ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

PRODUCTIVITY AND PHYSIOLOGY OF YAKUTAT FORELANDS MOOSE

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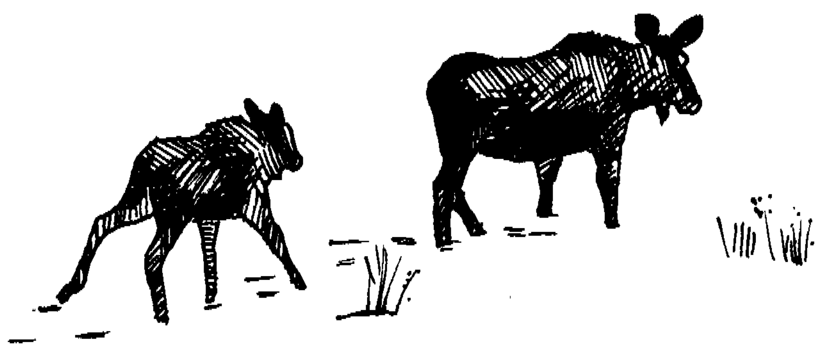

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Final Report
Federal Aid in Wildlife Restoration
Projects W-17-10 and W-17-11, Job 1.25R

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FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: Christian A. Smith and Albert W. Franzmann

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Job No: 1.22R Job Title: Yakutat Forelands Moose Productivity and Physiology Study

Period Covered: July 1, 1977 to June 30, 1979

SUMMARY

During March and April 1978, 41 adult female moose were immobilized, examined and marked with visual collars on a portion of the Yakutat forelands. Age distribution was highly skewed, indicating low recruitment in recent years. Pregnancy rate was within the normal range at 89.5 percent. Body condition did not reflect acute nutritional stress, but blood physiology data indicate that even after a mild winter the moose had below average blood parameter values. Aerial surveys indicated that substantial calf losses occur between late-pregnancy and 6 to 8 months of life, but no direct information was gathered on causes of this mortality. Nutritional factors may be contributing to low recruitment and/or predators may be taking many newborn calves. Additional research should be initiated to evaluate causes of calf mortality.

CONTENTS

BACKGROUND

The Yakutat moose (*Alces alces*) population originated in the 1930's through immigration down the Alsek River drainage from Canada (Klein 1963). Open seral communities and forested cover on the coastal plain provided ideal habitat and the population grew rapidly. By the early 1960's, this herd was estimated to contain over 2,000 animals (U.S. Forest Service and Alaska Department of Fish and Game unpubl. data) and was providing an annual harvest of 200 to 300 moose of both sexes (A.D.F. & G.) 1976).

By the late 1960's, however, the herd had begun declining in numbers (Fig. 1). Department of Fish and Game Biologist Loyal Johnson noted in a memo in 1968, that he felt the population had "peaked" prior to that time and was in a "declining stabilization" phase due to over-utilization of the range. Data from Forest Service browse utilization transects and exclosures supported the range abuse explanation (Perensovich 1970). No change in hunting regulations was made and the harvest remained at over 300 moose per year through 1973. By that time, the decline had reached "crash" proportions and the estimated population in fall 1974 was 400 to 600 moose. The hunting season was closed in this portion of Game Management Unit 5 in fall 1974 and remained closed through 1977.

Following cessation of hunting, it was expected that the herd would begin to rebuild toward former numbers. Results of annual fall surveys conducted by A.D.F. & G. indicated, however, that the herd was not increasing noticeably (Fig. 1).

Several suggestions were advanced to explain the population's failure to respond to protection from hunting. One such hypothesis was that nutritional stress was impacting calf production and survival. Nutritional stress, intensified by the deep, heavy snows typical of Yakutat winters, could limit a cow's ability to carry a calf to term or produce a viable offspring.

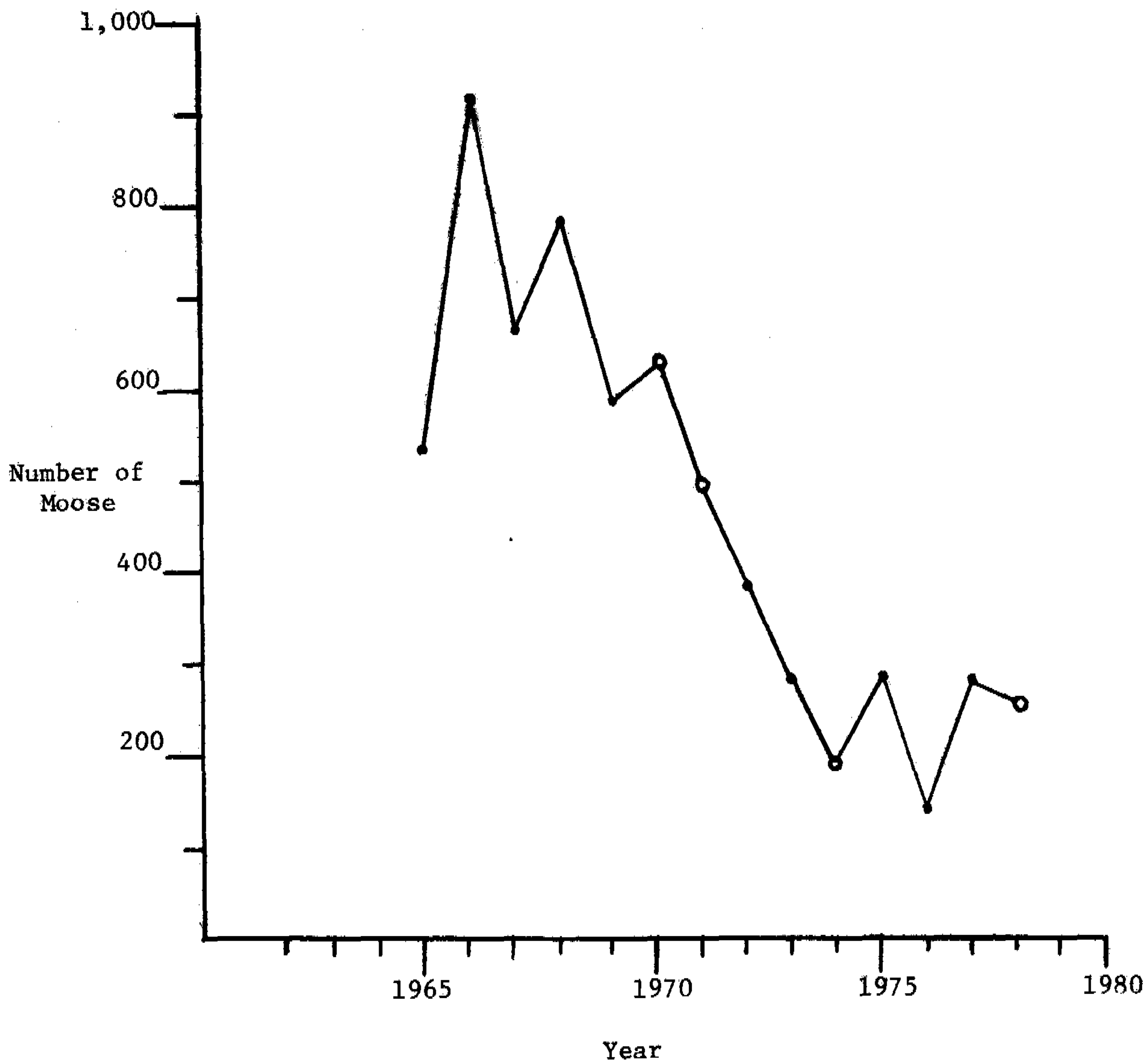

Figure 1. Trend in total numbers of moose counted on the Yakutat forelands during annual fall sex and age composition counts. (0= extrapolated totals for years with incomplete coverage of survey area)

Analysis of snow depth records and calf:cow ratios over the period 1959 to 1977 indicated an apparent correlation between the number of days with over 76 cm (50 in) of snow on the ground in a winter and the calf:cow ratio in the subsequent fall composition count. This relationship is best described by the equation: Calf:Cow Ratio = 1.0/[0.0229 + (0.004) x Snow Days], which is hyperbolic in form (Fig. 2) and has an index of determination of 0.77.

Procedures have been developed at the Kenai Moose Research Center (MRC) for assessing the physical condition and nutritional status of moose in late winter (Franzmann et al. 1976). These techniques have been applied in the field in several locations in Alaska (Franzmann et al. 1976, Faro and Franzmann 1978), and are believed to be satisfactory for evaluating the degree of nutritional stress experienced by a moose population during a given winter.

This study was designed to apply these physiological assessment techniques, coupled with aerial surveys during calving and in the fall, to test the hypothesis that the lack of population growth in Yakutat moose was a function of decreased calf production and survival resulting from nutritional factors.

OBJECTIVES

To determine the physical and physiological condition and pregnancy rates of adult cow moose on the Yakutat Forelands during late winter.

To assess calf production and survival at parturition and in the fall.

STUDY AREA

The Yakutat Forelands is a coastal plain area of approximately 1800 km^2 consisting of glacial and alluvial gravel deposits on the northeast shore of the Gulf of Alaska. Soil development is limited and recurrent uplifting due to seismic movement is evident. Vegetative cover of the plain is complete, except in river channels, but plant communities reflect the geologic youth of the plain.

Seral plant communities, dominated by willow (*Salix* sp.), alder (*Alnus sinuata*) and cottonwood (*Populus trichocarpa*) capable of producing large quantites of moose browse, occupy nearly half of the Forelands. The remainder is heavily forested by western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Piceas stichensis*). Farr (1968) described this forest and its timber producing capacity.

The study area was located on the lower portions of the Situk River, Seal Creek, Ahrnklin River, Dangerous River and Italio River drainages (Fig. 3). This section of the coastal plain is predominantly open willow/sedge meadows or alder/cottonwood stands with riparian spruce/hemlock forest.

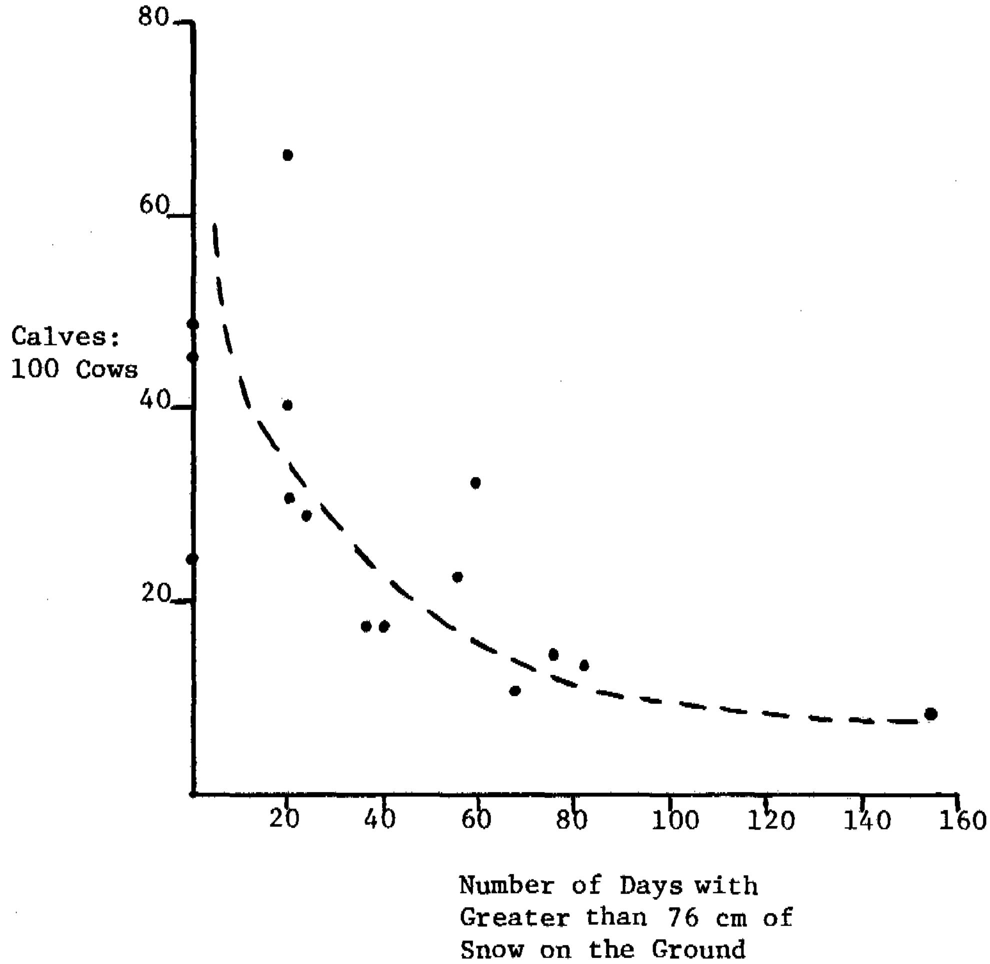

Figure 2. Relationship between snow depth/duration during a winter period and the calf:cow ratio found in the subsequent fall sex and age composition count.

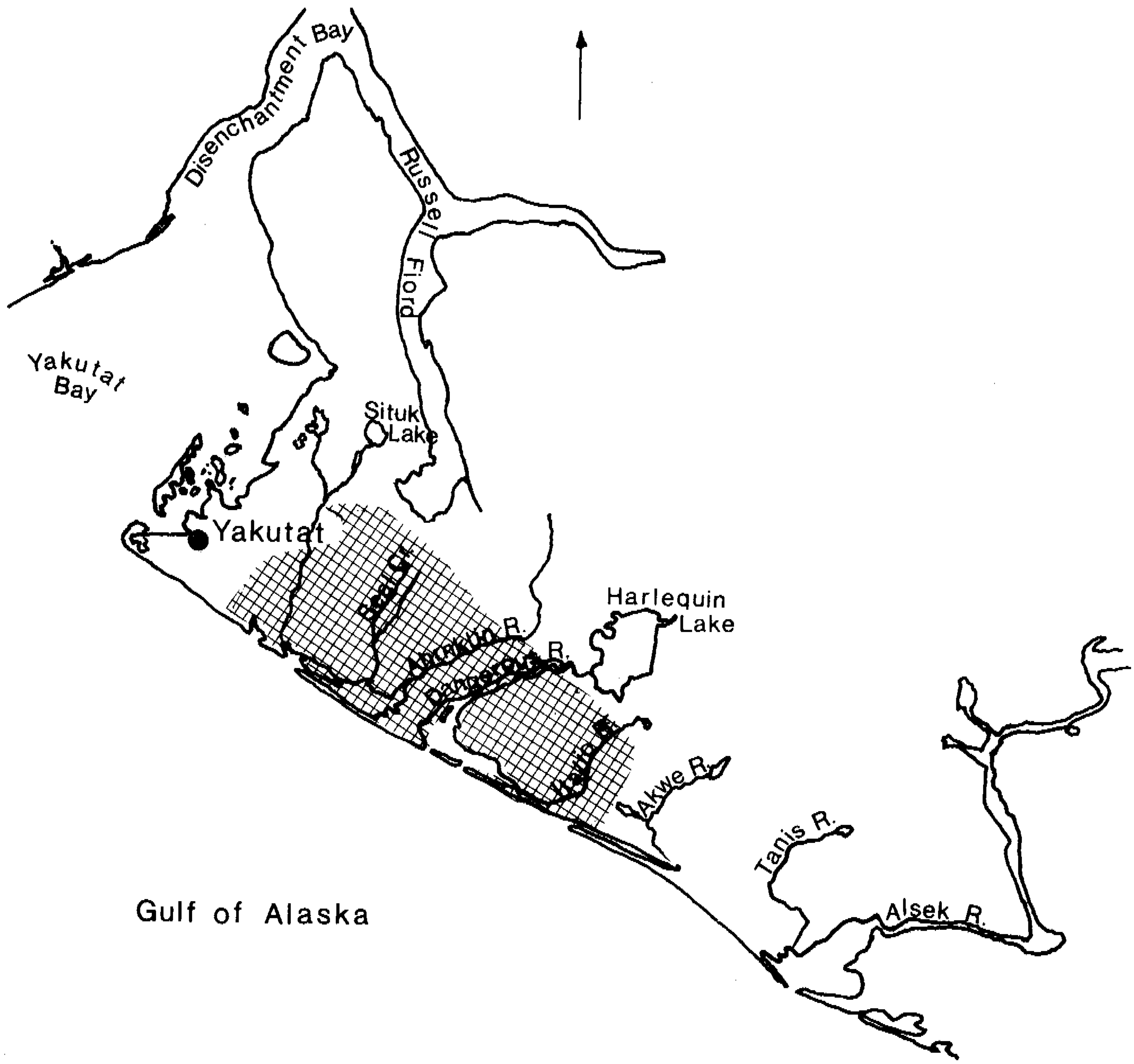

Figure 3. Yakutat forelands study area.

METHODS

Between 28 March and 1 April 1978, 42 female moose (one of which was a yearling) were located and captured within the study area by two crews using helicopter darting techniques similar to those described by Gasaway et al. (1978). Standard dosages were either 7 or 8 mg. of M-99 (etorphine hydrochloride) with 3 or 2 mg. Rompun (xylazine hydrochloride), respectively. If, after 8 to 12 minutes, no effect was noted, an additional 3 mg. of M-99 or 7 mg. M-99 with 3 mg. Rompun was administered.

Once the animals were immobilized, the crews were dropped off by helicopter to process the moose. Processing involved collecting blood, hair and tooth specimens; measuring total length, hind foot length and girth; affixing ear tags and a visual collar; subjectively evaluating "condition" as described by Franzmann et al. (1976); and rectal palpation to determine pregnancy. Presence of calves (i.e., short-yearlings) with cows when first observed was also recorded.

Following processing, the animals were given 14-20 mg. M-50/50 (diprenorphine) intravenously to counteract the M-99. Dosage varied according to the extent of immobilization. In most cases, animals were observed until they were back on their feet.

After returning from the field each night, crew members set hair samples out to air dry, labeled and froze teeth for future grinding and aging and began blood analysis. Uncoagulated samples were tested for packed cell volume (PCV) and hemaglobin (Hb). The remaining vials were centrifuged and the sera were collected and frozen for subsequent laboratory analysis (Franzmann et al. 1976).

Three aerial surveys were flown during and after parturition to determine movements and calving success within the study area. The density of vegetation, widely dispersed nature of the population and early green-up limited the results of these surveys.

FINDINGS AND DISCUSSION

The initial, subjective impression of the field crew was that two subpopulations existed within the study area. Those cows found east of the Dangerous River appeared older and in poorer physical condition than those west of the river, and were accompanied by fewer calves. As a result, all data collected from the moose were tested to determine statistical significance of the subpopulation differences. The only significant difference between populations was the disparity between calf:cow ratios. Thus all other data have been pooled to maximize sample size.

Age, Pregnancy rates and Body Condition

Table 1 lists the age, pregnancy and condition index of the collared moose; Figure 4 illustrates their age distribution. Although animals recognizable as yearlings were avoided (this age class is not adequately represented in the sample), other ages were assumed to be present in proportion to their frequency in the population. Thus, it appears that the age distribution of Yakutat moose is severely skewed toward the

Table 1. Age, pregnancy and condition index of Yakutat moose, March-April, 1978.

Collar #	Age	Pregnant	C.I.*	Collar #	Age	Pregnant	C.I.
B-1	12	+	7	0-5	10	No Data	8
B-2	12	+	6	0-6	14	+	7
B-3	3	+	7	0-7	12	0	7
B-4	9	+	8	0-8	14	+	6
B-5	7	+	8	0-9	11	+	8
B-6	7	+	7	0-10	17	0	5
B-7	8	+	8	0-11	14	+	7
B-9	11	+	7	0-12	12	+	8
B-10	15	+	6	0-13	10	+	8
B-11	11	+	6	0-14	2	+	7
B-12	11	No Data	No Data	0-15	13	+	7
B-13	3	+	7	0-16	8	+	7
B-14	14	+	6	0-17	3	+	7
B-15	1	No Data	6	0-18	7	+	8
B-16	7	0	7	0-19	2	+	8
B-21	12	+	7	0-20	12	+	5
B-23	13	+	6	0-21	14	+	7
0-1	15	No Data	7	0-22	10	+	8
0-2	8	+	8	0-23	15	0	5
0-3	14	+	7	0-24	14	+	6
0-4	12	+	No Data	0-25	6	+	8
				Mean	10.1	89.5%	7.0

* C.I.: Condition Index, Scale from 1 (poorest) to 10 (best).

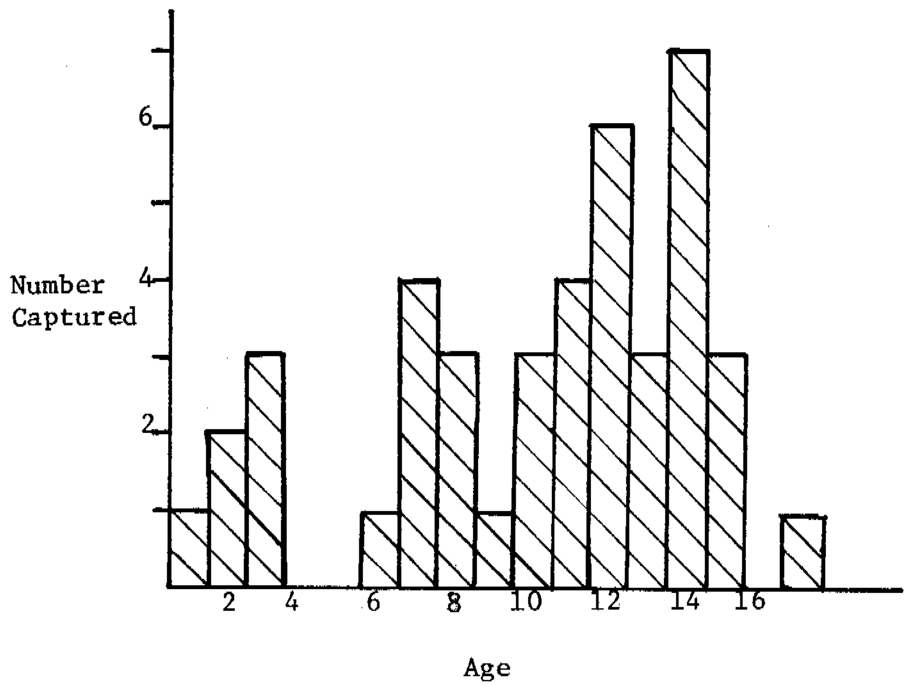

Figure 4. Age distribution of female moose captured on the Yakutat forelands, March-April, 1978.

older age classes. The average age of the sample is 10.1 years and 64 percent of the cows were more than 10 years old. This age distribution reflects the poor recruitment during the past decade. The virtual absence of cows aged 4, 5 and 6 years represents nearly complete loss of the cohorts that would have been produced in 1971-1973.

Snow depth data obtained over the last 25 years (Fig. 5) show that the period of 1964 through 1973 was one of increasingly severe weather. The last three winters in this period correspond to the years for which cohorts were "missing" in the sampled moose. Coady (1974) and many others have discussed the influence of snow on moose populations. It has generally been found that snow depths in excess of 76 cm seriously restrict moose movements and result in excess energy expenditures. The relationship between snow depth and calf:cow ratios (Fig. 2) and the age data coupled with snow depths over the past 15 years, indicate that the severity of winter weather, reflected in snow depth and duration, is a major factor influencing the population dynamics of moose on the Yakutat Forelands.

Rectal palpation revealed that 89.5 percent of the sampled cows were pregnant (Table 1). This is well within the normal range of pregnancy rates for healthy moose populations (Franzmann et al. 1976). It appears that, despite the old age distribution in the population, the lack of population growth is not related to problems of fertility or conception.

Condition Index values for the sampled moose ranged from 5 to 8 and averaged 7.0. These values are nearly identical to those reported by Faro and Franzmann (1978) for the Alaska Peninsula and indicate that, at current densities and under the mild weather conditions prevalent in 1977-78, Yakutat moose were not suffering from acute nutritional stress as reflected by physical condition.

Physiology

Table 2 lists blood chemistry and hematology values for the adult female moose studied. Blood parameters for triglycerides, serum glutamic pyruvic transaminase (SGPT), thyroxine (T4), sodium (Na), potassium (K), chloride, carbon dioxide, and creatanine are presented as base-line values for Alaskan moose. Other blood parameters listed in Table 2 (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, lactic dehydrogenase [LDH], serum glutamic oxalacetic transaminase [SGOT], alkaline phosphotase, blood urea nitrogen [BUN], total bilirubin, and uric acid) have been regularly obtained from Alaskan moose populations (Franzmann and LeResche 1978).

Those parameters which reflect condition differences in moose (Ca, P, glucose, TP, albumin, beta globulin, Hb and PCV) are listed in Table 3 for the study area population (Yakutat) and other Alaskan moose populations (Copper River Delta, MRC), GMU 13, GMU 15C, GMU 14C and GMU 9) sampled during late winter and spring. Franzmann et al. (1976) considered that the following, or higher, blood parameter values 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

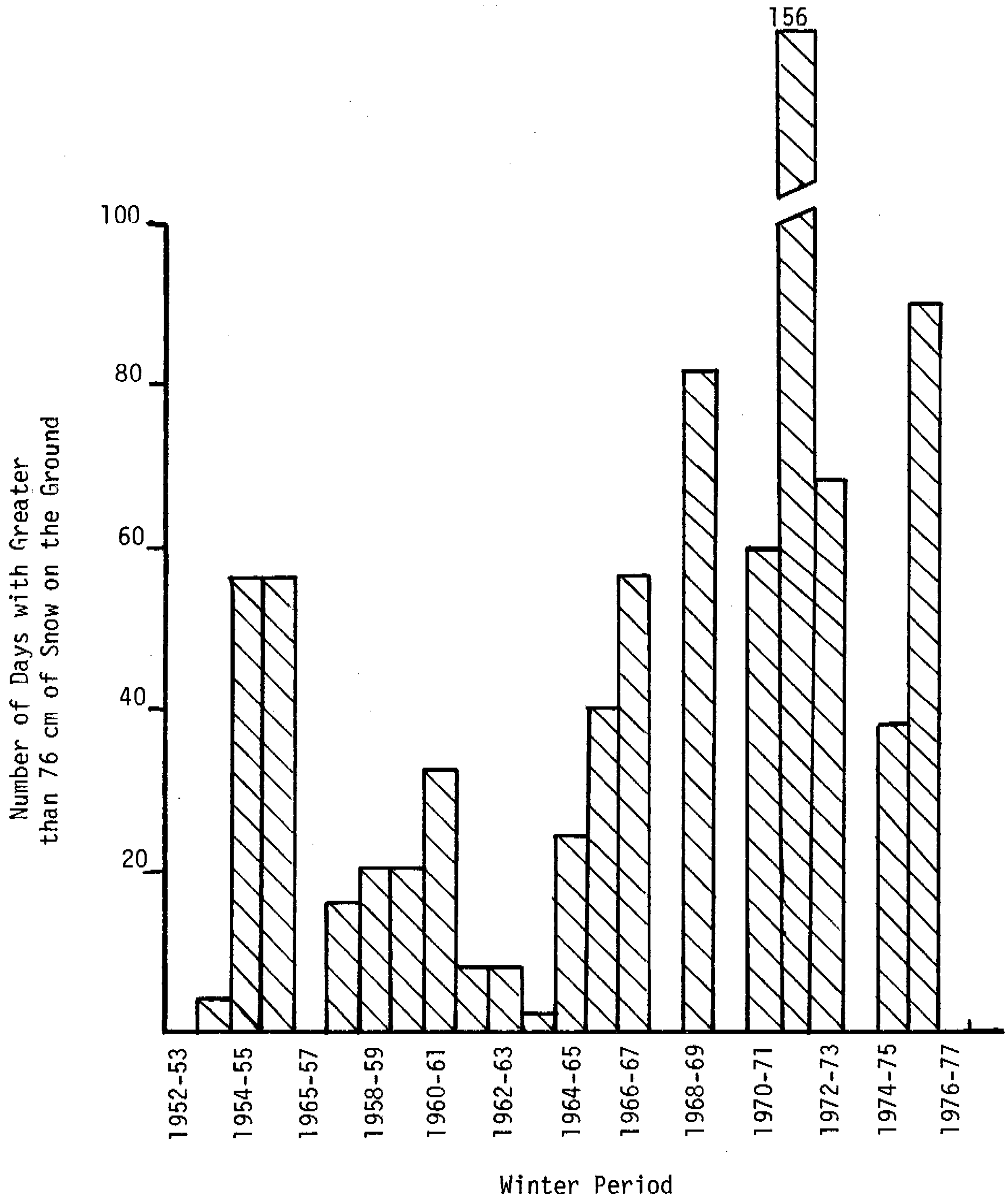

Figure 5. Duration of snow in excess of 76 cm (50 inches) at Yakutat, Alaska, during the 1952-53 through 1977-78 winter periods.

Table 2. Blood values from Yakutat, Alaska, moose population, April 1978.

Blood Values		Mean	S.D.	N
Packed Cell Volume (PCV)	%	40.6	3.6	42
Hemoglobin (Hb)	g/dl	16.7	1.3	42
Total Protein (TP)	g/dl	7.45	0.43	41
Albumin	g/dl	5.38	0.30	41
Globulin	g/dl	2.07	0.37	41
A/G ratio	ratio	2.69		41
Alpha 1 globulin	g/dl	0.20	0.02	41
Alpha 2 globulin	g/dl	0.46	0.12	41
Beta globulin	g/dl	0.62	0.09	41
Gamma globulin	g/dl	0.81	0.35	41
Calcium (Ca)	mg/dl	10.98	0.57	41
Phosphorus (P)	mg/dl	3.71	1.06	41
Ca/P ratio	ratio	2.96		41
Glucose	mg/dl	143.8	23.1	41
Cholesterol	mg/dl	66.0	15.8	41
Triglycerides	mg/dl	26.9	9.9	41
LDH	U/L	176.3	31.3	41
SGOT	U/L	83.7	21.4	41
Alkaline Phosphotase	U/L	54.2	21.2	41
Sodium (Na)	meg/L	137.0	3.4	38
Potassium (K)	meg/L	5.1	0.7	38
Chloride	meg/L	97.0	3.0	38
Carbon Dioxide	meg/L	22.4	3.8	37
Blood Urea Nitrogen (BUN)	mg/dl	6.8	2.2	39
Creatanine	mg/dl	2.25	0.25	37
Total Bilirubin	mg/dl	0.19	0.06	41
Uric Acid	mg/dl	0.26	0.11	41
Creatanine/BUN ratio	ratio	0.33		37
Thyroxine T4	mg/dl	6.60	1.33	41

Yakutat population mean blood values were lower for all of these values except albumin.

Albumin, glucose and beta globulin levels may be influenced by excitability (Franzmann and LeResche 1978) and were not considered since helicopter darting was used. All remaining values considered for condition evaluation (PCV, Hb, Ca, P and TP) were lower than values considered to be average or better. However, they were higher than values for the MRC population, the base-line low or poorest condition population in the state based upon blood parameters. Blood values from the Yakutat population were very similar to those from the Alaska Peninsula population (Table 3).

Blood urea nitrogen (BUN) levels were also low (6.8 mg/dl, Table 2), indicating a lower than average 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 Yakutat moose was 66.0 mg/dl, which was lower than the late winter mean from 273 Alaskan moose collected prior to 1976 (Franzmann et al. 1976). Low blood cholesterol reflects low saturated fatty acid diets (Coles 1967).

The Yakutat population assessment revealed that moose condition was below the average based upon condition-related blood parameters. This population ranks with the Alaska Peninsula population sampled in 1977 (Faro and Franzmann 1978). Three key blood parameters 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. These blood levels do not indicate that the population situation was critical. However, winter 1977-78 was very mild and these animals were not subjected to the stress of a severe or even a "normal" winter prior to capture in spring 1978. Concern for the physiologic status of this population when it is exposed to a severe or even "normal" winter is warranted.

Morphometry

Mean total length for the Yakutat population (289.2 cm), was similar to the Game Management Unit 15 population mean (288.9 cm, Table 3). The Yakutat population hind foot measurement mean (79.4 cm) was similar to the MRC population mean (79.3 cm). The Yakutat chest girth measurement mean (202.6 cm) was, however, the largest mean chest girth measurement we have recorded from an Alaskan population (Table 3). The value is not, however, significantly higher than the Copper River Delta chest girth mean (201.3 cm) due to the variability in chest girth measurements (SD for Yakutat = 12.2 cm.).

Parturition and Calf Survival

Three aerial surveys were flown in spring 1978 to monitor movements and parturition in the study area. Because of the extensive development of vegetation, however, little information was gathered. A survey on 25 April, resulting in 25 moose observations, showed that many of the moose had moved inland from the coastal meadows and brushy deltas

Table 3. 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	Yakutat (Mar.1978) 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(19)	10.80	0.43(57)	10.98	0.57(41)
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)	3.71	1.06(41)
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)	143.8	23.1 (41)
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)	7.45	0.43(41)
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)	5.38	0.30(41)
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)	0.62	0.09(41)
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)	16.7	1.3 (42)
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)	40.6	3.6 (42)
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)	289.2	13.0 (39)
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)	202.6	12.2 (39)
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)	79.4	13.7 (37)
Shoulder Height	cm	-	-	175.9	8.1	185.5	11.1 (7)	174.9	14.1 (65)	-	-	-	-	-	-

occupied during winter. Five of the marked cows were observed; four of these were positively identified. No short yearlings or newborn calves were seen. The marked cows observed on 25 April were ones that were not followed by calves in March (and no cows that were with calves in March were observed in April) indicating perhaps, that cows with calves are less "visible" due to differences in behavior and habitat selection than are lone cows.

A second survey, on 25 May, produced sightings of 14 adult moose, all females, two of which were marked. One of the marked cows was accompanied by two newly born calves. The observer on the survey noted that many of the cows appeared to have swollen abdomens and appeared pregnant.

The final survey, attempted at the suspected peak of parturition on 6 June 1978, was discontinued when only two bull moose had been seen in 20 minutes. The advanced state of leaf development made it virtually impossible to observe moose from the air.

Fall aerial sex and age composition counts were conducted in the study area on 4 and 5 December 1978 to assess calf survival into early winter (Tables 4 and 5). A total of 135 moose were classified, of which 15 were marked cows. The overall sex ratio of 42.9 males:100 females reflects the lack of heavy harvest pressure on males in recent years, and the high ratio of small males:100 large males and 10.4 percent value for small males in the herd indicate that survival of the 1977 calf crop was good and that the male segment of the herd is composed largely of young bulls.

The ratios of calves:100 cows determined by the surveys are less informative. The overall observed ratio was 13.1 calves:100 cows, but the ratio for the collared sample was 40 calves:100 cows. Even when the former value is corrected by excluding a number of females (equal to the number of small bulls) assumed to be yearlings, the overall ratio increases to only 15.7. Thus it appears that the collared cows were disproportionately productive and/or that standard aerial survey techniques underestimate calf production.

A similar disparity appears in previous data for the study area. The fall 1977 aerial survey indicated a calf:adult cow ratio of 28.5:100 based on a sample of 123 cows, but the 41 adult cows collared in spring. 1978 had 43.9 calves:100 cows. This means that once again the overall ratio varied from the marked sample ratio by nearly 40 percent. This phenomenon has been reported previously by Didrickson and Taylor (1978) and appears to be common in Southcentral Alaska (Taylor, Ballard and Eide pers comm.). Although a thorough discussion of the implications of this disparity to management is beyond the scope of this paper, the fact that fall calf:cow ratios in the Yakutat area, as measured by aerial survey, appear consistently low is worthy of documentation here.

Based on the sample of collared cows, 70 percent of the females that were pregnant in late March did not have a calf at heel the following December. The lack of data on parturition and neo-natal survival prevents determination of causes and timing of calf losses. It is possible that the nutritional factors previously discussed have in fact resulted in

Table 4. Sex and age composition of moose classified by aerial survey on 4 and 5 December 1978 in the Yakutat study area.

Large MM	Small MM	FF w/o	FF w/1	FF w/2	Total FF	Total Calves	Unknown Sex/Age	Total Moose
22	14	77	3	4	84	11	4	135
Collared Cows		11	2	2	15	6		21

Table 5. Sex and age ratios of moose classified by aerial survey on 4 and 5 December 1978 in the Yakutat study area.

Total MM per 100FF	Small MM per 100FF	Small MM per 100 Large MM	Small MM % in herd	Small MM per 100 Ca.	Calves per 100 FF	Twins per 100 FF w/Ca	Calf % in herd
42.9	16.7	63.6	10.4	127	13.1	57	8.1
Collared Cows					40.0	50	

reduced calf production and/or survival. Wolf (*Canis lupus*) and brown bear (*Ursus arctos*) densities are moderate on the study area, so it is also possible that predators are at least the proximate cause of major calf mortality as has been found in the Nelchina Basin (Ballard and Taylor 1978) and implied on the Alaska Peninsula (Faro and Franzmann 1978).

CONCLUSIONS

The data presented in this report demonstrate that snow depth and duration have apparently influenced moose population dynamics on the Yakutat Forelands over the past 15 to 20 years. Throughout that period, calf:cow ratios in the fall have appeared to decline following severe winters. During the period 1965 to 1975, increasingly snowy winters contributed to reduced calf survival which has resulted in an age structure heavily skewed toward older ages.

Physical, physiological and reproductive examinations of 42 captured cows indicated that although physical condition and pregnancy rates were normal, physiologically the moose reflected nutritional stress. This nutritional condition, though not severe, existed despite the relatively low density of moose on the range and the exceptionally mild winter weather in 1977-78.

Although data are extremely limited, it appears that production and/or survival of calves is low in this population. As many as 70 percent of the cows which are pregnant in March are not accompanied by calves in the following December. Data gathered for this study indicate that physiological stress may be one factor causing reduced calf numbers. However, the total lack of information on timing and causes of calf losses makes it impossible to ascertain the actual role of nutrition, predation or other factors on calf survival.

RECOMMENDATIONS

1. Similar studies should be continued in this area or repeated following a severe winter to gather additional data on physiological parameters and age structure.

2. Causes and timing of calf losses should be determined by using radio telemetry systems to overcome the problems of working in dense vegetation.

3. A thorough review of existing data on this population should be undertaken to further examine apparent relationships between weather, range, production and numbers over the past half century.

ACKNOWLEDGEMENTS

This project represents the culmination of many individuals' efforts. Roland Quimby identified the relationship between snow depth and calf:cow ratios, wrote the project proposal and organized preliminary data. Galen Hansen

accomplished the statistical analysis of the snow depth:calf ratio data. Chuck Schwartz was a valuable assistant in the field and offered several suggestions on analysis of data. Ron Ball aged the teeth collected from the moose, flew two of the parturition surveys and flew the fall composition counts.

LITERATURE CITED

A.D.F.&G. 1976. Annual report of survey-inventory activities. Part II Moose. pp. 14-19

Ballard, W. and K.P. Taylor. 1978. Moose calf mortality study, Game Management Unit 13. Prog. Rept. Fed. Aid. Wildl. Rest. Proj. W-17-9 & 10, Job 1.23R. A.D.F.&G. Juneau. 43 pp.

Coady, J. 1974. Influence of snow on behavior of moose. Nat. Can. 101:417-436.

Coles, E.H. 1967. Veterinary clinical pathology. W.B. Saunders Co., Philadelphia and London. 455 pp.

Didrickson, J. and K.P. Taylor. 1978. Lower Susitna moose population studies. Final Rept. Fed. Aid Wildl. Rest. Proj. W-17-8 & 9, Job 1.16R. A.D.F.&G. Juneau. 20 pp.

Faro, J. and A.W. Franzmann. 1978. Productivity and physiology of moose on the Alaska Peninsula. Final Rept. Fed. Aid Wildl. Rest. Proj. W-17-9 and 10. Job 1,22R. A.D.F.&G. Juneau. 29 pp.

Farr, W. 1968. Report on the forest productivity of the Yakutat work area. U.S.F.S. mimeo. (filed in Yakutat).

Franzmann, A.W., R.E. LeResche, P.D. Arneson, and J.L. Davis. 1976. Moose productivity and physiology. Final Rept. Fed. Aid Wildl. Rest. Proj. W-17-2, 3, 4, 5, 6, and 7. Job 1.1R. A.D.F.&G. Juneau. 87 pp.

______ and R.E. LeResche. 1978. Alaskan moose blood studies with emphasis on condition evaluation. Jour. Wildl. Manage. 42(2):344-351.

Gasaway, W., A.W. Franzmann and J.B. Faro. 1978. Immobilizing moose with a mixture of etorphine and xylazine hydrochloride. Jour. Wildl. Manage. 42(3):686-690.

Klein, D.R. 1963. Postglacial distribution patterns of mammals in the south coastal regions of Alaska. Presented at the 14th Alaska Sci. Conf. Aug. 29, 1963. 22 pp.

Perensovich, M. 1970. Report on the Yakutat moose browse utilization transects exclosures. U.S.F.S. mimeo (filed in Yakutat).

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