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ALASKA DEPARTMENT OF FISH AND GAME

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ALASKA PENINSULA MOOSE PRODUCTIVITY AND PHYSIOLOGY STUDY

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Job No: 1.22R Job Title: Alaska Peninsula Moose Productivity and Physiology Study

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SUMMARY

In April 1977, 57 adult cow moose were immobilized and marked with visual collars in the Mother Goose Lake area of the Alaska Peninsula. A pregnancy rate of 84 percent was determined by rectal palpation at the time of capture. Analysis of blood samples indicated the population was nutritionally stressed as reflected by low PCV values, low BUN and low cholesterol levels. Other blood parameters were at acceptable levels suggesting the nutritional situation was not crisis. Aerial calving surveys indicated that following successful parturition, newborn calves experienced a high rate of mortality.

CONTENTS

BACKGROUND

Moose (*Alces alces)* populations on the central Alaska Peninsula have been declining since 1969, apparently as a result of poor reproductive success caused by past overuse of the range (Faro 1977). Recently developed techniques (Franzmann et al.1976), which use spring pregnancy rates, body condition and physiological condition to assess the nutritional status of a moose herd, provided the opportunity to determine if declining range condition was an important factor in the decline of this moose herd.

Ledger (1968) outlined the premise that animal form and body composition are largely dictated by the interaction of the complexes of climate and nutrition. Body condition is relative and reflects the state of an animal's health and fitness at a particular time. To make condition a usuable term, it must be quantified. Robinson (1960) established condition evaluation criteria for white-tailed deer *(Odocoileus virginianus*) based on form, composition and motion. Franzmann et al. (1976) adapted these criteria to Alaskan moose *(Alces alces gigas)* and determined that certain blood chemistry and hematological values corresponded to changes in these condition criteria. Comparisons of condition-related blood parameters from different moose populations in Alaska, sampled during the nutritionally critical late winter-early spring period, provided a means to rank populations of relatively unknown nutritional status with those of better or well-known status (Franzmann et al. 1976).

Pregnancy rates, a good index to the condition of animals on a given range (Simkin 1974), can be determined during late winter-early spring on immobilized animals by rectal palpation pregnancy examination. Although they do not necessarily relate to natality rates, they are a good comparative index for that time period. Late winter-early spring pregnancy rates of several Alaskan moose populations, as determined by rectal palpation, have been reported to be 83 to 91.6 percent (Franzmann and Arneson 1974a, 1975). However, lower pregnancy rates (59.5 percent) in the confined, low production Kenai Moose Research Center (MRC) population were also reported (Franzmann et al. 1976).

Data on pregnancy rate, actual calf production, and survival immediately following parturition provide additional insight into the population productivity complex.

Morphometric measurements are potentially valuable techniques in wild animal studies primarily because most data are easy to obtain and values are not subject to acute stress-related changes. They are perhaps some of the better criteria to evaluate long range trends. Genetic characteristics must be considered when comparing populations, however (Tanner et al. 1970).

OBJECTIVES

To determine the physical condition and pregnancy rates of adult cow moose on the Alaska Peninsula during the late winter. To estimate calf production and survival immediately following parturition.

STUDY AREA

A portion of the Bering Sea flats of the Alaska Peninsula, Game Management Unit 9, immediately south and west of Mother Goose Lake, was selected as the study area (Fig.1). The area was known to have a high concentration of wintering moose. Available data from spring calving surveys (Fig. 2, Table 1) and fall sex and age composition surveys (Fig. 3, Table 2-4) indicated the population has had poor calf recruitment since 1970.

The eastern portion of the study area is in foothills of the Aleutian Range Mountains with the terrain gradually changing to wet, open tundra flats on the western boundary. In well-drained areas, vegetation is predominantly alder *(Alnus* sp.), balsam poplar *(Populus balsamifera)*, and willow (*Salix* sp.) interspersed with grasses. Vegetation on lower elevations is a mixture of lichens, sedges and grasses with stands of willow along stream bottoms or in areas with good drainage. Observations indicated heavy browsing by moose had occurred, and many of the individual plants of preferred willow species were decadent. No range studies have been conducted in this area to provide data on range condition.

METHODS

Between 5 and 7 April 1977, 57 adult female moose (Table 5) were immobilized using helicopter darting techniques described by Gasaway (1977). Drugs used were a mixture of M-99 (etorphine hydrochloride) and Rompun (xylazine hydrochloride). All animals except one were captured in the foothill area between Pumice Creek and the King Salmon River (Fig.1). The remaining cow was immobilized immediately northeast of Mother Goose Lake on Volcano Creek. No mortality occurred as a result of capture or marking and all animals were on their feet shortly after administration of the antagonist, M 50-50 (diprenorphine).

Colored-numbered neck collars were placed on each cow to permit future identification (Franzmann and Arneson 1974b). The majority (50 collars) were blue with yellow numbers, and the remainder (7 collars) yellow with black numbers. Numbered metal ear tags were placed in each ear.

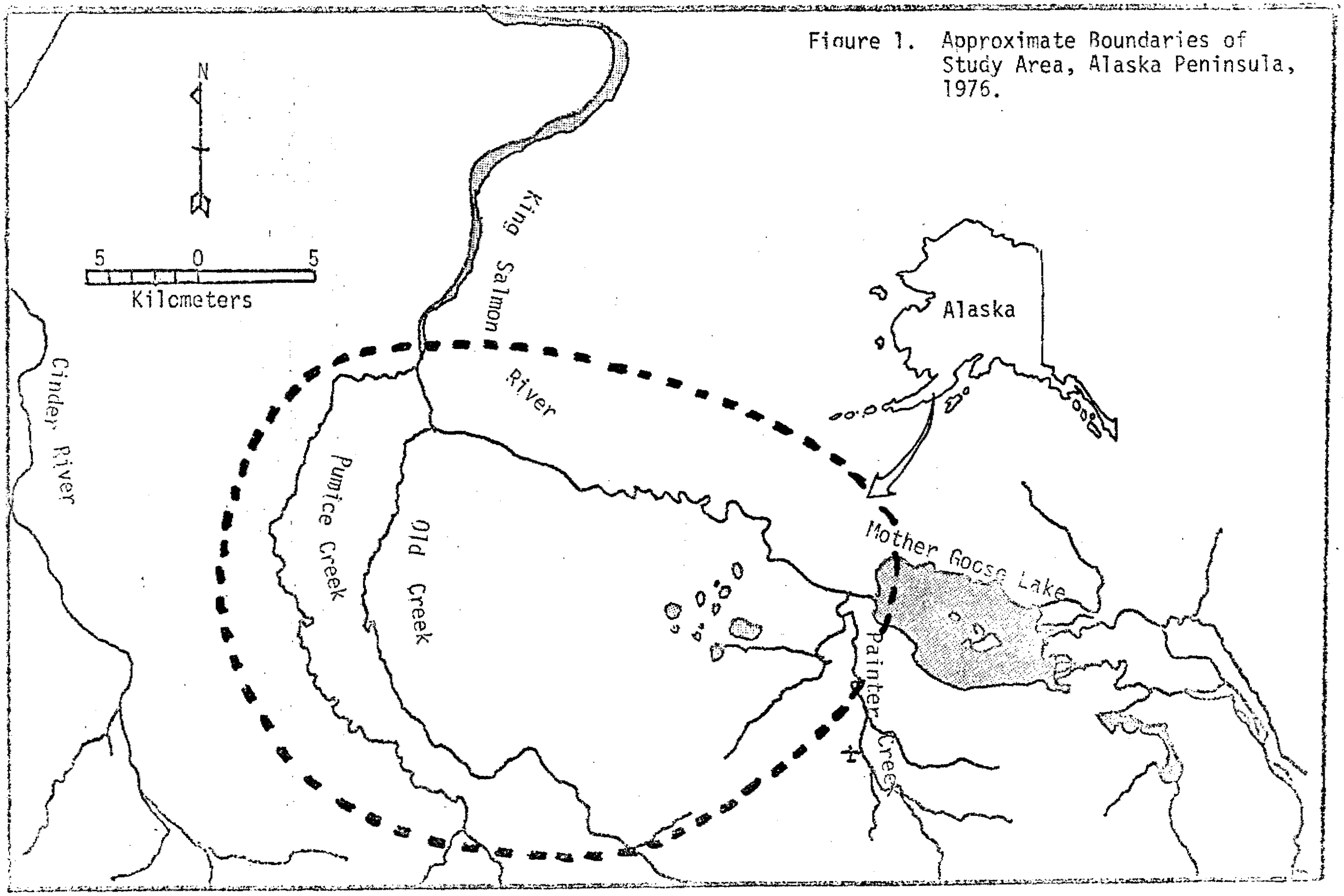

Figure 1. Approximate Boundaries of Study Area, Alaska Peninsula, 1976.

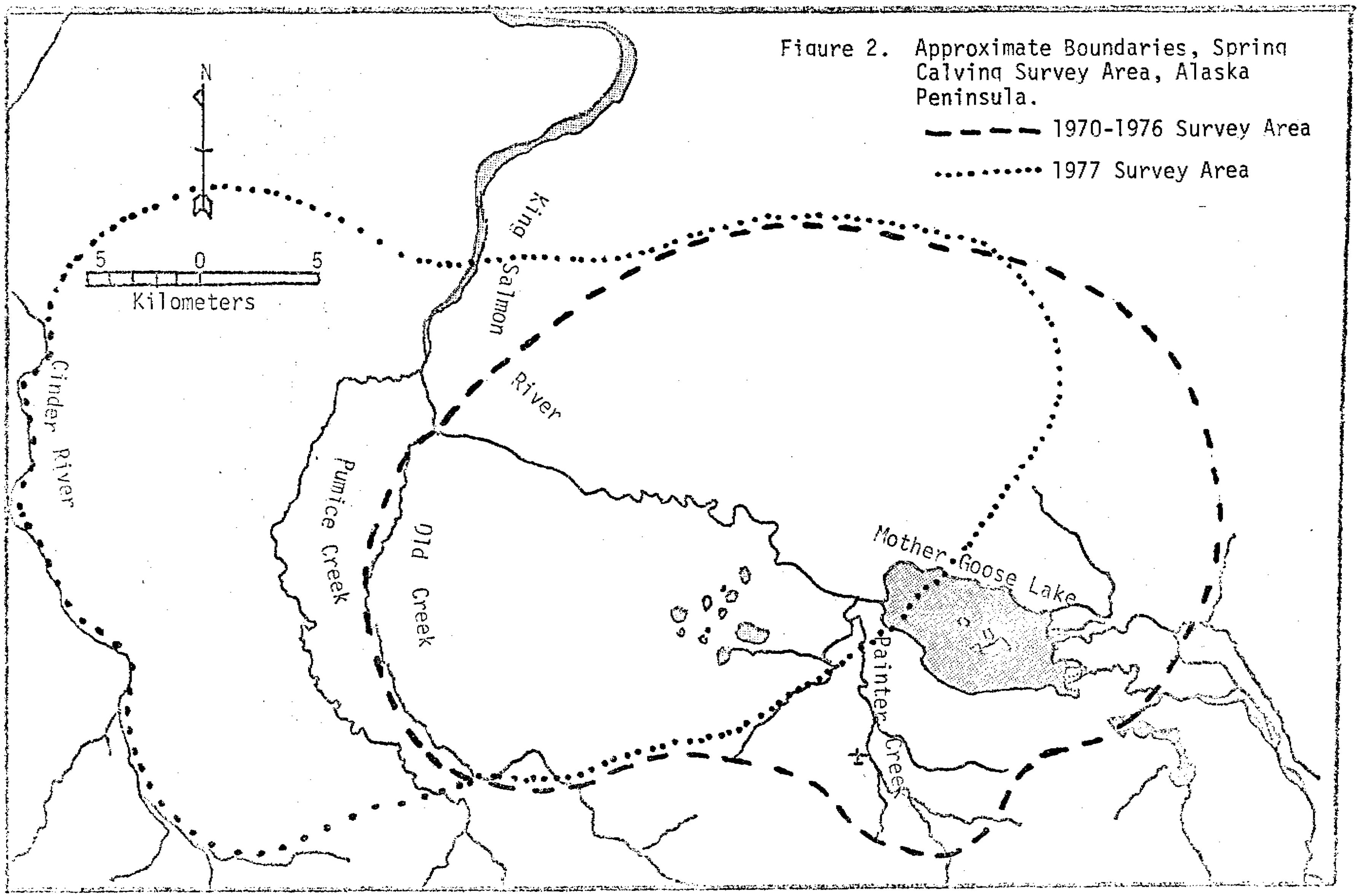

Figure 2. Approximate Boundaries, Spring Calving Survey Area, Alaska Peninsula.

Table 1. Summary of moose parturition surveys, King Salmon to Mother Goose, 1970-1977.

Year	Date	Calves Per 100 Cows	Calves Per 100 Cows & Yearlings	Incidence of Twins	Sample Size
1970	May 18	4.9	3.5	50.0	112
	May 22	14.5	10.3	57.1	158
	May 26	31.9	21.0	22.2	203
	May 30	75.0	44.7	55.5	221
	June 6	55.9	27.4	39.2	482
	June 13	43.1	28.6	15.8	128
1971	June 2	43.3	32.6	52.6	214
	June 5	53.9	38.9	33.3	221
	June 12	23.8	19.2	19.0	237
1972	June 7	-	22.3	35.7	322
	June 12	23.1	19.3	41.2	233
1973	May 28	13.1	10.1	60.0	105
	June 3	40.0	30.6	57.9	156
	June 8	25.0	19.4	50.0	250
	June 14	15.2	13.0	45.5	187
1974	June 10	29.6	25.0	41.1	146

1975	June 8	30.9	28.2	34.6	169
1976	June 1	18.0	15.4	38.5	126
	June 11	13.5	12.0	25.0	115
	June 22	15.2	13.8	14.3	167
1977	May 28	28.8	25.7	66.7	106
	May 31	33.3	32.4	60.0	104
	June 3	40.0	37.4	61.9	144
	June 6	45.8	44.0	65.0	121
	June 9	28.8	25.6	50.0	111
	June 12	20.9	19.7	16.1	95
	June 15	25.9	24.6	25.0	86

Table 2. Summary of fall sex and age composition data, Mother Goose Lake trend area, 1972-1976.

Year	Bulls Per 100 Cows	Calves Per 100 Cows	Incidence of Twins	Sample Size
1962	59.5	38.2	-	486
1964	54.2	16.9	7.3	597
1966	39.6	26.4	16.7	94
1967	60.6	21.3	15.4	844
1968	49.0	17.6	18.7	691
1969	28.1	20.6	3.1	242
1970	33.3	10.7	6.7	216
1971	23.6	6.7	0.0	348
1972	30.0	17.1	6.9	278
1973	24.0	8.4	16.7	238
1974	15.3	14.3	3.7	254
1975	15.8	13.7	0.0	123
1976	14.0	14.1	0.0	91

Table 3. Summary of fall sex and age composition data, Patch trend area, 1972-1976.

Year	Bulls Per 100 Cows	Calves Per 100 Cows	Incidence of Twins	Sample Size
1970	30.8	26.9	0.0	41
1971	43.0	4.0	0.0	147
1972	24.7	14.8	0.0	113
1973	15.6	8.3	14.3	135
1974	15.8	13.3	6.7	155
1975	17.2	5.2	50.0	71
1976	14.7	5.3	0.0	90

Table 4. Summary of fall sex and age composition data, Flats trend area, 1974-1976.

Year	Bulls Per 100 Cows	Calves Per 100 Cows	Incidence of Twins	Sample Size
1974	12.5	11.8	3.1	348
1975	14.2	11.1	25.0	283
1976	11.2	6.6	6.7	284

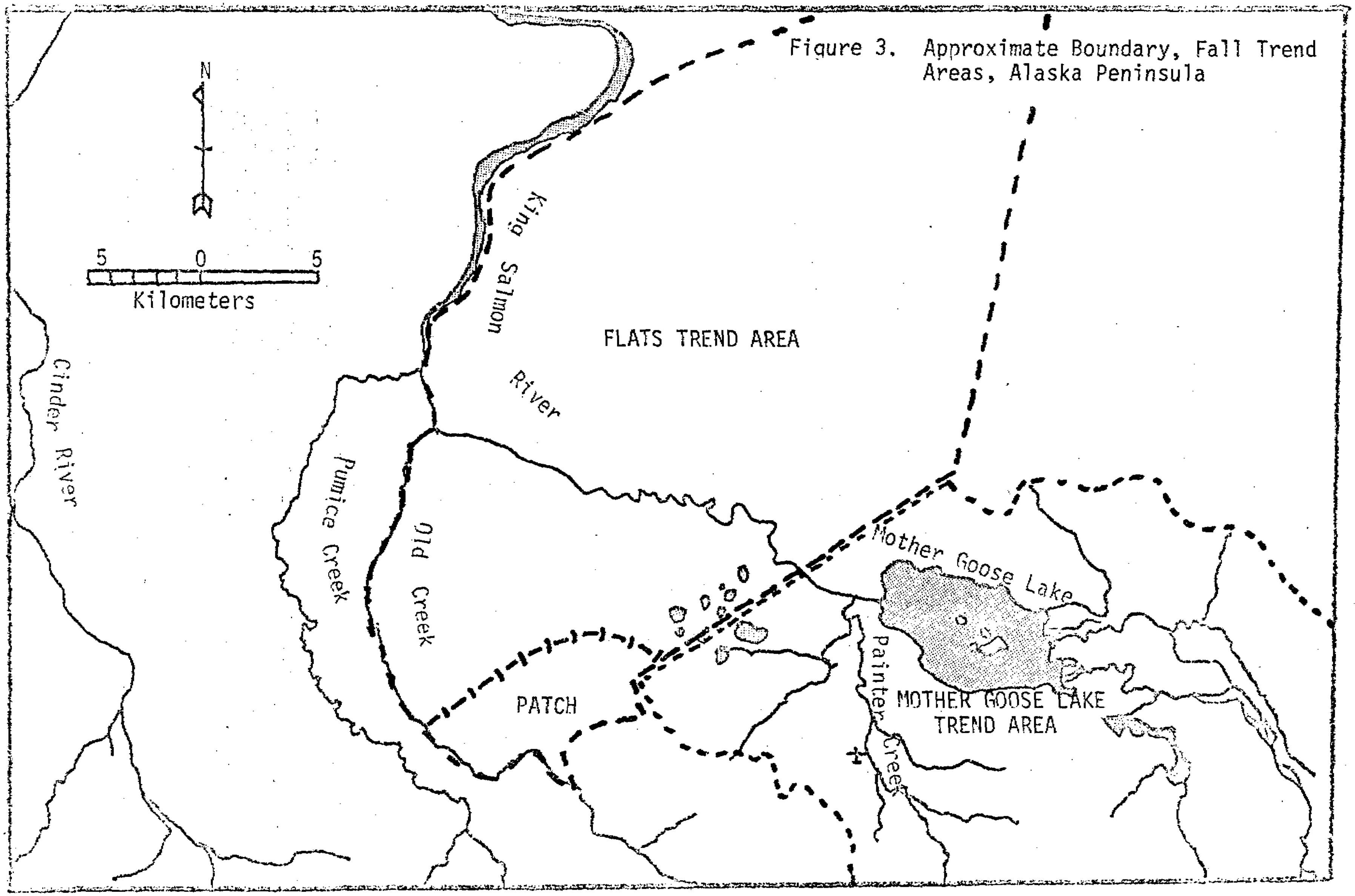

Figure 3. Approximate Boundary, Fall Trend Areas, Alaska Peninsula

Table 5. Numerical designation and collar color of visual collars fitted on female moose in Game Management Unit 9, April 1977.

Numerical Designation	Collar[1/] Color	Date	Numerical Designation	Collar[1/] Color	Date
1	B & Y	April 5	31	B & Y	April 7
2	B & Y	April 5	32	B & Y	April 7
3	B & Y	April 5	33	B & Y	April 7
4	B & Y	April 5	34	B & Y	April 7
5	B & Y	April 5	35	B & Y	April 7
6	B & Y	April 6	36	B & Y	April 7
7	B & Y	April 6	37	B & Y	April 7
8	B & Y	April 6	38	B & Y	April 7
9	B & Y	April 6	39	B & Y	April 7
10	B & Y	April 6	40	B & Y	April 7
11	B & Y	April 6	41	B & Y	April 7
12	B & Y	April 6	42	B & Y	April 7
13	B & Y	April 6	43	B & Y	April 7
14	B & Y	April 6	44	B & Y	April 7
15	B & Y	April 6	45	B & Y	April 7
16	B & Y	April 6	46	B & Y	April 7
17	B & Y	April 6	47	B & Y	April 7
18	B & Y	April 6	48	B & Y	April 7
19	B & Y	April 6	49	B & Y	April 7
20	B & Y	April 6	50	B & Y	April 7

21	B & Y	April 6	41	Y & Bk	April 7
22	B & Y	April 6	42	Y & Bk	April 7
23	B & Y	April 6	50	Y & Bk	April 7
24	B & Y	April 6	51	Y & Bk	April 7
25	B & Y	April 6	52	Y & Bk	April 7
26	B & Y	April 6	53	Y & Bk	April 7
27	B & Y	April 7	54	Y & Bk	April 7
28	B & Y	April 7			
29	B & Y	April 7			
30	B & Y	April 7			

1/ B & Y - Blue collar with yellow number, Y & Bk - Yellow collar with black number.

After capture, each cow was palpated to determine pregnancy, and blood samples were taken for hematological and chemical examination (Franzmann et al. 1976). A single incisor was removed for age determination. Standard body measurements were taken and the overall body condition was estimated and rated from 1 to 10, using criteria recommended by Franzmann et al. (1976). Data were recorded on 5" x 8" data cards and specimens were processed or preserved immediately upon completion of the daily field work.

Seven aerial surveys were flown between 28 May and 15 June 1977 to obtain data on calving success of collared cows (Table 6). These surveys were conducted at three-day intervals using a STOL Cessna 180 for the first survey and a Super Cub (PA-18) for the remaining surveys. Surveys were attempted in the early morning, but unfavorable weather often delayed the work until later in the day.

FINDINGS AND DISCUSSION

Pregnancy rate, age and body condition

A high incidence of pregnancy was determined by palpation with 48 cows, or 84 percent of the sample, pregnant. Age distibution is presented in Table 7; the relatively low occurrence of younger age classes for adult moose captured reflects the poor calf recruitment of recent years. Seventy-four percent were 6 years old or older with the majority of the sample (67 percent) being between 6 and 12 years of age. The mean age for pregnant cows was 8 years (7 years, 10 months), and for non-pregnant cows 11 years (10 years, 10 months). On the basis of this small sample, older cows appeared less productive than younger cows.

All of the 52 cows for which body condition was determined ranked in condition classes 5 through 8, with none being in either extremely good or poor body condition. Fifty-six percent were placed in the "average moose" category (Condition Class 7). Again, the small sample size precludes positive correlation, but the trend appeared to be for a higher incidence of pregnancy in cows in the higher body condition classes (Table 8). Older cows tended to have a poorer overall body condition than younger animals (Table 9). Body condition criteria alone did not indicate that the population was nutritionally stressed or otherwise affected by adverse winter weather conditions.

Physiologic and morphometric considerations

Table 10 lists blood chemistry and hematology values for these adult female moose. Some of the parameters (triglycerides, serum glutamic pyruvic transaminase [SGPT], iron [Fe], sodium [Na], potassium [K], chloride, carbon dioxide, and creatanine) are presented as initial baseline values for Alaskan moose. Other blood parameters listed in Table 10 (packed cell volume [PCV], hemoglobin [Hb], total protein [TP], albumin, globulin, alpha 1 globulin, alpha 2 globulin, beta globulin, gamma globulin, calcium [Ca], phosphorus [P], glucose, cholesterol,

Table 6. Moose parturition surveys, collared moose data, 1977.

Date	Cow/0	Cow/1	Cow/2	Calf per 100 Cows	Incidence of Twins	Percent Cows With Calves	Sample Size	Collared Moose Per Hour
May 28	13	0	4	47.1	100.0	23.5	17	4.7
May 31	10	0	2	33.3	100.0	16.7	12	4.0
June 3	12	1	7	75.0	87.5	40.0	20	4.3
June 6	13	1	3	41.1	75.0	23.5	17	4.8
June 9	11	1	1	23.1	50.0	15.4	13	3.9
June 12	8	2	1	36.4	33.3	27.3	11	3.5
June 15	8	1	0	11.1	0.0	11.1	9	3.2

Table 7. Age distribution of moose collared in the Mother Goose Lake area, April, 1977.

Sample Size - 57 Moose

Age* Year + Month	Number	Percent of Sample
2 + 10	3	5.3
3 + 10	5	8.8
4 + 10	3	5.3
5 + 10	3	5.3
6 + 10	8	14.0
7 + 10	6	10.5
8 + 10	3	5.3
9 + 10	8	14.0
10 + 10	3	5.8
11 + 10	6	10.5
12 + 10	2	3.5
13 + 10	2	3.5
14 + 10	1	1.8
15 + 10	1	1.8
Undetermined	3	5.3
Total	57	100.7

Mean age

Sample size 54 7.6 + 10 mo.

Mean age of pregnant moose

Sample size 45 7.0 + 10 mo.

Mean age of non-pregnant moose

Sample size 9 10.6 + 10 mo.

* Because specimen collection occurred in April, all moose were within two months of their next birthday.

Table 8. Body condition as related to pregnancy of moose collared in the Mother Goose Lake area, April, 1977.

Body Condition Class	Sample Size	Percent Pregnant	Percent Not Pregnant
5	3	33	67
6	10	60	40
7	29	93	7
8	10	100	0
Unid.	5	75	25
Total	57	84.2	15.8

Table 9. Age-body class condition relationships of collared moose in the Mother Goose Lake area, April 1977.

Age Class			Number of Moose			Sample Size
			Body Condition Class			
Year-Mo.	5	6	7	8	Unid.	
2 + 10	0	1	2	0	0	3
3 + 10	0	1	3	1	0	5
4 + 10	0	1	1	0	1	3
5 + 10	0	1	1	1	0	3
6 + 10	0	0	3	2	3	8
7 + 10	0	1	4	1	0	6
8 + 10	0	0	2	1	0	3
9 + 10	1	1	3	3	0	8
10 + 10	0	0	3	0	0	3
11 + 10	0	2	3	1	0	6
12 + 10	0	1	1	0	0	2
13 + 10	1	0	1	0	0	2
14 + 10	1	0	0	0	0	1
15 + 10	0	1	0	0	0	1
Unid.	0	0	2	0	1	3
Total	3	10	29	10	5	57

Table 10. Blood values from Mother Goose Lake, Alaska, moose population, April 1977.

Blood Values		Mean	SD	N
Packed cell volume (PCV)	%	39.0	5.4	56
Hemoglobin (Hb)	g/dl	16.4	1.3	54
Total Protein (TP)	g/dl	7.79	0.43	57
Albumin	g/dl	5.05	0.28	57
Globulin	g/dl	2.74	0.32	57
A/G ratio	ratio	1.84		
Alpha 1 Globulin	g/dl	0.23	0.0	57
Alpha 2 Globulin	g/dl	0.42	0.0	57
Beta Globulin	g/dl	0.74	0.11	57
Gamma Globulin	g/dl	1.34	0.32	57
Calcium (Ca)	mg/dl	10.80	0.43	57
Phosphorus (P)	mg/dl	4.35	0.86	57
Ca/P ratio	ratio	2.48		
Glucose	mg/dl	158.1	22.2	57
Cholesterol	mg/dl	68.2	9.1	57
Triglycerides	mg/dl	17.0	7.7	57
LDH	U/L	236.8	77.0	57
SGOT	U/L	53.3	13.3	56
SGPT	U/L	24.5	8.2	57
Alkaline Phosphotase	U/L	54.2	21.2	57
Iron (Fe)	ug/dl	170.2	43.0	57
Sodium (Na)	meg/L	137.1	2.1	57
Potassium (K)	meg/L	4.5	0.4	57

Chloride	meg/L	100.3	2.7	57
Carbon Dioxide	meg/L	14.2	4.4	57
BUN	mg/dl	4.8	2.0	57
Creatanine	mg/dl	3.6	0.4	57
Total Bilirubin	mg/dl	0.16	0.14	57
Uric Acid	mg/dl	0.4	0.22	57
Creatanine/BUN ratio	ratio	0.75		

lactic dehydrogenase [LDH], serum glutamic oxalacetic transaminase [SGOT], alkaline phosphatase, blood urea nitrogen [BUN], total bilirubin, and uric acid) have been regularly obtained from Alaskan moose populations (Franzmann et al. 1976).

Those parameters which reflect condition differences in moose (Ca, P, glucose, TP, albumin, beta globulin, Hb, and PCV) are listed in Table 11 for the study area population and other Alaskan moose populations (Copper River Delta, Kenai Moose Research Center [MRC], GMU 13, GMU 15C, and GMU 14C) sampled during late winter and spring (Franzmann, unpublished data). Franzmann et al. (1976) considered that the following levels or greater blood levels, represented adult moose in an average or better than average condition; PCV - 50 percent, Hb - 18.6 g/dl, Ca - 10.4 mg/dl, P -5.2 mg/dl, TP - 7.5 g/dl, albumin - 4.5 g/dl, beta globulin - 0.7 g/dl, and glucose 140 g/dl. The Alaska Peninsula population blood means were higher than these values for all but PCV and Hb.

Glucose, albumin, and beta globulin may be influenced by excitability (Franzmann et al. 1976) and will not be considered since helicopter darting was used and excitability and stress were factors of the collection. Calcium, P, and TP values in the study area moose population were at acceptable levels; however, PCV and Hb were at extremely low levels. Packed cell volume (PCV) appears to be the most useful single parameter to reflect condition status (Franzmann et al. 1976), and this population ranks lower than the lower baseline MRC population data (39 percent and 39.9 percent, respectively). Hemoglobin values in the sample (16.4 g/dl) were slightly higher than the MRC population (15.9 g/dl), but still must be considered low.

Blood urea nitrogen (BUN) levels were also low (4.8 mg/dl), Table 10, indicating a low nitrogen (protein) intake at time of collection. The mean BUN level from all adult Alaskan moose collected in late winter was 9.3 mg/dl (n=273) (Franzmann et al. 1976). Mean blood cholesterol level from the study area moose was 68.2 mg/dl which was lower than the late winter mean for all Alaskan moose (85.8 mg/dl). Low blood cholesterol reflects low saturated fatty acid diets (Coles 1967).

In summation, the three key blood parameters for the study area indicate that the population was nutritionally stressed at time of blood collection: Low condition was indicated by low PCV values; low protein intake by low BUN, and low fatty acid intake by low cholesterol. The acceptable levels of CA, P, glucose, TP, albumin, beta globulin, as well as other parameters not discussed, indicate the situation was not critical. It must be recognized ,however, that winter 1976-77 was very mild and these animals were not subjected to the stress of a "normal" winter prior to capture in spring 1977. Obviously the population warrants close monitoring of aspects which influence late winter nutritional status.

Measurements

Total length, chest girth, and hind foot measurements obtained from the study population (Table 11) were similar to those from the Copper River Delta population which produced the largest mean measurements of populations previously sampled.

Table 11. Condition related blood parameters and measurements from Alaskan moose population during late winter and spring (sample size in parenthesis).

Blood Values		Copper River Delta (Mar.1974) Mean	SD	Moose Research Center (Feb.,Mar.,Apr.) Mean	SD	GMU 13 (Apr.1973) Mean	SD	GMU 15C (Apr.1975) Mean	SD	GMU 14C (Feb.1976) Mean	SD	GMU 9 (Apr.1977) Mean	SD
Calcium	mg/dl	10.38	0.74(44)	9.81	0.64(39)	10.91	0.86(58)	9.61	0.98(29)	10.33	0.81(18)	10.80	0.43(57
Phosphorus	mg/dl	5.50	0.69(44)	3.90	1.09(39)	5.63	0.99(59)	4.72	1.08(29)	4.74	1.51(18)	4.35	0.86(57
Glucose	mg/dl	147.0	37.5(44)	116.2	26.1(39)	127.8	20.2(59)	91.3	16.2(29)	109.9	16.3(18)	158.1	22.2(57)
Total Protein	g/dl	7.07	0.57(45)	6.60	0.44(39)	7.43	0.40(61)	6.70	0.83(30)	7.20	0.54(18)	7.79	0.43(57
Albumin	g/dl	3.82	0.39(45)	3.76	0.46(39)	5.21	0.39(61)	4.21	0.51(30)	4.80	0.41(18)	5.05	0.28(57
Beta globulin	g/dl	0.72	0.09(45)	0.58	0.10(39)	0.60	0.11(61)	0.55	0.12(30)	0.60	0.07(18)	0.74	0.11(57
Hemoglobin	g/dl	19.8	0.5(46)	15.9	2.2(39)	19.7	0.7(60)	18.7	1.5(29)	15.4	1.2(17)	16.4	1.3(54)
PCV	%	53.2	4.2(46)	39.9	4.6(39)	49.2	3.7(60)	45.9	3.9(29)	43.4	2.8(19)	39.0	5.4(56)
Total Length	cm	301.5	8.1(23)	282.6	9.1(254)	295.6	10.9(115)	288.9	14.2(210)	-	-	302.1	6.8(54)
Chest Girth	cm	201.3	13.8(25)	179.5	11.1(252)	191.3	14.3(105)	182.2	16.3(194)	-	-	201.1	12.2(53)
Hind Foot	cm	81.5	1.8(16)	79.3	1.9(246)	80.0	2.9(79)	79.9	3.8(203)	-	-	80.8	1.8(12)
Shoulder Height	cm	-	-	175.9	8.1	185.5	11.1(7)	174.9	14.1(65)	-	-	-	-

With measurements essentially the same as the high baseline Copper River Delta population (Franzmann et al. 1976), and antler measurements from recent years some of the largest in the State (Gasaway 1975), the nutritional stress reflected by blood parameters has apparently not been of a long standing nature. In time, antlers and body size would likely decrease if nutritional stress was seasonally persistent (assuming the Alaska Peninsula population is genetically similar to that on the Copper River Delta).

Movements

The majority of the collared moose observed during calving surveys were found in the area between the King Salmon River and Pumice Creek (Fig. 4). No collared animals were located north of the King Salmon River in spite of fairly extensive reconnaissance flights. A few individuals were located as far south as Cinder River, but the majority appeared to have remained in the immediate vicinity of capture.

Parturition and calf survival

During calving surveys, 35 of the cows collared in April were observed at least once. None were observed on all surveys, but 57 percent (20 individuals) were seen on three or more surveys providing sequential information on these individuals. Of the 35 collared moose observed, 32 were pregnant when palpated in April. There was a high incidence of twinning observed among collared cows with newborn calves (12 sets of twins for the 15 cows observed with calves). Data for individual calving surveys from 1970 through 1977 are included in Table 1, and these data for collared moose are summarized in Table 6. Calving survey data for individual collared moose are presented in Table 12.

Because of the high spring pregnancy rate, and the high observed incidence of twins in the collared sample, it appears that the population retains the ability to produce a large number of calves (at least during a mild winter). Differences in data for the general area calving surveys (Table 1) and collared moose data (Table 6) are likely a result of the small sample size and increased visibility of collared moose. For this reason, and others given below, our data must merely be considered reflective of trends in calf mortalities. Nevertheless, both sets of data indicate that following parturition, calves are subject to a high rate of mortality. A peak abundance of 45.8 calves per 100 cows for the general survey area occurred on 6 June 1977 with a decline to 25.9 calves per 100 cows by 15 June (Table 1). Collared moose data showed a peak of 75 calves per 100 cows on 3 June, and a decline to 11.1 calves observed per 100 cows on the last survey (Table 6).

Mortality figures determined by our aerial surveys may not accurately reflect the actual calf mortality for several reasons. On no survey were more than 35 percent of the total collared sample (57) observed, so a significant number of marked individuals were missed on each survey. Factors that could bias the observed mortality rate include calves bedded down away from the cow and not observed, behavioral differences between cows with calves and unaccompanied cows, and the increasing vegetative cover associated with spring phenology making it difficult to observe moose (particularly wolves) in later surveys .

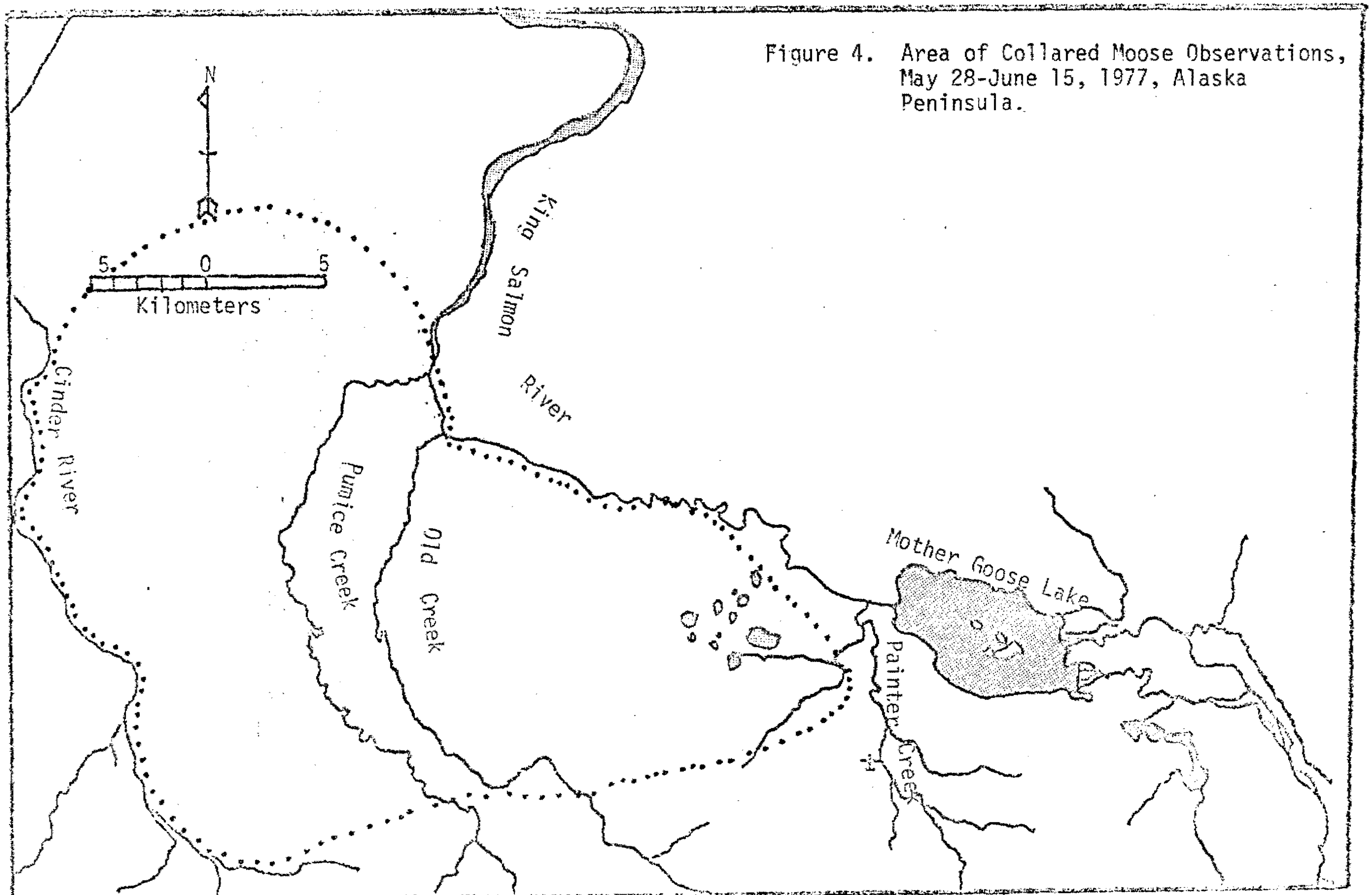

Figure 4. Area of Collared Moose Observations, May 28-June 15, 1977, Alaska Peninsula.

Table 12. Age, body condition, and status of collared moose observed during calving surveys, May 28–June 15, 1977, Mother Goose Lake Area.

No.	Pregnant	Age yrs-mo	Body Condition	5/28	5/31	New Born Calf Observations 6/3	6/6	6/9	6/12	6/15
3	Yes	4–10		2		2		0	0	
4	Yes	3–10	8		0	0			0	
6	Yes	12–10	7			0			0	0
8	Yes		7			2		0		0
10	Yes	3–10	6	0	0	0		0	0	
12	Yes	11–10	7	0	0	0				
13	Yes	6–10	7	0	0	0				
14	Yes	6–10	7			0	0		0	0
15	Yes	5–10	6	0	2	2				
16	Yes	6–10	7	0		1				
17	Yes		7		0				2	
18	Yes	7–10	7	0						
19	Yes	13–10	7	0		0	0			
20	Yes	6–10	8				0	0		
21	Yes	5–10	7	2		2	1			
22	Yes	11–10	6	0		0	0		0	
24	Yes	5–10	8	0	0		0			
27	No	13–10	5	0	0	0	0	0		
28	Yes	9–10	7				2			0
29	Yes	10–10	7		0	0				0
30	No	7–10	6	0	0					
31	Yes	6–10	8	2	2	0	0	0	0	
33	Yes	10–10	7						1	
35	Yes	11–10	7				0			0
36	Yes	4–10	7				2			

Table 12 (cont.) Age, body condition, and status of collared moose observed during calving surveys, May 28–June 15, 1977, Mother Goose Lake Area.

No.	Pregnant	Age yrs-mo	Body Condition	New Born Calf Observations						
				5/28	5/31	6/3	6/6	6/9	6/12	6/15
37	No	12–10	6	0			0	0		0
38	Yes	9–10	8			2	2	0	0	0
39	Yes	7–10	7			2		2		1
40	Yes	7–10	7				0	0		
42	Yes	8–10	8	0	0			0		
43	Yes	11–10	8			0	0			
45	Yes	6–10		2			0			
46	Yes	2–10	6			2				
47	Yes	8–10	7					1	1	
51Y	Yes	7–10	8				0	0		

The 15 collared cows observed with newborn calves produced a minimum total of 27 calves. Of these, 8 cows still had their initial complement of calves when last observed (Table 12). Fourteen calves, or 52 percent, of those observed with collared cows, were apparently lost prior to the last survey. Six cows with twins evidently lost both calves, and one cow apparently lost a single twin. None of the collared cows observed with a single calf were observed to have lost the calf by the time surveys were terminated.

The causes of calf mortality have not been identified, but two factors, physical condition of the cows and calves, and losses to predators, need additional evaluation. Analysis of blood samples indicates the population is nutritionally stressed, and the effects of that stress on reproduction and recruitment of calves into the population are unknown. The stress could be such that newborn calves are physically weakened and their chances of survival are significantly decreased. Also, the cow's ability to feed and care for its offspring may be impaired as a result of late winter nutritional problems. Nutritional problems may indirectly affect calf mortality through starvation, disease, accidents, exposure to weather, or vulnerability to predators.

Both wolves *(Canis lupus)* and brown bears *(Ursus arctos)* occur in the study area and are known to prey on moose calves. Wolves do not appear to be present in high densities and for this reason are probably not as important predators on newborn calves as brown bears. During calving surveys only three wolves were observed, each one a lone animal (Table 13). Brown bears are abundant, but not observed in consistent numbers by aerial surveys. On five separate occasions, bears were observed feeding on newborn calves, and one small bear was observed attempting to capture a calf. Dirt piles, typical of the carcass burial-feeding behavior of brown bears, were also observed during surveys. Initially, it appears brown bears are the major predator on newborn moose calves. However, because the condition of the calves fed upon by bears is unknown, it is unknown if predation by bears is substantially affecting the low calf-cow ratios obtained in the fall in recent years.

RECOMMENDATIONS

Studies need to be conducted to determine the physical conditions of cows and calves following parturition and how this affects survival of calves. The exact cause of calf mortality needs to be identified. A telemetry program with radios placed on both the cow and calf should provide this information. The condition of the family group could be assessed at the time of capture using the same basic techniques applied in this study. Periodic aerial surveys would monitor the fate of the family group and, whenever possible, the calf carcasses would be recovered immediately following death to determine the cause of mortality.

Table 13. Predators observed in study area during spring calving surveys, 1977.

Date	No. of Brown Bears	No. of Wolves
May 28	15	0
May 31	0	0
June 3	7	1
June 6	9	1
June 9	14	0
June 12	8	0
June 15	5	1

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