehicles, except aircraft, boats, and licensed highway vehicles, from transporting game or hunters, thus bringing game regulations into alignment with the Alaska statutes, which already contained a restriction on use of motorized vehicles. It was also done to provide a penalty for violations, because none was included when the statute was originally passed by the Legislature.

Restrictions imposed on hunting within the DHMA have not prevented a long-term increase in harvest. Failure of this regulation is primarily due to lack of enforcement. Only 1 Fish and Wildlife Protection Officer is assigned to the entire eastern Arctic and Brooks Range.

POPULATION OBJECTIVES

To determine population distribution, composition, density, and trends by 1991.

To determine movements and habitat use in heavily harvested drainages beginning in 1991.

To maintain an annual posthunting season sex ratio of at least 50 bulls:100 cows.

To maintain a mean annual antler spread of at least 50 inches among bull moose harvested during the general season.

To maintain an annual hunter success rate of at least 40%.

To determine subsistence needs and harvest levels by 1991.

METHODS

The riparian willow habitat associated with drainages of Subunit 26B are normally searched systematically during the early winter using Piper PA-18 aircraft and flying at 70-90 miles per hour at altitudes of 300-600 feet above ground level. In 1988 portions of several drainages having poor habitat and few moose (Mauer 1988) were not surveyed. Mandatory hunter harvest reports provided data on harvest characteristics and hunter effort.

RESULTS AND DISCUSSION

Population Status and Trend

Population Composition:

Sex and age ratios observed in the Canning River survey area increased from 1983 to 1985 and then declined (Table 1). The decline in recruitment is a major concern, because it lessens the likelihood that the desired bull:cow minimum and availability of large bulls in the harvest can be maintained at current harvest levels. Equally disturbing is the added fact that the harvest of bulls has increased substantially since 1984, because hunters have been concentrating on the larger animals. As a result, total bulls:100 cows has declined by 35% and the number of large bulls:100 cows has dropped by 60% between 1985 and 1988. These data suggest that the harvest of large bulls cannot be sustained by the population.

Sex and age ratios observed in the survey area west of the Canning River during 1988 were similar to those obtained in 1986, except for the indices of yearling recruitment (Table 1). The ratio of yearling bulls:100 cows jumped from 9:100 in 1986 to 30:100 in 1988, and the percentage of yearlings in the population rose by a similar margin. It is possible that survey results were somehow biased between years for yearlings. The low and declining ratio of large bulls:100 cows could be attributed to greater hunting pressure on large males; e.g., the Canning River drainage.

Mortality

Seasons and Bag Limits:

The subsistence season is from 1 August to 31 December; the bag limit is 1 moose. The season for resident and nonresident hunters is from 1-30 September; the bag limit is 1 bull. For all hunters, there is no open season within 2 miles of the Dalton Highway in Subunit 26B.

Human-induced Mortality:

The reported harvests from Subunits 26B and 26C in 1988 were 33 and 10 bull moose, respectively (Table 2). Most of the harvest in Subunit 26B came from areas adjacent to the Dalton Highway. No cow harvest was reported during the current year by subsistence hunters; however, the harvest ticket system under-represented the subsistence harvest because of poor compliance with reporting requirements.

The reported harvests from Subunits 26B and 26C increased until 1986 and 1987, respectively, before declining (Fig. 1). A similar pattern was apparent in the numbers of hunters reporting for these subunits, except that the peak in hunting effort occurred 1 year earlier in Subunit 26B than the peak in harvest (Fig. 2). The magnitude of the change was greatest in Subunit 26B, where the Dalton Highway had vastly improved access for the general public.

The decreases in total harvests following the peak years were most likely due to a bag limit change in 1987 that restricted most hunters to taking only bull moose. Only subsistence hunters were permitted to continue taking cow moose; however, hunting regulations for the DHMA may also have contributed by slowing the harvest rate in the most accessible portion of Subunit 26B. The reported harvest near the Dalton Highway seems to have stabilized at 15-20 moose (Fig. 3), although hunting effort increased for 1988 (Fig. 4).

In spite of increasing harvest, mean antler spread has been fairly stable over the past 5 years; it has always exceeded 50 inches (Table 3). Mean antler spread has averaged from 50.3 to 61.2 inches for all areas.

Hunter Residency and Success. Based on harvest reports, 54% of the moose hunters in the eastern Arctic during 1988 were not residents of Alaska (Table 4). This represents an actual increase in the proportion of nonresident hunters, if the biases in the reporting have remained somewhat consistent over time. Usually, reporting by local residents has been minimal. In 1988 no local residents submitted harvest reports.

The success rate among reporting hunters remained very high (Table 2). Sixty-four percent of all hunters reporting in 1988 were successful. Success during the previous 4 years has varied from 64% to 86%. No trend was apparent.

Harvest Chronology. During 1988, 74% of the moose harvest occurred during the first 3 weeks of September (Table 5). Although the majority of the harvest has always occurred during this period, the proportion has increased since 1987 because of a regulatory change that restricted most hunters to the month of September.

Transport Methods. As in previous years, airplanes were the most commonly used means of transportation for successful hunters (Table 6). Aircraft have composed 57-81% of the total over the past 5 years.

Natural Mortality:

Very little is known about natural mortality of moose in the eastern Arctic. Reports from the public and incidental observations by biologists have indicated that predation by wolves and grizzly bears is important. Habitat is limited, but its role in natural mortality is unknown.

CONCLUSIONS AND RECOMMENDATIONS

Management goals and objectives for moose in Subunits 26B and 26C are being achieved. The relatively small subsistence demand has been easily satisfied, bull:cow ratios were high, hunter success was excellent, and antler size in the harvest has been adequate. The population continues to have the characteristics necessary to support high-quality hunting experiences; however, the increasing harvests of bull moose have jeopardized efforts to sustain these characteristics and continue to meet management goals and objectives.

Recent harvest levels have precipitated a decrease in the availability of large-antlered bulls, which means that they have been harvested at a greater rate than their recruitment to the population. If the estimates of population size and recruitment are correct, the sustainable harvest may be less than 40 bulls annually, which is less than what the actual harvests have been for the past 4 years. It will become impossible to achieve our objectives of maintaining an average antler size of 50 inches or greater in the harvest and an annual hunter success rate of at least 40% if the harvest remains at current levels. To avoid having to institute a permit system, I recommend that the general moose seasons in Subunits 26B and 26C be reduced to 1-15

September and that the bag limit be changed to 1 bull with $\geq$50-inch antlers. These changes should reduce the total take and provide more large bulls in the population.

Aerial surveys will be continued and expanded to monitor this situation. I also recommend that the Department and the USFWS cooperate in radio-collaring moose in the heavily harvested drainages to document movements, mortality, and habitat use. Determining the timing of seasonal movements and the amount of interchange of moose among drainages is important to understanding how large a population base is supporting the current harvest levels. This information will help delineate options for managing the harvest to meet the specified objectives. It is also important to ascertain the causes and magnitudes of calf and adult mortality, since worsening recruitment of moose to the large bull age class will further aggravate attempts to achieve management goals and objectives.

Failure to adequately enforce the existing regulations and statutes in the DHMA has contributed to the increased harvest in Subunit 26B. I recommend that the enforcement effort along the road be increased. This will be difficult for Division of Fish and Wildlife Protection, given recent funding cuts; however, both the Bureau of Land Management and the USFWS have expressed willingness to increase their enforcement efforts on lands under their jurisdiction.

Hunter crowding, both along the Dalton Highway and at aircraft landing areas elsewhere in both subunits, is also a source of concern. I recommend that the phrase "aesthetic conditions" be examined and defined relative to hunting in the eastern Arctic. To assist with this endeavor, a hunter survey should be done in cooperation with the USFWS to find out how hunters define "aesthetic conditions" and how important this aspect of their hunting experience is to them. I consider it important to know whether present levels of crowding are as negatively affecting hunters as they seem to be affecting guides, outfitters, transporters, and the ANWR staff. Increased effort should be made to improve compliance with the harvest reporting requirements.

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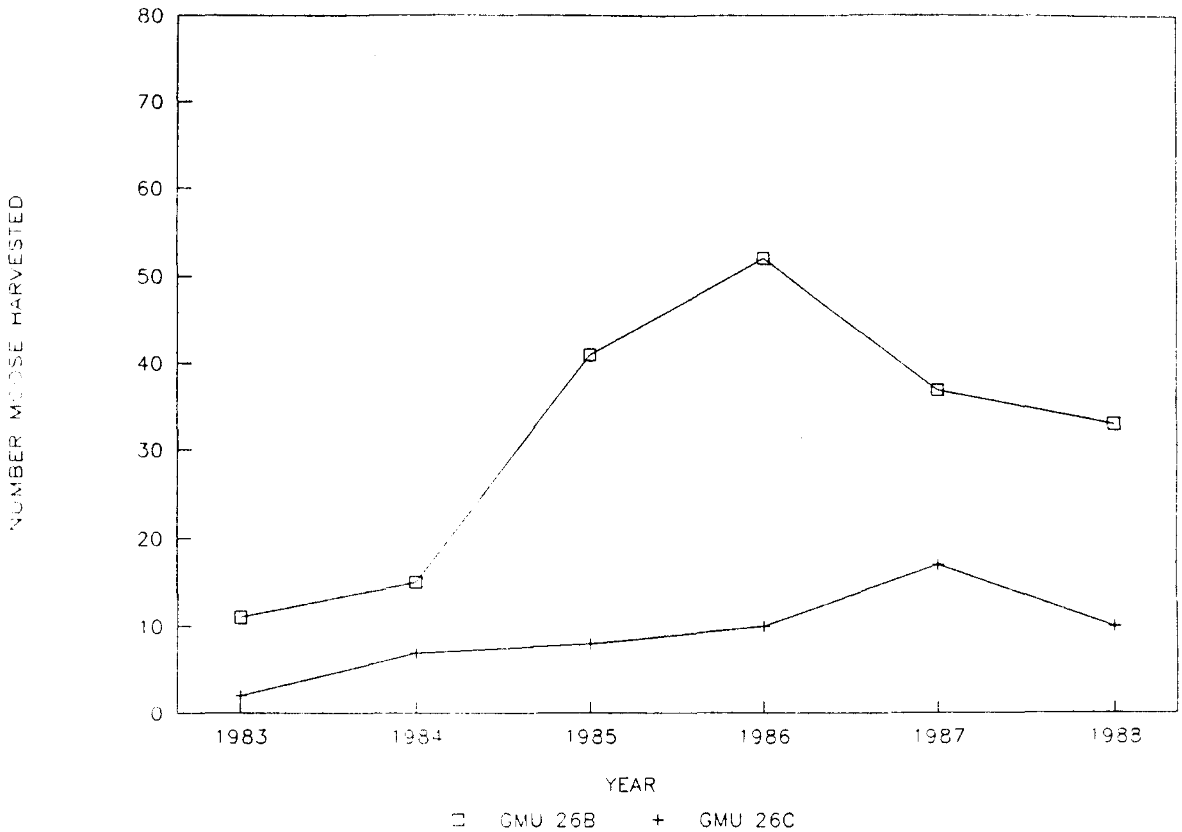

Figure 1. Trends in the reported harvest of moose in the eastern arctic, 1983-88.

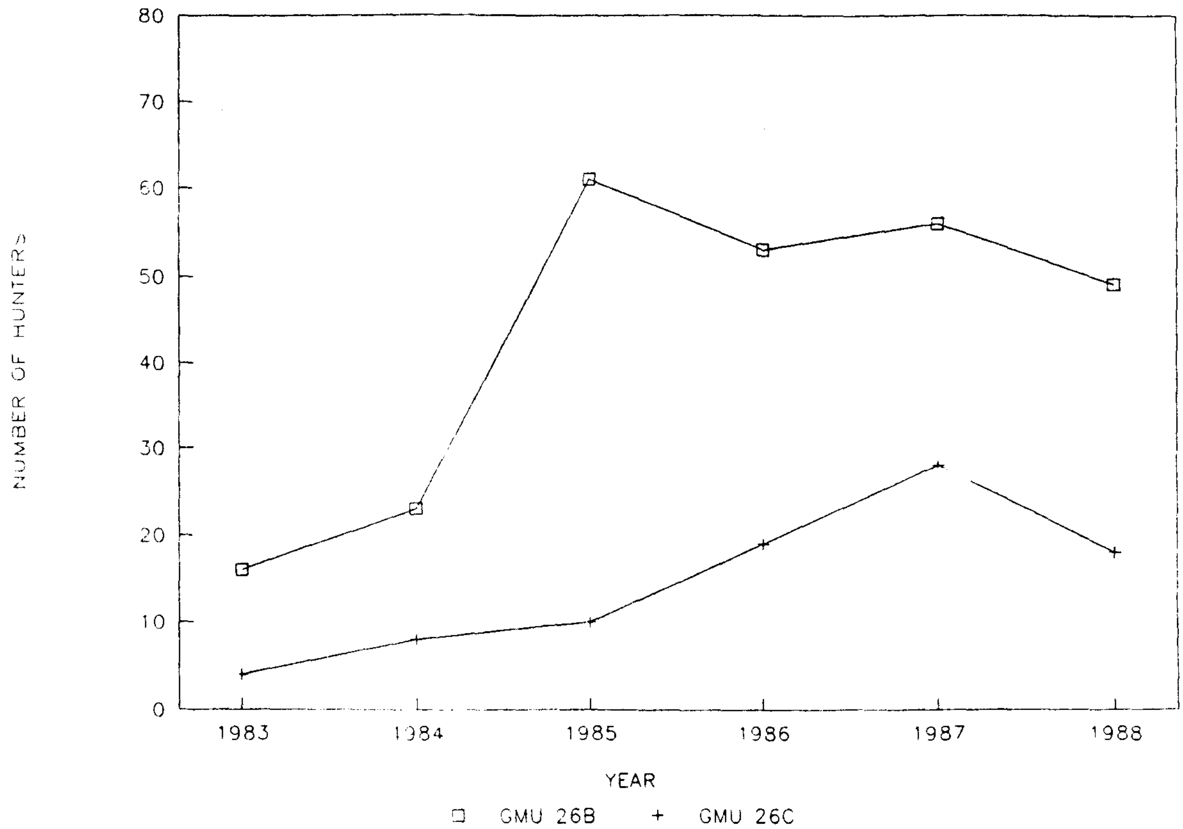

Figure 2. Trends in the numbers of moose hunters in the eastern arctic, 1983-88.

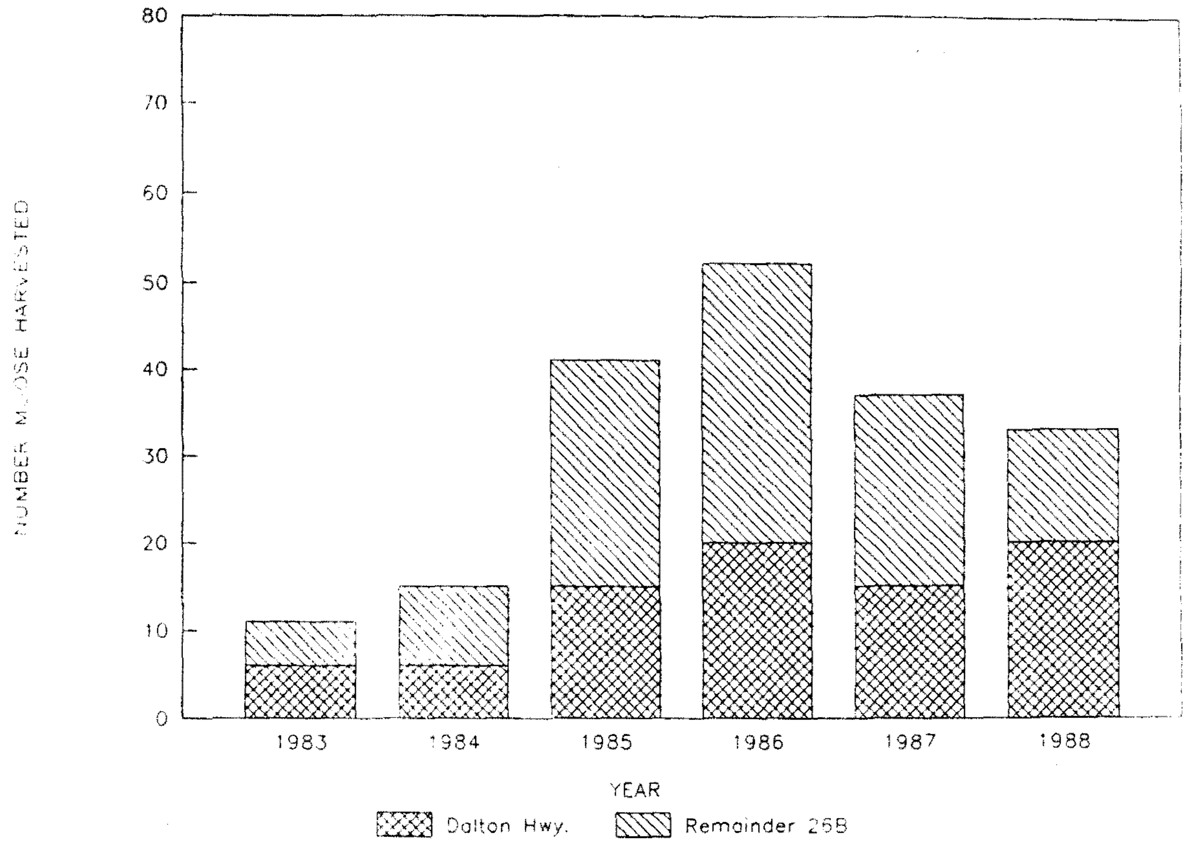

Figure 3. Trends in the reported harvest of moose in Subunit 26B, 1983-88.

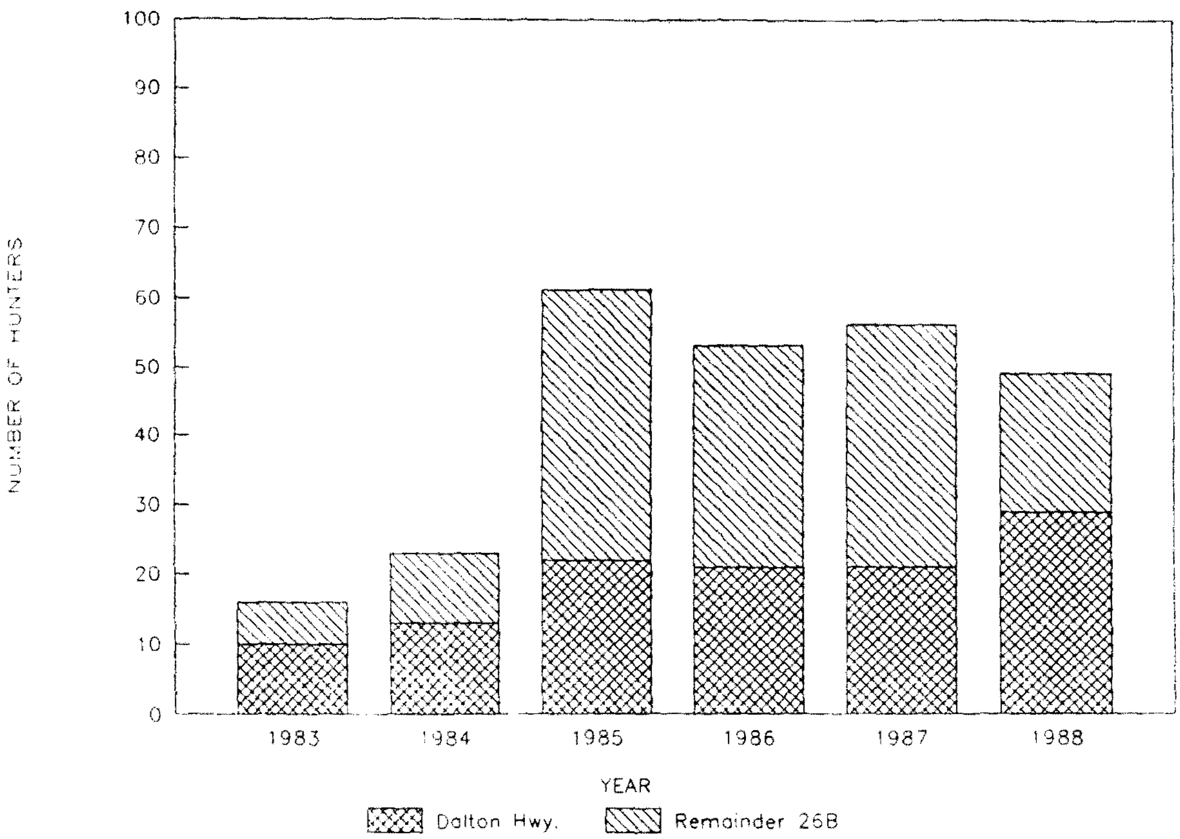

Figure 4. Trends in the numbers of moose hunters in Subunit 26B, 1983-88.

Table 1. Early winter sex and age ratios among moose surveyed in Subunits 26B and 26C, 1983-86 and 1988.[a]

Area	Year	Calves: 100 cows	Yearling bulls: 100 cows	Total bulls: 100 cows	Large[b] bulls: 100 cows	% of herd		Sample size
						Calves	Yearlings	
Canning River	1983	38	11	68	38	17	9	150
	1984	35	15	71	44	15	13	156
	1985	44	28	75	47	16	20	187
	1986	21	18	70	30	9	16	139
	1988	16	4	49	19	9	5	118
Kavik River to Sagavanirktok River	1986	36	9	52	17	17	9	478
	1988	34	30	49	13	14	25	511

[a] Modified from Martin and Garner 1984, Weiler and Leidberg 1987, and Mauer 1988.

[b] Antler spread $\geq$50 inches.

Table 2. Moose harvest composition, hunter numbers, and hunter success in Subunits 26B and 26C, 1984-88.

Year	Harvest area	Harvest composition			No. of	%
		Male	Female	Total	hunters	Success
1984	26B(Dalton Hwy)	6	0	6	13	46
	26B(Remainder[a])	9	0	9	10	90
	26C	7	0	7	8	88
1985	26B(Dalton Hwy)	8	7	15	22	68
	26B(Remainder)	24	2	26	39	67
	26C	7	1	8	10	80
1986	26B(Dalton Hwy)	18	2	20	21	95
	26B(Remainder)	25	7	32	32	100
	26C	6	4	10	19	53
1987	26B(Dalton Hwy)	15	0	15	21	71
	26B(Remainder)	22	0	22	35	63
	26C	16	1	17	28	61
1988	26B(Dalton Hwy)	20	0	20	29	69
	26B(Remainder)	13	0	13	20	65
	26C	10	0	10	18	56

[a] Those portions of Subunit 26B not adjacent to the Dalton Highway.

Table 3. Antler spreads of bull moose harvested from Subunits 26B and 26C, 1984-88.

Year	Subunit	Antler spread category (inches) ≤44.9	45.0 49.9	50.0-54.9	55.0-59.9	60.0-64.9	≥65.0	Unk	Total known bull harvest	Mean antler spread (inches)
1984	26B(Dalton Hwy)	1	3	0	1	1	0	0	6	51.1
	26B(Remainder[a])	0	0	1	2	4	1	1	9	61.2
	26C	2	0	1	0	3	1	0	7	53.1
1985	26B(Dalton Hwy)	1	0	1	0	3	1	2	8	53.8
	26B(Remainder)	4	1	3	5	8	1	2	24	53.2
	26C	0	2	1	1	2	1	0	7	56.3
1986	26B(Dalton Hwy)	5	1	1	5	5	0	1	18	50.3
	26B(Remainder)	3	1	4	5	6	1	5	25	53.6
	26C	1	1	2	1	1	0	0	6	51.7
1987	26B(Dalton Hwy)	2	1	3	6	3	0	0	15	53.7
	26B(Remainder)	2	3	7	3	6	0	1	22	53.4
	26C	3	1	4	6	2	0	0	16	52.1
1988	26B(Dalton Hwy)	4	2	4	6	1	1	2	20	50.3
	26B(Remainder)	2	2	4	2	3	0	0	13	51.3
	26C	3	1	0	3	2	1	2	10	52.4

[a] Those portions of Subunit 26B not adjacent to the Dalton Highway.

Table 4. Moose hunter residency and success in Subunits 26B and 26C, 1984-88.[a]

	Successful					Unsuccessful					Total	Total
Year	Local[b] resident	Other resident	Non-resident	Unk	Total	Local resident	Other resident	Non-resident	Unk	Total	Alaska resident	non-resident
1984	0	10	8	4	22	2	5	2	0	9	17	10
1985	1	24	20	4	49	0	19	3	0	22	44	23
1986	0	33	20	9	62	0	8	0	2	10	41	20
1987	0	21	22	11	54	1	21	5	3	30	43	27
1988	0	13	26	4	43	0	14	6	4	24	27	32

[a] Data from both subunits are combined.

[b] Resident of Subunits 26B or 26C.

Table 5. Moose harvest chronology in Subunits 26B and 26C, 1984-88.

Year	Aug	Week in September 1	2	3	4	5	Oct	Nov	Dec	Unk
1984	-	2	7	5	3	1	3	0	1	0
1985	-	20	8	2	2	-	4	8	5	0
1986	-	23	13	6	5	-	2	3	4	6
1987	1	19	17	12	3	-	0	0	1	1
1988	6	15	9	8	4	-	0	0	0	1

Table 6. Successful moose hunter transport methods in Subunits 26B and 26C, 1984-88.

Year	Air-plane	Horse	Boat	3- or 4-wheeler	Snow-machine	Offroad vehicle	Highway vehicle	Unk
1984	16	0	0	3	1	0	1	1
1985	28	0	0	1	12	0	3	5
1986	45	0	0	2	7	2	4	2
1987	44	0	2	0	1	0	0	7
1988	34	1	2	0	1	0	3	2

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