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Nelchina Yearling Moose Mortality Study

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

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Job No.: 1.27R Job Title: Nelchina Yearling Moose Mortality Study

Period Covered: July 1, 1978 to June 30, 1980

SUMMARY

Between 26 March and 27 April 1979, 64 short yearling (10 to 11 months old) moose were radio-collared in Game Management Subunit 13A in Southcentral Alaska in an attempt to determine causes and extent of yearling moose mortality. Drug dosages of .4 cc etorphine (M-99) and 1.7 cc xylazine hydrochloride (Rompun) were utilized to immobilize these moose.

Blood parameters of captured short yearlings were compared with those obtained from the Kenai Peninsula, Alaska. It was concluded that GMU 13 yearling moose were nutritionally stressed because of winter severity. Winter 1978-79 was the second most severe winter, in terms of snow depth, since 1952 when records were first kept in the Nelchina Basin. Several key blood parameters incidated male yearlings were in poorer physical condition than female yearlings. Thirty-six of 41 yearlings had erupted, or partially erupted, incisors by late March. No differences in blood values were observed between moose with erupted incisors and those which had not yet erupted.

During the reporting period 16 of 43 yearling moose died; 14 from natural mortality, 1 from tagging mortality, and 1 was taken by a hunter. Winter-related mortality accounted for 71.4 percent of the deaths while predation by brown bears and unidentified predators accounted for the remaining mortalities. Descriptions of both the circumstances surrounding each mortality and individual movements of yearlings are presented.

CONTENTS

BACKGROUND

Intensive studies of wolf *(Canis lupus)* food habits from 1976 through 1978 indicated that newborn moose *(Alces alces)* calves comprised a relatively small portion of the summer diet of wolves in the Nelchina Basin (Ballard and Spraker 1979). During summer, wolves appeared to be selecting yearling or adult moose. Therefore, this study was initiated in an effort to determine the importance of wolf predation to yearling moose survival. History and background of Nelchina Basin predator-prey studies have been presented elsewhere (Ballard and Taylor 1978a,b; Ballard and Taylor 1980; Ballard and Spraker 1979; Ballard et al. 1980a,b,c; Ballard In Press).

OBJECTIVES

To determine the extent and causes of yearling moose mortality in the Nelchina Basin of Southcentral Alaska.

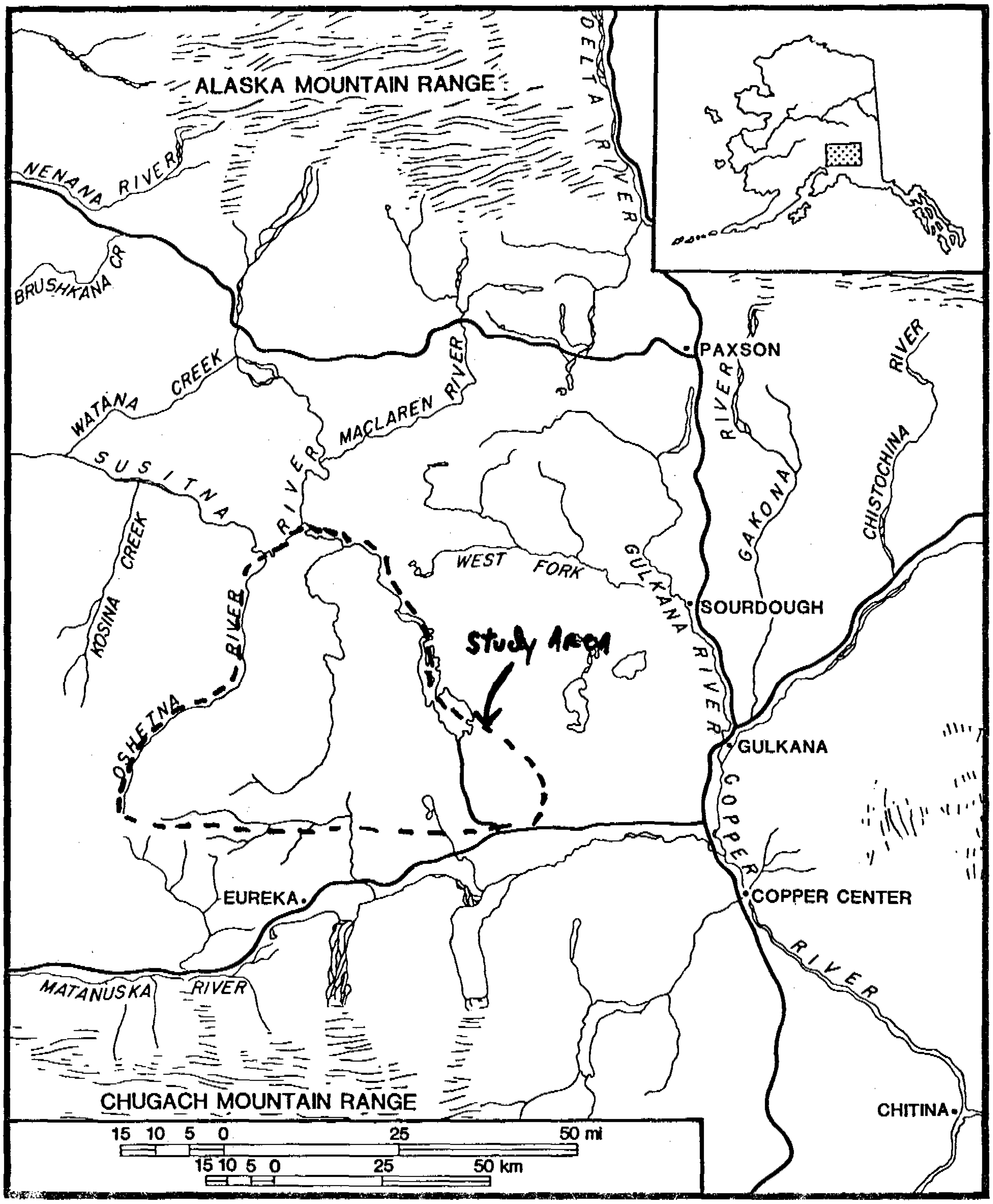
PROCEDURES

Yearling moose mortality was studied in the western half of Game Management Unit 13A (Fig. 1). This area basically consists of the Oshetna, Tyone, and Little Nelchina River Basins. Topography, weather, range conditions, and vegetation have been described elsewhere (Skoog 1968, Ballard and Taylor 1980, Ballard In Press).

Calf moose (10 to 11 months old) were radio-collared and tracked through their second year of life. To avoid confusion with the succeeding cohort these moose will be referred to as "short yearlings" or simply yearlings.

Cow-short yearling pairs were located by visual search from fixed-wing aircraft (Piper Super Cub PA-18) during late March and April 1979. Yearlings, and in some cases their dams, were captured by darting with a Cap-Chur gun (Palmer

Fig. 1. Location of study area in southcentral Alaska where causes of short yearling moose mortality were studied from March through December, 1979.



Chemical Co.) from a Jet Ranger 206B helicopter. Initially, a combination of 7 cc etorphine (1 mg/cc M-99, D-M Pharmaceuticals, Inc., Rockville, MD) and 3 cc xylazine hydrochloride (100 mg/cc, Rompun, Haver-Lockhart, Shawnee, ICS) as prescribed by Gasaway et al. (1978) was used to immobilize adults. However, this dosage was insufficient so a drug dose of 9 cc etorphine and 1 cc xylazine was utilized. For short yearlings a dosage of 4 cc etorphine and 1.7 cc xylazine hydrochloride was used. Initially 10-cc and 7-cc darts were used for cows and yearlings, respectively, but these did not completely inject the drug in 0 to -20°F temperatures. This problem was alleviated by using two darts per moose; 5 cc for adults and 3 cc for calves. After each moose was processed the antagonist diprenorphine (M 50-50, D-M Pharmaceuticals, Inc., Rockville, MD) was injected into either the jugular or radial vein.

Yearlings were fitted with radio transmitters (Telonics Co., Mesa, AZ) which emitted a signal at approximately 60 pulses per minute on frequencies ranging from 150.00 to 150.460 MHz. Each transmitter was equipped with a mortality sensor which doubled the pulse rate when the transmitter remained motionless for 4 hours (Ballard et al. 1980a). Power was provided by a lithium battery and the entire unit had a theoretical life span of 4 years.

Collars were constructed of two layers (urethane over butyl rubber) and had an inner circumference ranging from 92 to 97 cm. The radio was riveted to the collar through metal flaps attached to each side of the radio. The antenna (43 cm long) was partially enclosed between the urethane and butyl rubber layers with 16.5 cm protruding from the dorsal side of the collar. Each collar was taped to protect the animal from abrasion. An entire collar with transmitter weighed 879 g.

Following the March tagging period, 15 of 47 collars slipped off within a 3-week period because of their size and inflexibility. Before the April collaring operation, collars were modified by fastening foam rubber inside the bottom half of the collar with electrical tape so the collar was snug around the neck, but flexible enough to not restrict growth. Weight of a collar increased to 992 g.

Numbered metal tags were placed in each moose's ear. Adult moose were not radio-collared but were fitted with visual collars. Visual collars had black numerals on either red, white, or orange backgrounds. Blood and hair samples were taken from each animal (Franzmann et al. 1976) for assessment of its nutritional condition (Franzmann et al. 1975, Franzmann and LeResche 1978).

Radio-collared yearlings were monitored from fixed-wing aircraft (Piper Super Cub PA-18), generally once a day through the months of April and May, every 3 days in June, and once a week throughout the remainder of the summer until September. Total flight time for each monitoring period was between 3 and 4 hours. When moose were found dead, an intensive aerial search was made of the area in an attempt to determine the cause of death. When time was available, or if the cause of death could not be determined from the air, we returned to do a ground examination.

A two-element, hand held antenna (Telonics Co., Mesa, AZ) attached to a receiver was used to locate dead moose from the ground. Cause of mortality was determined using methods described by Ballard et al. (1980b).

RESULTS AND DISCUSSION

Between 26 March and 27 April 1979, 64 short yearlings were radio-collared and 18 adult cow moose were visual-collared. Initial tagging efforts in March 1979 (26 through 30 March) resulted in 45 short yearlings and 18 adult cows being captured. By 26 April, 15 of these short yearlings had lost their collars as a result of the collar design. The urethane collar was too rigid and did not conform to the shape of a moose's neck, consequently the collars slipped over the moose's head presumably during feeding. Collar design was subsequently modified and 19 additional short yearlings were captured and radio-collared on 27 and 28 April 1979.

Summaries of tagging locations, physical measurements, and other statistics associated with tagging are presented in Tables 1 and 2.

A drug dose of 4 cc of etorphine and 1.7 cc xylazine hydrochloride was adequate for all but five (10.4%) short yearlings which required additional drugs. Induction time was variable, ranging from 2 to 24 minutes. Males took longer than females to immobilize (Mann-Whitney Test, $P<0.05$), probably due to their larger body size.

Condition Assessment

Physical condition of short yearlings and their cows was subjectively estimated according to criteria described by Franzmann et al. 1976. Short yearling condition classes ranged from 5 to 8 ($\bar{x} = 6.3$), while adult condition ranged from 6 to 8 ($\bar{x} = 7.0$). Blood parameters for condition classes 5, 6, and 7 were compared for short yearling moose. No significant correlation ($P>0.05$) existed between the subjective condition index and the three condition related parameters Franzmann and LeResche (1978) believed were most useful for assessing the condition of moose. Either the assigned subjective condition evaluations were erroneous or these blood parameters did not accurately reflect the condition of these moose. Since only two of six members of the

Table 1. Location, ages, physical measurements, incisor status, and statistics associated with capturing and collaring of 64 short yearling moose in Game Management Unit 13A from 26 March through 28 April 1979.

Accession #	Date	Collaring location	Sex	Age (months)	Measurements (cm) Total length	Hind foot	Neck circum.	Chest girth	Head length	Cond. index	Incisor status	Drug dosage(cc)[1]	Induction time (min.)	Shot placement
120225	3/26/79	4.8 km S. of Little Lake Louise	F	10	208.3	71.8	--	142.2	55.9	6	Erupted	4:1.7	5	--
120227	3/26/79	4.8 km S. of Little Lake Louise	M	10	207.0	69.9	61.0	150.0	55.9	5	Erupted	4:1.7	5	--
120229	3/26/79	4.8 km S. of Little Lake Louise	F	10	200.7	73.7	--	132.1	52.1	-	Erupted	5:0	8	--
120231	3/26/79	6.4 km S. of Little Lake Louise	M	10	213.4	72.4	62.2	162.6	59.1	-	Erupted	4:1.7	6	--
120233	3/26/79	4.8 km S. of Little Lake Louise	F	10	208.3	66.0	63.5	147.3	47.6	8	Not erupted	4:1.7	13	--
120235	3/26/79	4.8 km W. of T. Lake	M	10	226.1	74.9	68.6	142.2	59.7	7	Erupted	4:1.7	17	Lt. rump
120236	3/28/79	Mendeltna Springs	F	10	198.1	76.2	61.0	--	53.3	-	--	4:1.7	17	--
120237	3/28/79	8 km E. Old Man Lake	F	10	208.3	69.9	62.2	133.4	55.9	-	Erupted	4:1.7	5	--
120239	3/28/79	4.8 km S. of Little Lake Louise	F	10	198.1	73.7	58.4	132.1	50.8	5	Erupted	4:1.7[2]	10	--
120241	3/28/79	3.2 km N.E. Old Man Lake	M	10	193.0	81.3	58.4	121.9	55.9	6	Erupted	4:1.7	--	--
120244	3/28/79	1.6 km W. Old Man Lake	F	10	--	--	--	--	--	-	Not erupted	4:1.7	--	--
120249	3/28/79	4.8 km S. Little Lake Louise	M	10	223.5	81.3	66.0	137.2	55.9	-	Erupted	4:1.7 1:0	--	--
120250	3/28/79	1.6 km N. Old Man Lake	M	10	229.0	81.3	71.1	152.4	58.4	7	Partially erupted	4:1.7	6	--

Table 1. (cont.)

Accession #	Date	Collaring location	Sex	Age (months)	Measurements (cm) Total length	Hind foot	Neck circum.	Chest girth	Head length	Cond. index	Incisor status	Drug dosage(cc)[1]	Induction time (min.)	Shot placement
120252	3/29/79	3.2 km N.E. Curtis Lake	F	10	203.2	76.2	55.9	137.2	55.9	6	Erupted	4:1.7[2] 4:1.7	--	--
120253	3/29/79	1.6 km W. Curtis Lake	F	10	196.2	70.5	58.4	153.7	54.0	6	Partially erupted	4:1.7	7	--
120254	3/29/79	3.2 km N.W. Grayling Lake	M	10	205.7	74.9	53.3	116.8	53.3	6	Erupted	4:1.7[2] 4:1.7	4	--
120255	3/29/79	South shore Grayling Lake	F	10	193.0	73.7	55.9	116.8	53.3	7	Partially erupted	4:1.7	4	--
120256	3/29/79	1.6 km S. Grayling Lake	F	10	200.7	71.1	55.9	127.0	50.8	6	Partially erupted	4:1.7	6	--
120257	3/29/79	1.6 km E. Moyler Lake	M	10	215.9	74.9	63.5	121.9	55.9	7	Erupted	4:1.7	13	--
120258	3/29/79	1.6 km S. Nye Lake	F	10	195.6	73.7	55.9	132.1	53.3	7	Erupted	4:1.7	11	--
120259	3/29/79	4.8 km N.E. John Lake	F	10	193.0	73.7	55.9	127.0	53.3	6	Erupted	4:1.7	6	--
120260	3/29/79	1.6 km N.E. Marie Lake	F	10	198.1	76.2	58.4	127.0	53.3	-	Erupted	4:1.7	5	--
120261	3/29/79	3.2 km N. John Lake	M	10	203.0	76.2	55.9	132.1	53.3	-	Erupted	4:1.7	6	--
120262	3/29/79	3.2 km N. John Lake	F	10	188.0	73.7	50.1	132.1	53.3	7	Erupted	4:1.7	5	--
120263	3/29/79	4.8 km N. John Lake	F	10	203.2	69.5	--	--	57.2	-	Erupted	4:1.7	4	--
120264	3/29/79	2.4 km E. Marie Lake	F	10	205.7	72.1	58.7	162.4	57.8	5	Erupted	4:1.7	5	Front of
120265	3/29/79	3.2 km E. Marie Lake	M	10	213.4	71.1	65.4	152.4	60.3	7	Erupted	4:1.7	18	Left side
120266	3/29/79	Blue Lake	M	10	--	--	--	--	--	-	Erupted	7:1.7	24	Left ha

Table 1. (cont.)

Accession #	Date	Collaring location	Sex	Age (months)	Measurements (cm) Total length	Hind foot	Neck circum.	Chest girth	Head length	Cond. index	Incisor status	Drug dosage (cc)[1]	Induction time (min.)	Shot placement
120267	3/29/79	0.5 km N. Grayling Lake	F	10	--	73.7	--	--	--	7	Erupted	2:0.8	5	--
120268	3/29/79	N. shore Grayling Lake	M	10	193.0	72.4	62.2	132.1	53.3	7	Not erupted	4:1.7	5	--
120269	3/29/79	N.E. shore Grayling Lake	F	10	205.7	68.6	--	147.3	54.6	6	Erupted	4:1.7	5	--
120270	3/30/79	S.E. side Tyone Mt.	M	10	205.7	74.3	--	--	53.3	5	Erupted	4:1.7	2	--
120271	3/30/79	0.8 km E. Tyone Mt.	M	10	210.9	72.4	56.4	152.4	56.5	6	Erupted	4:1.7	3	--
120273	3/30/79	8 km upstream Tyone Lake	F	10	200.7	71.1	61.0	121.9	50.8	7	--	4:1.7	12	--
120275	3/30/79	8 km upstream Tyone Lake	F	10	196.2	69.9	54.6	158.8	50.2	6.5	Not erupted	4:1.7	10	--
120276	3/30/79	7.2 km upstream Tyone Lake	F	10	215.3	70.2	60.3	147.3	56.6	7	Erupted	4:1.7	4	--
120277	3/30/79	9.6 km S.W. Tyone	M	10	221.0	77.5	61.0	137.2	55.9	7	Erupted	4:1.7	--	--
120278	3/30/79	4.8 km N.W. Tyone Village	M	10	201.0	76.2	55.9	137.2	53.3	7	Erupted	4:1.7	18	--
120279	3/30/79	4.8 km N.W. Tyone Mt.	F	10	218.4	76.2	55.9	132.1	55.9	6	Erupted	4:1.7	--	--
120280	3/30/79	1.6 km N. Moore Lake	M	10	213.4	74.9	58.4	137.2	55.9	6	Erupted	4:1.7	--	--
120281	3/30/79	13 km W. Tyone Mt.	M	10	213.4	78.7	58.4	142.2	58.4	6	Erupted	4:1.7	3	--
120284	3/30/79	8 km S.W. Tyone Village	M	10	226.1	70.5	--	147.3	52.7	6	Not erupted	4:1.7	3	--

Table 1. (cont.)

Accession #	Date	Collaring location	Sex	Age (months)	Measurements (cm)					Cond. index	Incisor status	Drug dosage(cc)[1]	Induction time (min.)	Shot placement
					Total length	Hind foot	Neck circum.	Chest girth	Head length					
120285	3/30/79	8 km S.W. Tyone Village	M	10	205.1	69.0	59.7	142.9	53.3	7	Partially erupted	4:1.7	4	--
120287	4/10/79	Lily Lake	M	10.4	--	--	--	--	--	-	--	4:1.7	2	Gut shot
120288	4/10/79	Mile 182 Glenn Hwy.	F	10.5	--	--	--	--	--	-	Erupted	4:1.7	-	Gut shot
120290	4/28/79	7.2 km N. Old Man Lake	F	11	203.2	77.4	50.8	141.0	54.0	-	Partially erupted	4:1.7	6	Left rump
120291	4/28/79	7.2 km N. Old Man Lake	F	11	--	--	--	--	--	-	Erupted	4:1.7	10	--
120292	4/27/79	Mouth Little Oshetna River	M	11	--	77.5	--	--	--	5	Erupted	4:1.7	8	--
120293	4/27/79	Mouth Little Oshetna River	F	11	--	69.9	--	--	--	-	Erupted	4:1.7	-	--
120294	4/27/79	6.4 km S. of Twin Hills	M	11	223.5	76.2	63.5	137.2	55.9	-	Erupted	4:1.7	8	--
120295	4/27/79	Mouth Little Oshetna River	M	11	203.2	76.2	--	--	55.9	-	Erupted	4:1.7	10	--
120296	4/27/79	4.8 km S.E. Lone Butte	F	11	208.3	73.7	--	--	52.1	-	--	4:1.7	-	--
120297	4/27/79	4.8 km S.E. Lone Butte	F	11	221.0	73.7	--	--	58.4	-	Erupted	4:1.7	5	--
120298	4/27/79	4.8 km S.E. Lone Butte	F	11	--	76.2	--	--	--	-	Erupted	4:1.7	13	--
120299	4/27/79	Mouth Little Oshetna	F	11	--	76.8	--	--	--	5	Erupted	4:1.7	11	--
120300	4/27/79	4.8 km S.E. Lone Butte	F	11	213.4	71.1	58.4	--	55.9	-	Erupted	4:1.7	5	--

Table 1. (cont.)

Accession #	Date	Collaring location	Sex	Age (months)	Measurements (cm) Total length	Hind foot	Neck circum.	Chest girth	Head length	Cond. index	Incisor status	Drug dosage(cc)[1]	Induction time (min.)	Shot placement
120301	4/27/79	3.2 km S.E. of Moore Lake	M	11	210.8	71.1	--	---	50.8	-	Erupted	4:1.7	8	--
120302	4/27/79	3.2 km S. of Square Lake	F	11	--	71.1	--	--	--	-	Erupted	4:1.7	9	--
120303	4/27/79	4.8 km S.E. Lone Butte	F	11	--	76.2	--	--	--	-	Erupted	4:1.7	5	--
120304	4/27/79	Mouth Little Oshetna River	M	11	--	76.2	--	--	--	-	Erupted	4:1.7	9	--
120305	4/27/79	Mouth Little Oshetna River	F	11	--	76.2	--	--	--	6	Erupted	4:1.7	6	--
120306	4/27/79	4.8 km S. Square Lake	F	11	--	--	--	--	--	-	Erupted	4:1.7	5	--
120307	4/27/79	Mouth Little Oshetna River	F	11	--	--	--	--	--	-	Erupted	4:1.7	20	--
120308	4/27/79	Mouth Little Oshetna River	F	11	203.2	72.4	65.5	149.9	53.3	-	Erupted	4:1.7	5	--
				η =	48	57	38	40	48	38				
				$\bar{x}$ =	207.10	73.81	59.17	138.90	54.63	6.33				
				S.D. =	9.86	3.24	4.38	11.72	2.63	0.76				

Table 2. Ages and morphometric measurements of adult moose captured and tagged in Game Management Unit 13A during spring 1979.

Moose accession #	Age	Total length (cm)	Hind foot (cm)	Neck circum. (cm)	Chest girth (cm)	Head length (cm)
120224	14	289.6	81.3	-	203.2	-
120226	7	294.6	88.9	-	208.3	-
120228	8	284.5	86.4	-	190.5	-
120230	8	292.1	80.6	-	182.9	-
120232	10	281.9	78.7	-	198.1	-
120234	4	295.9	91.4	-	184.2	-
120238	8	271.8	83.8	-	162.6	-
120240	10	274.3	85.1	-	182.9	-
120243	9	279.4	71.1	-	188.0	-
120245	7	292.1	90.2	-	193.0	-
120246	2	264.2	83.8	66.0	162.6	68.6
120248	9	299.7	88.9	-	213.4	-
120251	9	309.8	88.9	-	180.3	-
120272	2	238.8	78.7	61.6	182.9	64.8
120274	2	254.0	85.1	-	167.6	-
120282	2	232.4	81.3	66.0	162.6	67.3
120283	2	237.5	78.7	72.4	152.4	66.0
n =		17	17	4	17	4
$\bar{x}$ =		276.0	83.7	66.5	183.3	66.7
S.D. =		22.59	5.14	3.85	16.82	1.42

field crew had had previous experience in applying the index, and none had previously used it on short yearlings, we suspect that many of the condition evaluations were erroneous. Also, we suspected that although there were differences between individual yearlings, many of them were very minor and, in retrospect, most moose were very similar in appearance. Several moose, however, were in very weak condition and, as expected, later died.

Table 3 presents blood values of short yearlings sampled in GMU 13 during spring 1979. Franzmann and LeResche (1978) believed that calcium (Ca), phosphorus (P), total protein (TP), hemoglobin (Hb), and packed cell volume (PCV) were the most useful blood parameters for assessing the physical condition of moose. Consequently, we compared those parameters from this study with those obtained by Franzmann et al. (1976) at the Kenai Moose Research Center on the Kenai Peninsula, Alaska. TP, Hb, and PCV values for GMU 13 short yearlings were significantly lower (t-test, P<0.05) than those found on the Kenai Peninsula. Since the Kenai Peninsula moose blood values were on the low side of the range of values determined for other Alaskan moose populations, we surmised that the GMU 13 short yearling moose were nutritionally stressed when sampled in 1979. Blood values from adult moose sampled during the same period are shown in Table 4. When compared with those from six other Alaskan moose populations, these blood values were low and reflected nutritional stress (Ballard et al. In Press). Winter 1978-79 was the second most severe winter, in terms of total snowfall, since 1952 when records were first kept (U.S. SCS 1979). The 1979 adult and short yearling moose blood values reflected the severity of the 1978-79 winter.

PCV, hemoglobin, and total protein values were significantly lower (t-test, P<0.05) in male than in female yearlings. However, no significant differences (P>0.05) were detected for calcium and phosphorus. These data suggest that males were in poorer condition than females. This may partially account for the preponderence of males dying from starvation (8 of 10).

Stage of permanent incisor eruption was recorded with the idea that the date of eruption might reflect the relative age and that moose born late in the calving season might enter the winter in poorer physiologic condition. Thirty-six of 41 (88%) short yearlings captured in March had either fully or partially erupted incisors. There were no significant differences (P>0.05) between the blood values for moose which had erupted permanent incisors and those which had not. All 19 of the short yearlings checked during April collaring had erupted incisors.

Table 3. Blood values of short yearling moose sampled in GMU 13 of southcentral Alaska from 26 March 1979 through 28 April 1979.

Yearling moose accession number	Sex	Carbon dioxide (meg/L)	BUN (mg/dl)	Creatinine (mg/dl)	Bilirubin (mg/dl)	Uric acid (mg/dl)	Total protein (Gm %)	Albumin (Gm %)	Globulins (g/dl)	Alpha 1 (Gm %)	Alpha 2 (Gm %)	Beta % (Gm %)	Gamma % (Gm %)	A/G ratio	Packed cell volume	Percent hemoglobin
120225	F	17.0	2.0	1.5	0.1	0.2	4.8	3.8	1.8	0.5	0.2	0.1	0.2	3.8	40	17.3
120227	M	32.0	4.0	1.9	0.2	0.4	5.6	4.3	2.2	0.2	0.4	0.2	0.4	3.5	37	17.5
120229	F	7.0	3.0	1.7	0.2	0.4	5.8	4.6	2.3	0.4	0.4	0.3	0.3	3.6	37	15.4
120231	M	14.0	1.0	1.6	0.2	0.1	5.0	3.8	1.9	0.3	0.3	0.2	0.4	3.3	36	16.0
120233	F	16.0	4.0	1.1	0.1	0.2	3.5	2.7	1.3	0.1	0.3	0.2	0.3	3.3	45	18.0
120235	M	35.0	2.0	1.3	0.1	0.2	5.9	4.3	2.4	0.4	0.6	0.4	0.3	2.7	35	15.3
120236	F	11.0	5.0	1.3	0.2	0.3	4.3	3.2	1.6	0.2	0.4	0.2	0.3	3.1	45	18.1
120237	F	11.0	2.0	1.8	0.1	0.4	5.6	4.1	2.1	0.2	0.5	0.3	0.4	3.0	40	17.2
120239	F	25.0	3.0	1.1	0.1	0.3	4.4	3.0	1.8	0.3	0.4	0.3	0.4	2.2	33	15.4
120241	M	25.0	2.0	1.9	0.1	0.3	5.2	3.6	2.2	0.4	0.3	0.3	0.7	2.2	31	13.5
120244	F	20.0	8.0	1.3	0.1	0.5	4.2	2.7	1.7	0.2	0.6	0.2	0.5	1.9	32	-
120249	M	23.0	3.0	1.5	0.2	0.2	4.7	3.4	1.9	0.2	0.4	0.2	0.5	2.7	40	18.1
120250	M	13.0	3.0	1.0	0.0	0.2	3.2	2.1	1.1	0.1	0.3	0.4	0.3	2.0	31	15.0
120252	F	10.0	3.0	1.7	0.2	0.3	6.1	4.3	2.7	0.3	0.5	0.3	0.7	2.5	40	16.2
120253	F	10.0	1.0	1.4	0.1	0.2	4.4	3.4	1.7	0.1	0.3	0.2	0.3	3.5	39	16.6
120254	M	15.0	1.0	1.2	0.1	0.2	4.6	3.4	1.9	0.3	0.3	0.3	0.4	2.3	34	14.5
120255	F	7.0	4.0	1.9	0.1	0.2	5.4	3.7	2.3	0.3	0.5	0.2	0.6	2.2	42	17.4
120256	F	18.0	3.0	1.5	0.1	0.3	5.7	4.2	2.4	0.7	0.3	0.2	0.4	2.8	33	14.2
120257	M	20.0	1.0	1.7	0.2	0.2	4.6	3.4	1.7	0.2	0.4	0.3	0.3	2.8	34	16.4
120258	F	8.0	2.0	1.9	0.2	0.3	5.8	4.0	2.4	0.2	0.6	0.4	0.7	2.2	44	17.7
120259	F	9.0	3.0	1.3	0.1	0.2	4.5	3.4	1.7	0.3	0.3	0.3	0.3	3.1	42	18.5
120260	F	8.0	6.0	1.5	0.2	0.3	5.3	3.9	1.9	0.2	0.7	0.2	0.3	2.8	47	20.0+
120261	M	14.0	3.0	1.6	0.1	0.4	4.8	3.4	2.0	0.2	0.4	0.3	0.5	2.4	39	17.8
120262	F	9.0	4.0	1.2	0.1	0.4	4.4	3.5	1.6	0.2	0.2	0.3	0.3	3.8	44	19.8
120263	F	12.0	5.0	1.1	0.1	0.4	3.8	2.8	1.5	0.2	0.3	0.2	0.3	2.9	39	16.4
120264	F	12.0	2.0	1.7	0.2	0.3	5.3	3.8	2.3	0.3	0.3	0.3	0.6	2.6	42	18
120265	M	18.0	6.0	1.6	0.3	0.4	5.0	3.8	1.8	0.2	0.4	0.3	0.4	3.1	41	18.4
120266	M	11.0	2.0	1.8	0.2	0.2	5.1	3.9	1.9	0.3	0.4	0.2	0.3	3.3	41	18.1
120267	F	3.0	3.0	1.8	0.1	0.2	5.8	4.0	2.1	0.3	0.9	0.2	0.4	2.3	38	16.4
120268	M	11.0	1.0	1.3	0.1	0.2	4.7	3.3	2.0	0.7	0.3	0.1	0.4	2.4	35	15.5
120269	F	5.0	1.0	1.0	0.1	0.1	3.0	2.3	1.1	0.2	0.2	0.1	0.2	3.3	40	17.0
120270	M	18.0	2.0	1.5	0.1	0.2	4.5	3.6	1.8	0.3	0.3	0.2	0.2	3.7	35	16.3

Table 3. (cont.)

Yearling moose accession number	Sex	Carbon dioxide (meg/L)	BUN (mg/dl)	Creatinine (mg/dl)	Bilirubin (mg/dl)	Uric acid (mg/dl)	Total protein (Gm %)	Albumin (Gm %)	Globulins (g/dl)	Alpha 1 (Gm %)	Alpha 2 (Gm %)	Beta % (Gm %)	Gamma % (Gm %)	A/G ratio	Packed cell volume	Percent hemoglobin
120271	M	8.0	1.0	1.3	0.1	0.2	3.4	2.4	1.3	0.2	0.3	0.2	0.3	2.3	35	15.4
120273	F	19.0	2.0	1.5	0.0	0.2	4.2	2.6	1.8	0.2	0.5	0.3	0.6	1.6	35	14.5
120275	F	13.0	5.0	1.6	0.1	0.2	5.2	2.7	2.2	0.3	0.3	0.7	0.5	1.4	39	17.5
120276	F	17.0	3.0	1.7	0.1	0.3	5.7	4.1	2.4	0.7	0.4	0.2	0.3	2.6	36	17.3
120277	M	19.0	2.0	1.5	0.1	0.2	4.6	3.2	1.9	0.2	0.5	0.3	0.4	2.3	33	14.5
120278	M	16.0	2.0	1.4	0.1	0.2	5.4	4.0	2.0	0.2	0.5	0.3	0.4	2.8	32	14.9
120279	F	22.0	5.0	1.4	0.1	0.2	4.5	3.4	1.7	0.2	0.3	0.2	0.3	3.2	34	14.5
120280	M	22.0	2.0	1.4	0.1	0.3	5.1	2.7	2.1	0.3	0.4	0.3	0.5	2.5	34	15.2
120281	M	23.0	2.0	1.6	0.1	0.2	5.0	3.6	2.1	0.2	0.4	0.3	0.5	2.7	33	14.5
120284	M	18.0	2.0	1.4	0.1	0.2	4.7	3.3	2.0	0.3	0.4	0.3	0.5	2.3	31	14.5
120285	M	18.0	1.0	1.6	0.1	0.2	4.6	3.3	1.7	0.3	0.5	0.3	0.3	2.5	32	14.7
120290	F	18.0	5.0	2.0	0.1	0.3	5.9	4.7	2.0	0.0	0.5	0.3	0.4	3.3	37	17.6
120292	M	27.0	1.0	1.6	0.1	0.2	5.6	4.0	2.3	0.1	0.6	0.3	0.6	2.7	41	18.5
120293	F	14.0	1.0	1.7	0.1	0.1	5.6	4.2	2.2	0.1	0.6	0.3	0.4	2.8	34	16.0
120294	M	17.0	2.0	1.9	0.1	0.2	5.0	3.7	1.8	0.0	0.6	0.2	0.5	2.9	35	15.9
120295	M	16.0	1.0	1.6	0.1	0.2	5.5	4.1	2.2	0.1	0.5	0.3	0.5	2.8	27	12.5
120296	F	18.0	3.0	1.9	0.1	0.1	5.0	3.8	2.0	0.1	0.4	0.2	0.5	3.0	35	15.0
120297	F	24.0	2.0	1.9	0.1	0.1	5.4	4.0	2.0	0.1	0.4	0.4	0.5	3.0	32	15.0
120298	F	20.0	2.0	1.8	0.1	0.3	5.4	3.8	2.0	0.1	0.7	0.4	0.4	2.6	33	14.5
120299	F	16.0	2.0	1.9	0.2	0.3	5.8	4.2	2.4	0.1	0.6	0.3	0.6	3.3	40	17.7
120300	F	17.0	4.0	1.9	0.1	0.3	5.4	4.1	2.2	0.3	0.3	0.4	0.4	3.1	33	14.0
120301	M	22.0	4.0	1.8	0.1	0.1	4.6	3.4	1.6	0.2	0.3	0.2	0.5	2.8	32	14.4
120302	F	25.0	4.0	1.5	0.1	0.2	5.1	3.0	2.3	0.1	1.1	0.3	0.6	1.4	36	14.7
120303	F	28.0	2.0	1.3	0.1	0.1	5.2	3.7	2.2	0.0	0.5	0.3	0.6	2.5	32	14.7
120304	M	21.0	2.0	1.7	0.2	0.1	5.7	4.0	2.2	0.1	0.6	0.3	0.7	2.2	38	15.4
120305	F	17.0	2.0	2.0	0.1	0.1	5.6	3.9	2.3	0.2	0.4	0.4	0.7	2.4	37	16.8
120306	F	17.0	3.0	1.6	0.1	0.2	5.6	4.0	2.2	0.1	0.4	0.3	0.7	2.5	38	17.6
120307	F	21.0	3.0	1.8	0.1	0.0	5.7	3.9	2.3	0.1	0.7	0.3	0.7	2.2	33	14.4
120308	F	20.0	2.0	2.0	0.1	0.1	5.1	3.4	1.9	0.1	0.7	0.4	0.5	2.4	40	19.6
Totals																
n =		61	61	61	61	61	61	61	61	61	61	61	61	61	61	60
$\bar{x}$		16.72	2.74	1.57	0.12	0.23	4.99	3.61	1.97	0.23	0.44	0.28	0.44	2.71	36.69	16.23
S.D.		6.41	1.45	0.26	0.05	0.10	0.69	0.55	0.33	0.15	0.17	0.09	0.14	0.54	4.19	1.67

Table 4. Blood values from adult cow moose marked with visual-collars in Game Management Unit 13A during spring 1979.

		Hemoglobin g/100 ml	Packed Cell Volume %	Calcium mg/100 ml	Phosphorus mg/100 ml	Glucose mg/100 ml	B.U.N. mu/100 ml	Uric Acid mg/100 ml	Cholesterol mg/100 ml	Bilirubin mg/100 ml	Ak. Phos. mg/100 ml	L.D.H. mu/100 ml	S.G.O.T. mu/100 ml	Total Protein g/100 ml	Albumin %	Globulin %	Alpha 1 %	Alpha 2 %	Beta %	Gamma %	A/G Ratio
120224	168	----	--	10.2	5.5	112	1.0	0.2	74	0.1	35	226	59	5.7	3.9	1.8	0.2	0.4	0.3	0.9	2.2
120226	84	15.0	36	8.9	5.0	117	2.0	0.2	63	0.1	45	184	61	5.4	3.7	1.7	0.2	0.6	0.4	0.7	2.3
120228	96	16.3	42	10.1	5.7	151	4.0	0.3	78	0.2	93	170	61	6.1	4.6	1.5	0.2	0.4	0.4	0.5	3.1
120230	96	17.5	40	10.4	5.5	139	2.0	0.2	70	0.2	62	197	69	5.7	4.3	1.4	0.2	0.3	0.4	0.6	3.1
120232	120	18.0	45	10.6	5.7	109	3.0	0.3	99	0.2	80	250	84	6.6	5.0	1.6	0.2	0.5	0.4	0.5	3.1
120234	48	16.8	43	8.6	4.2	102	2.0	0.2	68	0.1	44	192	57	5.3	3.8	1.5	0.2	0.5	0.3	0.6	2.8
120238	96	18.3	42	8.9	5.4	84	2.0	0.3	69	0.1	59	172	85	5.2	3.8	1.4	0.3	0.2	0.3	0.6	2.8
120240	120	18.0	--	8.5	3.7	79	4.0	0.2	77	0.2	37	179	63	5.1	3.6	1.5	0.6	0.4	0.1	0.5	2.4
120243	108	16.0	35	8.0	4.5	106	5.0	0.1	67	0.1	27	231	67	4.9	3.5	1.4	0.2	0.4	0.3	0.6	2.5
120247	180	13.8	38	10.5	4.0	80	5.0	0.3	76	0.1	58	162	54	6.7	4.5	2.2	0.4	0.4	0.3	1.1	2.0
120248	108	----	46	9.7	5.2	101	4.0	0.2	94	0.2	62	236	107	6.0	4.2	1.8	0.2	0.6	0.3	0.7	2.4
120251	108	18.5	42	7.8	3.4	106	4.0	0.2	66	0.1	46	162	71	4.8	3.6	1.2	0.2	0.3	0.3	0.4	2.6
120272	24	17.6	37	11.5	5.9	116	3.0	0.3	92	0.1	36	275	70	5.9	4.4	1.5	0.3	0.4	0.3	0.5	2.9
n =		11	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
$\bar{x}$ =		16.89	40.55	9.52	4.90	107.85	3.15	.23	76.38	.14	52.62	202.77	69.85	5.65	3.76	1.55	.26	.42	.28	.60	2.57
S.D.=		1.49	3.64	1.14	.84	20.95	1.28	.06	11.60	.05	18.91	36.86	14.60	.60	1.14	.30	.12	.11	.11	.25	.43

Causes of Mortality

Between 5 April and 15 December 1979, 16 of 43 (37.2%) radio-collared yearlings died; 14 (87.5%) died of natural causes, 1 (6.3%) died as a result of collaring activities, and 1 (6.3%) was shot by a hunter. Winter-related mortality accounted for at least 71.4 percent of the natural deaths. Predation by brown bears (*Ursus arctos*) and unidentified predators accounted for 28.6 percent of the natural mortality. Individual descriptions of the circumstances surrounding each mortality follow.

Moose 120239, collared on 28 March, was dead by 5 April. It had moved 1 mile from the collaring location. Ground examination on 11 April indicated it to be a winter kill. No predator sign was observed; however, the carcass had been scavenged by birds.

Moose 120270 was evaluated as being in poor condition (condition index 5) when first captured on 30 March. On 6 April, it was observed dead. Ground examination on 11 April indicated it was a winter kill. Carcass had been scavenged by a lynx (*Lynx canadensis*) and by birds.

Moose 120273 was found dead on 14 April, 2 days after the previous sighting. The cow remained near the dead yearling until 27 April when ground examination was conducted. Cause of mortality was determined to be winter kill. No scavenging had occurred.

Moose 120288 was collared 4 miles west of Glennallen along the Glenn Highway on 10 April. The radio activated on 20 April, 2 days after previous location. Ground inspection determined death to be tagging related. The dart had penetrated the rumen causing extreme peritonitis. Dogs and birds had scavenged the carcass.

Twin moose 120284 and 120285 were found to be in poor condition at time of collaring on 30 March (PCV values; 284 - 31%, 285 - 32%). Franzmann et al. (1976) had determined the PCV baseline value for short yearlings to be approximately 41 percent. Yearling 120284 died on 20 April and yearling 285 died on 22 April. Ground examination on 27 April revealed that both were winter kills. Both had broken several of their incisors and canines while attempting to browse willows (*Salix* sp.) with stems greater than 2 cm in diameter.

Moose 120278 had difficulty standing on 6 April, 7 days after it was collared. By 20 April the mortality sensor was activated, 2 days after it had last been observed. Ground investigation on 27 April determined it was a winter kill. No scavenging had occurred on the carcass.

Moose 120258 was collared on 29 March. By 22 April, 2 days after its previous location, it was dead. No predator sign was observed and it was classified as a winter kill. Ground examination on 28 April revealed the carcass had been scavenged by either foxes *(Vulpes vulpes)* or wolves.

Moose 120281 was found dead on 24 April, 2 days after its previous relocation. Ground assessment on 27 April determined this yearling to be a winter kill; it had been browsing willow stems 1 cm, and larger, in diameter. Scavenging by birds and foxes occurred on the ribs and the pelvic region.

The radio signal from moose 120292 was not received after collaring until 15 May, at which time it was activated and the calf was found to be dead. Ground investigation on 18 May revealed no sign of predation, but the exact cause of death could not be ascertained. For this discussion, however, we classified it as a winter kill. Birds and foxes had scavenged and consumed approximately 50 percent of the carcass.

The mortality sensor was activated for yearling 120277 on 2 May, 2 days after its last relocation. The cause of mortality was predation by a brown bear. The bear was observed at the buried carcass on the morning of 2 May. By the time of ground investigation on 7 June, the carcass had been totally consumed.

Moose 120287 was detected dead on 2 May, 2 days after the last relocation. Aerial observation revealed that the yearling was a winter kill. Scavenging by foxes was apparent.

The mortality sensor activated for yearling 120296 on 18 May, 3 days after the previous relocation. Cause of death was an undetermined predator. The carcass was not covered and it had been approximately 25 percent consumed. Ground assessment was not conducted.

The cause of mortality of yearling 120231 was brown bear predation. The mortality sensor was activated on 29 May, 5 days after it last had been relocated. The hide was inverted and bear scats were present; however, the carcass was not buried.

Moose 120295 was detected dead on 4 August, 1 day after its previous relocation. Aerial observation determined that the cause of death was brown bear predation. The bear was not observed on the buried carcass. No ground investigation was conducted.

Yearling 120304 was shot by a hunter on 12 September, 1 day after its previous relocation.

Our classification of yearling mortality attributable to winter kill was subjective because we had no way of differentiating it from tagging-related mortality except when a moose was physically injured. However, we were confident that the moose mortalities we classified as winter kills were correct. Many of these moose had been predicted to die because of their poor physical condition at the time of capture. At least three yearlings were barely able to stand when first approached by the helicopter.

The objective of determining the extent and nature of yearling moose mortality was not fully met during this study for a number of reasons. Although we were able to document that approximately 25 percent of the short yearlings were winter killed after March 1979, we are positive that the total extent of winter kill for 1978-79 was much greater in the study area. During, and prior to, the tagging operation we observed several other moose which had obviously succumbed as a result of winter severity. Recorded mortality would likely have been greater had we initiated the study prior to January.

Yearling mortality from predation accounted for only 28 percent of the natural mortality. Earlier observations of kills made by wolves and bears suggested a higher predation rate. The observed rate of predation may have been reduced by winter severity since a large number of carcasses were available for scavenging. Sample size and the relatively late date of initiation of the study may have contributed to the reduced observed predation rate.

Prior to and during this study three wolf packs were intensively monitored in the yearling moose study area in an effort to gather information on predation rates of packs of different sizes, and to determine the species, age, and condition of prey taken by wolves. Preliminary examination of these data revealed that approximately half of the moose taken were short yearlings. Many of the kills were made before the yearlings were collared. Had the yearling study been initiated earlier in the winter, the mortalities attributable to predation would have been greater. Further discussion of wolf predation rates will be provided in the final wolf report.

<u>Yearling Movements</u>

Between 5 April and 5 December 1979, a total of 120 relocation observations were obtained on 25 yearlings. Generally, yearlings remained within the home range of their cows through most of this period of study. Only two yearling bulls appeared to disperse from the area inhabited by their dams. A description of individual yearling movements follows.

Moose 120262 was collared 3 km north of John Lake on 29 March. By 5 April, the cow and yearling had moved approximately 5 km north. Between 6 April and 11 June, they separated and the yearling moved 11 km north to S Lake where it remained within 3 km of the 11 June location through 5 December.

Moose 120264 was collared on 29 March, 2.5 km east of Marie Lake. After collaring, the cow and yearling separated and the yearling remained within 3 miles of the collaring location. By 6 July, it had moved approximately 7 km southwest to the Little Nelchina River. By 11 September, it had returned to within 4 km of the collaring location. Between 12 September and 5 December it again moved southwest and was observed 4 km east of Old Man Creek, 23 km from the previous location.

Yearling 120268 was collared at Grayling Lake on 29 March. Through the entire study period it remained with the cow. The pair remained within 5 km of the collaring location through 18 May. By 6 July they had moved approximately 17 km northwest to Tyone Creek. They moved back (15 km) to the collaring location by 11 September. By 5 December the pair had moved 11 km southwest to Nicholson Lake.

Moose 120269 was collared on 29 March on the north shore of Grayling Lake. The cow and yearling remained there through 5 April. By 24 May the pair had moved 29 km to the northwest to the south side of Lone Butte. Between 24 May and 11 September they separated and the yearling moved back and forth along the same line of travel between Tyone Creek and Lone Butte. On 5 December it was observed on Tolson Creek, 12 km from its previous location, but still within the narrow belt of travel.

Moose 120271 was collared on 30 March, 1 km east of Tyone Mountain. The cow and yearling remained within 2 km of the collaring location through 22 May. By 8 July they separated and the yearling moved 20 km north to the southern slopes of the Alphabet Mountains. Contact was lost after this relocation.

Moose 120290 was collared on 28 April, 7 km north of Old Man Lake. After collaring, the cow and yearling separated and by 21 June the yearling had moved 8 km to the southeast. By 6 July, it had moved 7 km east, to a site 11 km east of Old Man Lake. Between 11 September and 5 December, it moved 19 km to the west, 1 km south of Nicholson Lake.

Moose 120291 was collared on 28 April, 7 km north of Old Man Lake. The cow and yearling remained together through the study period. By 2 July the pair had moved 5.5 km south, 1 km north of Old Man Lake. They spent the remainder of the summer in that area. By 11 September the pair moved 7 km southwest, to an area 3 km northeast of Slide Mountain where they remained through 5 December.

Moose 120293 was collared on 27 April at the mouth of the Little Oshetna River. Between 27 April and 22 May the cow and yearling remained within 2 km of the collaring location. The pair separated between 23 May and 2 July and the yearling remained within approximately 3 km of the collaring location through 11 September. By 5 December it had moved 3.5 km north, to a site 1.5 km north of Square Lake.

Moose 120294 was collared on 27 April, approximately 6 km south of Twin Hills on the Oshetna River. We did not observe the yearling again until 15 August at which time it was alone. It had moved approximately 85 km to the east, to a site 2 km southwest of Deep Lake. By 11 September it moved 14 km northwest to 3 km west of Minnesota Lake and remained within 2 km of this location through 5 December.

Moose 120295 was collared on 27 April at the mouth of the Little Oshetna River. By 22 May the cow and yearling had migrated 25 km down the Oshetna River. On 2 July the yearling was observed alone 19 km north on the west bank of the Susitna River. The yearling was killed by a bear around 3 August after it had moved approximately 26 km east to the Tyone River.

Moose 120297 was collared on 27 April on Sanona Creek. By 22 May the cow and yearling had migrated approximately 26 km northeast to the Tyone River. Between 22 May and 2 July the pair separated and the yearling moved 11 km north to the southern slopes of the Alphabet Hills. It remained within 5 km of this location through 7 December.

Moose 120298 was collared on 27 April on Sanona Creek. The yearling became separated from the cow and remained within 5 km of the collaring location through 17 June. By 2 July it had moved approximately 22 km northeast to the mouth of Tyone Creek. Between 2 July and 11 September the yearling migrated back to within 1 km of its collaring location. On 5 December it was observed approximately 21 km to the south-

Moose 120300 was collared on 27 April on Sanona Creek. The yearling separated from the cow after collaring and remained within a 18 km^2 area centered around Sanona Creek through the study period.

Moose 120302 was collared on 27 April at the mouth of the Little Oshetna River. The cow and yearling remained together and within a 15 km^2 area through the study period.

Moose 120303 was collared on 27 April on Sanona Creek. By 24 May the cow and yearling had moved 13 km west to the Oshetna River. Between 25 May and 6 July they moved back 15 km to Sanona Creek. By 11 September the pair was still utilizing Sanona Creek but was observed 14 km downstream.

The cow and yearling separated by 5 December and the yearling moved 5 km upstream to the original collaring location.

Moose 120304 was collared on 27 April at the mouth of the Little Oshetna River. By 19 May the cow and yearling moved 7 km down the Oshetna River. Between 20 May and 2 July the pair separated. The yearling then moved 10 km east to Sanona Creek where it remained until 12 September when it was shot by a hunter.

Moose 120304 was collared on 27 April at the mouth of the Little Oshetna River. By 19 May the cow and yearling had moved 13.5 km down the Oshetna River. Between 20 May and 2 July the pair separated and the yearling moved 6 km farther down river. The yearling remained on the Oshetna and by 11 September moved 8 km back upstream. By 5 December, it was 13 km upstream of its last location.

Moose 120308 was collared on 27 April at the mouth of the Little Oshetna River. By 19 May the cow and yearling had moved 15 km northeast to the base of Lone Butte. Between 20 May and 2 July the pair separated and the yearling had moved 3 km west from its last location. By 11 September it had moved back 12.5 km to the mouth of the Little Oshetna. Contact was lost after this location.

RECOMMENDATIONS

1. Future yearling moose mortality studies should be initiated much earlier in the year to better assess the nature and extent of mortality.

2. Radio collars constructed of urethane material should not be used on moose because they are too rigid and easily slip off the animal.

3. The yearling moose mortality study should be conducted for at least 1 additional year in an area of moderate wolf density and during a much milder winter.

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Karl Schneider and Don McKnight reviewed this report and made a number of suggestions for improvement.

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