MOOSE CALVING AREAS AND USE ON THE KENAI NATIONAL MOOSE RANGE, ALASKA

by

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Abstract: Although female moose (*Alces alces*) with newly-born calves have frequently been observed in open, bog-meadow, black spruce (*Pica mariana*) habitats on the Kenai National Moose Range, moose also calve in other denser habitats where they are more difficult to observe. A total of 139 aerial surveys were flown over one major calving area, the Moose-Chickaloon River area, from 1957 to 1971. Peak use during this period occurred 17-23 years after a wildfire burned 1255 km^2 in the region. Fluctuations in moose observed per hour in the calving area were probably related to winter mortality and human harvest. Reduced cow moose densities apparently triggered a reproductive response in the late 1960's despite previous low productivity and deteriorating winter range. Twinning rates were more closely and inversely related to the age of the 1947 burn, time of earliest annual survey, and, to a lesser extent, cows observed per hour. Observations of newly-born calves and calf:cow ratios indicated parturition extended from mid-May to late-June and early July. Estimates of cow numbers in the spring of 1979 indicated less than 10 percent of the region's cow population were observed in the Moose-Chickaloon River calving area.

Features and use of moose (*Alces alces*) calving areas can play an important role in moose population dynamics because of the vulnerability

of calves to predation. To protect their calves, cows usually select secluded birth sites (Peterson 1955) and become extremely aggressive after calving (Altmann 1958). On the Kenai Peninsula, Alaska, many cows reportedly give birth to young on islands (Klein in Stringham 1974), spots that would seldom be visited by predators. If islands offer protection from predators, calves born in less protected areas may be subjected to higher predation losses. This is also suggested by a recent study which showed that black bears (*Ursus americanus*) were a major predator of moose calves born in and near the Moose-Chickaloon River calving area on the Kenai National Moose Range (Franzmann and Schwartz 1979).

In this paper we describe the locations of several known moose calving areas on the Kenai National Moose Range, the features and vegetation in the Moose-Chickaloon River calving area, moose numbers, productivity, and birth period observed in these calving areas between 1957 and 1971, and attempt to estimate the numbers of cows and proportion of the region's cow population utilizing this calving area in 1978 and 1979.

STUDY AREA

Detailed descriptions of the Kenai National Moose Range and specific habitats within the refuge can be found in Spencer and Hakala (1964), LeResche et al. (1974), Oldemeyer et al. (1977), and Bailey et al. (1978). Creation of moose habitat on the refuge has been dynamic because of man-caused wildfires at periodic intervals in the past (1890, 1926, 1947, 1964, 1969, 1974) which burned 9.3 to 1255 km^2 per fire resulting in conditions favorable to moose for periods of up to 20-30 years after the fire.

Methods

Annual reports of the refuge were reviewed to document locations of moose calving areas. Undoubtedly, these areas were also used by moose before they were first recognized as calving areas. A descriptive summary of the overstory vegetation in the Moose-Chickaloon River calving area was obtained from a computer-based timber inventory program. Dominant overstory vegetation was determined by interpretation of aerial photographs and ground surveys (*J. Lewandoski, personal communication).

In 1957, intensive aerial surveys were initiated over the Moose-Chickaloon River calving area and continued annually through 1971. Surveys were flown in the early morning (0400-0800) in a Piper PA-18 at an elevation ranging from 125-350m. Observed moose were sexed and aged after circling at a lower elevation ranging from 31-62m and recorded by the pilot or observer. Coverage of the area was accomplished by flying across the calving area along a series of parallel flight paths. Surveys were flown between May 11 and July 19 at 1-16 day intervals. A total of 139 surveys were flown with an average recorded count time of 3.5 hours per survey (Table 1).

In 1978, the Moose-Chickaloon River calving area was divided in 2.6 km^2 quadrats and four to eight randomly-selected quadrats were intensively surveyed per flight. Survey procedures outlined by Evans et al. (1966) were followed with count time averaging 17 min. per quadrat. In 1979, quadrat size was enlarged to 10.4 km^2 in attempt to reduce the variability between quadrats encountered in 1978. The larger quadrats increased average count times to 28 min. per quadrat.

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Table 1. Moose calf survey data; Moose-Chickaloon River Flats moose calving area, Kenai National Moose Range, 1957-1971.

Year	Period of flights	Number of flights 13-31 May	1-15 Jun	16-30 Jun	1-19 Jul	Mean number of days and (range) between flights	Mean count time in hours per flight (N)	Mean
1957	23 May-19 Jul	1	2	1	2	11.4 (8-16)	--	--
1958	19 May-12 Jul	4	4	1	3	4.9 (1-13)	--	--
1959	19 May-15 Jul	4	5	2	3	4.4 (2-8)	3	2.9
1960	17 May-5 Jul	3	3	2	2	5.4 (4-8)	6	3.5
1961	15 May-11 Jul	5	3	3	1	5.2 (3-15)	7	3.3
1962	14 May-4 Jul	5	5	2	1	4.2 (2-9)	13	3.4
1963	13 May-10 Jul	8	5	2	2	3.6 (1-9)	14	3.7
1964	19 May-5 Jul	5	3	4	2	3.6 (3-7)	14	3.6
1965	18-25 Jun			5		1.8 (1-3)	5	3.5
1966	20-24 Jun			5		1.0	5	3.6
1967	18-27 Jun			5		2.2 (1-4)	5	4.1
1968	25-29 Jun			5		1.0	5	3.7
1969	15 May-26 Jun	6	2	3		4.1 (1-4)	11	3.8
1970	22-26 Jun			5		1.0	5	3.1
1971	21-26 Jun			5		1.2 (1-2)	5	3.0
Totals		41	32	50	16	4.1 (1-16)	98	3.5

RESULTS AND DISCUSSION

Features of Moose Calving Areas

The first recorded attempt to monitor moose calving areas on the refuge occurred in 1957 when three calving areas were identified and surveyed by aircraft. These areas of open, bog-meadow habitat included the Kasilof-Cohoe Area (south of Kenai to the Kasilof River), the Lower Killey-Funny River Area, and the Moose-Chickaloon River Area. Each area was similar in terrain, appearance, and vegetation. The terrain is flat, the water table is at or near the surface with much surface water visible during the calving period and the vegetation is low-lying shrubs (*Salix spp.*, *Ledum sp.*) mosses, grasses, and sedge interspersed with various sized stands of black spruce (*Picea mariana*).

A summary of overstory vegetation in three sample townships in the Moose-Chickaloon River calving area region (Fig. 1) revealed that in township No. 26 where cows with calves are frequently observed, the vegetation is dominated by large stands of open bog-meadow (50 percent) and black spruce (10 percent) (Table 2). In township No. 27 which lies outside the recognized calving area, there is much above-timberline vegetation (46 percent) and little open, bog-meadow vegetation. In township No. 25 which is partially outside the calving area, there are more but smaller open bog-meadows and more lakes than in township No. 26.

Sightability of moose during the calving period probably has played an important role in defining calving areas on the Kenai National Moose Range. Cows and calves are observed in open areas perhaps only because they are more visible there. Other wildlife surveys and general observations suggest that an unknown but potentially large number of

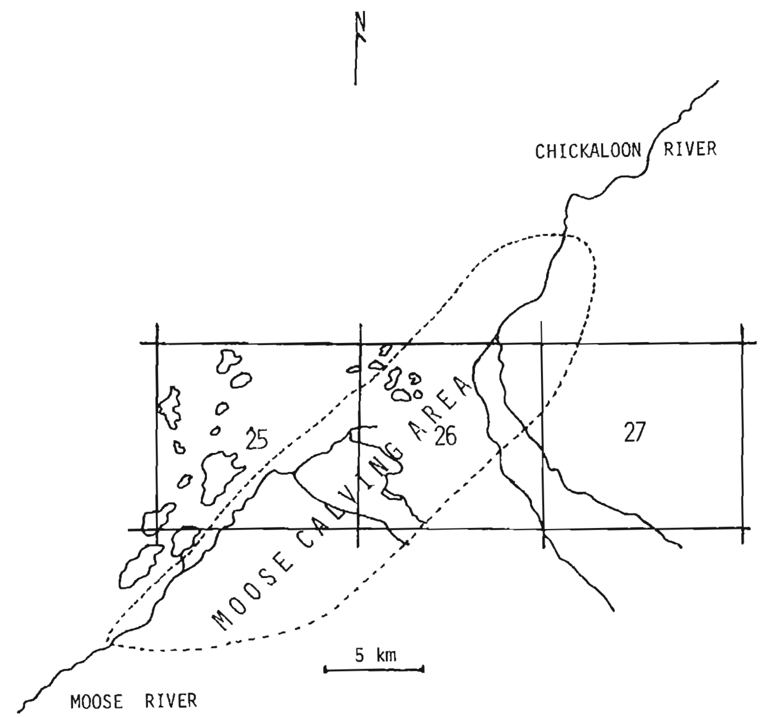

Figure 1. Moose-Chickaloon River calving area with superimposed townships 25-27.

Table 2. Numbers of stands, average size of stands, and percentage of various overstory vegetation types in three townships in and near the Moose-Chickaloon River moose calving area, Kenai National Moose Range.

Dominant vegetation type	Township Number[1]								
	25			26			27		
	Stands	Average size of stands ha	Percentage of total area	Stands	Average size of stands ha	Percentage of total area	Stands	Average size of stands ha	Percentage of total area
Open, Bog-meadow	49	71.5	38	18	248.8	50	16	22.2	5
Black spruce forest	10	8.7	1	23	40.5	10	7	61.4	6
Black-White Spruce forest	52	87.1	50	54	61.3	37	35	96.6	43
Hardwood forest	--	--	--	--	--	--	1	16.6	Tr
Above timberline and alpine	--	--	--	--	--	--	6	601.7	46
Lakes	85	11.2	11	31	6.7	2	3	0.6	Tr

[1]See Fig. 1 for locations of townships.

moose calves are born outside recognized calving areas especially in the lake-dotted region west of the Moose-Chickaloon River Area. During the trumpeter swan (*Cygnus buccinator*) surveys over this area, cows with calves are regularly observed on islands, peninsulas, and along lake shores. Klein (cited by Stringham 1974) also observed that many Kenai Peninsula cows give birth on islands. Since the number of ponds and lakes exceed 3,000 on the refuge, there appears to be many potential calving sites in addition to the large, open bog-meadow habitats already identified as calving areas.

A feature common to many moose calving sites is their proximity to water (Peterson 1955, Altmann 1958). During surveys in 1978 and 1979 we estimated the distances of 43 cows with calves from the nearest surface water. Thirty-one (72 percent) of the cows with calves were estimated to be within 50m of water and of these, five were standing or feeding in shallow water when first observed. The remaining 28 percent of cows with calves were less than 200m from water.

Although the probability of observing a moose a given distance from water could not be calculated from available maps, the data suggests that either cows with calves less than 8 weeks old preferred habitats with water nearby or that the calving area itself was characterized by an abundance of surface water. Either possibility suggests that water is an important component of an area used by cows with calves on the refuge especially during the first several weeks after the birth of the calf.

Utilization of the Moose-Chickaloon River Area during the Calving Period

Utilization of the Moose-Chickaloon River calving area by moose, based on the number of moose observed per hour of count time, indicates several trends (Table 3). First, there was an increase in the number of moose observed per hour between the late 1950's and mid-1960's. This is reflected in an average observation per hour increase of 84 and 104 percent for all moose and cows with calves, respectively. This increase in calving area utilization parallelled an observed increase in the refuge-wide moose population following a 1255 km^2 wildfire in the region in 1947 (Spencer and Hakala 1964). The calf survey data indicated a peak in calving area utilization was attained 17-18 years after the 1947 fire.

It is unlikely more moose were annually using the Moose-Chickaloon River calving area prior to the mid-1950's. Although systematic calf surveys were not conducted prior to 1957, refuge reports indicate it apparently was the rapidly growing moose population in the region following the 1947 burn that focused attention on the possible importance of this calving area. This first written report of cows calving in the area was in 1952 when cows and calves were noted using the area.

Another period of increased utilization of the calving area occurred in 1970 or 5-6 years after the first period and 23 years after the 1947 burn. In contrast to the earlier period, the latter period was characterized by relatively more observations per hour of all moose but fewer observations of cows with calves. The implications are that there were either fewer cows, fewer cows bearing calves, higher neonate mortality rates, or that cows with calves had become more

Table 3. Total observations and moose observed per hour over the Moose-Chickaloon River calving area, 1957-1971.

	Total observations				Observations per hour[2]		
Year	Adult cows	Calves	Adult bulls	All moose[1]	Cows	Cows with calves	Moose
1957	246	95	185	600	--	--	--
1958	713	278	422	1723	--	--	--
1959	751	352	407	1926	16.6	5.3	37.4
1960	622	317	395	1687	18.6	7.6	49.7
1961	843	266	356	2102	23.1	6.1	60.5
1962	1270	298	266	2242	28.9	5.3	51.1
1963	1389	329	379	2811	22.6	4.0	44.7
1964	1600	591	570	3505	31.9	9.8	69.8
1965	587	222	205	1200	33.7	11.8	69.0
1966	393	112	170	795	21.8	6.0	44.2
1967	374	236	155	1069	18.1	10.0	51.6
1968	395	178	108	963	21.2	8.2	51.8
1969	1296	434	294	2761	30.9	8.8	65.9
1970	575	160	198	1272	36.6	9.4	81.0
1971	657	136	243	1233	42.9	8.6	80.6
Total	11711	4004	4353	25889	--	--	--

[1]Includes moose classified as yearlings
[2]Only recorded count time surveys included

difficult to observe. Factors which could have reduced the number of cows and cows with calves observed in the calving area include natural mortality (winter-kills, predation), man-caused mortality (antlerless seasons, road-kills, poaching) or movement to other calving areas. Higher neonate mortality rates could have been related to increased predation losses or nutritional deficiencies. Cows with calves would have been more difficult to observe if they selected denser cover in the calving area or if the density of the vegetation increased during the period.

A number of events occurred between the two periods of high calving area utilization. There were three consecutive severe winters (1965-66 through 1967-68) (Bangs and Bailey 1980), forage conditions were deteriorating and density of cover increasing in the 1947 burn (Spencer and Hakala 1964), the refuge wolf (*Canis lupus*) population was beginning to increase (Peterson and Woolington 1979), and antlerless seasons were held for three years (1964-1966). These factors may have influenced the number of cows using the calving area during the two periods and perhaps also changed the age-structure in the cow segment of 1970 spring-calving-area population. Neonate predation may also have increased during the intervening period, especially if the habitat was becoming more favorable to black bears because of the increasing vegetative cover following the 1947 burn. This assumes there is a relation between vegetative cover and calf predation by black bears (*C. Schwartz, personal communication). The impact that predators actually had on calves at that time was unknown.

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Moose Productivity on the Moose-Chickaloon River Calving Area

Observed twinning rates and calf-cow ratios indicated the productivity of moose observed in the calving area was still increasing in the late 1950's, reached a high during 1960 and again in the late 1960's, and then declined until at least the last year of data (Table 4). The two periods of high productivity appeared different. During the first period, observed twinning rates were the highest recorded in the area, a relatively high proportion of the cows was observed with calves, and the number of cows observed per hour was relatively low. The observed twinning rate during the second peak was lower than during the first period, but the proportion of cows with calves and the number of cows observed per hour were similar.

To test the relationships of factors which may have influenced observed twinning rates and calf-cow ratios, the relationship of productivity to age of the 1947 burn, cows observed per hour, the spring bull-cow ratios observed on the calving area, a previous winter severity index (Bangs and Bailey 1980) and the time of the earliest annual calf survey were compared by linear regression (Table 5). Twinning rates were inversely related to the increasing age of burn, cow abundance, the winter severity index, and time of earliest survey and directly related to the bull-cow ratio. Calf-cow ratios were inversely related to the increasing age of burn, cow abundance and directly related to the bull-cow ratio, winter severity index and time of earliest survey. The relationship of these factors, in decreasing rank, to twinning rates were age of 1947 burn (r=0.84), time of earliest survey (r=0.82), cows observed per hour (r=0.55), the bull-cow ratio (r=0.40), and the previous winter's severity index (r=0.02). Factors,

Table 4. Productivity of moose observed on the Moose-Chickaloon River calving area, 1957-1971. Cows classified as yearlings excluded.

Year	Total observations			Twinning rate		Calves per 100 cows
	Cows	Single calves	Pairs of twin calves	N	%	
1957	246	57	19	76	25	39
1958	713	122	75	199[1]	38	39
1959	751	182	85	267	32	47
1960	622	177	70	247	28	51
1961	843	154	56	210	27	31
1962	1270	170	64	234	27	23
1963	1389	203	63	266	24	24
1964	1600	397	97	494	20	37
1965	587	188	17	205	8	38
1966	393	104	4	108	4	28
1967	374	180	28	208	13	63
1968	395	128	25	153	16	45
1969	1296	304	65	369	18	33
1970	575	136	12	148	8	28
1971	657	126	5	131	4	21

[1]Two observations of cows with triplets included

Table 5. Linear regression computation data, Moose-Chickaloon River calving area, 1957-1971.

Year	Independent variables					Dependent variables	
	Age of 1947 burn (years)	Cow abundance cows per hour	Bull-cow ratio bulls per 100 cows	Previous winter severity index[1]	Time of earliest survey[2]	Twinning rate	Calves per 100 cows
1957	10	--	75	21	11	25	39
1958	11	--	59	13	7	38	39
1959	12	17	54	7	7	32	47
1960	13	19	63	13	5	28	51
1961	14	23	42	9	3	27	31
1962	15	29	21	11	2	27	23
1963	16	23	27	21	1	24	24
1964	17	32	36	11	7	20	37
1965	18	34	35	14	37	8	38
1966	19	22	43	17	39	4	28
1967	20	18	41	19	37	13	63
1968	21	21	27	20	44	16	45
1969	22	31	23	12	3	18	33
1970	23	37	34	10	41	8	28
1971	24	43	37	5	40	4	21

[1]See Bangs and Bailey (1980) for computation of winter severity indices.
[2]Earliest initial survey date (13 May)=1; latest (25 June)=44.

in decreasing rank, related to calf-cow ratios were cows observed per hour (r=0.63), bull-cow ratios (r=0.42), the previous winter's severity index (r=0.30), age of 1947 burn (r=0.23), and time of earliest survey (r=0.09).

Since twinning rates were closely related to age of the 1947 burn, it appears that twinning was affected by nutrition and decreased with poorer range conditions. Such a relationship was previously suggested by Hosley in 1949 (in Pimlott 1959) and later supported by Pimlott (1959) and Simkin (1974). The data also indicate twinning rates were a better indicator of the nutritional quality of the range than were calf-cow ratios. The seasonal timing of surveys also influenced observed twinning rates with higher twinning rates reported for surveys conducted earlier in the spring. Surveys conducted earlier in the spring may have included proportionately more older cows which tend to have more twins than young cows (Pimlott 1959). Of 24 aged cows with twin fetuses collected on the Kenai Peninsula in 1964, only 4 (17 percent) were 3 years old or younger with the remaining 83 percent at least 4 years old (Rausch 1965).

Cow abundance, as indicated by the number of cows observed per hour, appeared more closely related to calf-cow ratios than twinning rates. Cow abundance was assumed to be a measure of the competition for resources with more resources potentially available per cow the lower the cow density. Its inverse relationship to productivity supports this view. Bull-cow ratios were more closely related to productivity than were winter severity indices and their direct relationship to productivity supports the view that at low ratios low numbers of bulls may negatively influence productivity. The impact of

various bull-cow ratios on productivity presumably varies with different environmental conditions, and would be dependent on other aspects of breeding such as bull and cow densities, age of bulls and cows, the social environment of moose during the rut, and the influence vegetative cover and type of terrain have on different modes of intraspecific communication.

The second period of high productivity observed in the Moose-Chickaloon River calving area might have been more apparent than real in regards to twinning rates. Since surveys during the latter period of high productivity were initiated later in the spring, it may have biased observations toward cows bearing single calves. However, since the overall quality of the winter range probably continued to decline with age of the 1947 burn and winters were severe during the second period of high productivity (1967-1969), lower cow abundance and/or higher bull-cow ratios may have been related to the observed increase in productivity. The observed lower cow abundance could have resulted from six years of antlerless seasons (1961-1966) and winter mortality during severe winters in 1963 and 1965 through 1967. The higher bull-cow ratios recorded in the mid-1960's may be explained by the observed lower number of cows -- no actual increase in numbers of bulls need have occurred.

The antlerless seasons probably benefited the population during this period because by reducing densities and browsing intensity on the deteriorating winter range, they reduced competition between moose for limited resources, perhaps slowed down the rate of decline of the winter range, and improved the bull-cow ratio. The antlerless seasons and three severe winters appeared to have reduced a high density moose population below the carrying capacity of the habitat and caused a reproductive response in the herd. Increasing the productivity of populations by reducing densities is a fundamental principle of the sustained yield management concept (Caughley 1978).

Calving Periods

Calf survey data and observations recorded in annual refuge narrative reports (Kenai National Moose Range 1961, 1963, 1964, 1969) indicated that calving on the Moose-Chickaloon River area usually reached a peak the first two weeks of June and was extended throughout the month until early July. Newly-born calves or peaks in calf production were recorded in mid-June (1963), the third week of June (1969), late June (1964), and early July (1961). Average calf:cow ratios summarized by period of observation between 1957 and 1971 showed an increase from late May to early June, a decrease in late June, and another increase in early July (Table 6).

Table 6. Cumulative progression of calf:cow ratios and twinning rates on the Moose-Chickaloon River area, 1957-1971.

	Total Observations				Productivity	
Period	Cows	Calves	Cows with calves	Cows with twins	Calves per 100 cows	Twinning rate
13-31 May	3649	646	409	132	18	32
1-15 June	2312	961	696	184	42	26
16-30 June	4750	1840	209	1616	39	13
1-19 July	1000	570	85	395	57	22

Factors which could have contributed to the extended period of births include differences in age structure of the cow population utilizing the calving area, nutritional regime of the diet of cows,

movement patterns of moose, and bull:cow ratios. It was already noted that younger cows (at least 2 years old) rarely produce twins, or produce fewer twins, and that only 17 percent of cows with twin fetuses examined on Kenai in 1964 were 3 years old or younger. It was also noted that the incidence of twins was higher earlier in the spring. Since the data suggest that the first period of births was dominated by cows giving multiple births, and that subsequent births were by cows bearing single calves, one explanation for the extended calving period was that older cows calved earlier than younger cows. One would expect the greater the proportion of younger cows in the population the more extended the calving period and the higher the proportion of single births. More young cows would enter a population after milder winters, but their contribution to productivity would not be evident until two years after their birth. Young cows may have been prevalent in the population after the mild winters in the late 1950's and early 1960's, but since severe winters were common in the middle 1960's fewer younger cows may have been present. These factors could have shifted the population's age structure and with lower cow densities, increased productivity.

Cows on a good summer diet might also be expected to produce more twins, earlier in the spring. Edwards and Ritcey (1958) believed moose summering at higher elevations had a higher twinning rate than those summering in valleys, and attributed this to a better summer diet. Studies of other ungulates indicate that females on higher quality diets give birth to greater numbers of twins. Tagging studies on the Moose-Chickaloon River area showed that an unknown proportion of cows using the calving area were migratory cows (LeResche 1972, Bailey et al. 1978) which may have been on a higher nutritional summer diet than lowland resident cows whose summer diet was obtained on deteriorating lowland range (Oldemeyer et al. 1977). Migratory cows were also generally older than lowland resident cows (Bailey et al. 1978.).

The effect of a bull:cow ratio which averaged 15:100 cows in the northern Kenai Peninsula during the 1960's (Bishop and Rausch 1974) on moose birth periods was unknown. Most observations of rutting moose have been in open habitats (Altmann 1959, Geist 1963, Lent 1974). Little is known about the influence of closed habitats, the various bull and cow densities, the age of bulls and cows on moose rutting behavior, and how the density of cover and type of terrain influence communication between moose. For example, during the rutting period on the western Kenai Peninsula, the average number of cows observed with bulls was 9.8 for moose in open upland areas compared to 1.5 for moose in dense lowland areas (Bailey et al. 1978).

Significance of Moose-Chickaloon River Area

In 1978 and 1979, estimates of cow and calf numbers in the Moose-Chickaloon River Area and a nearby mechanically-rehabilitated area revealed that about twice as many cows utilized the area in 1978 compared to 1979, and that in 1978 cow and calf densities were nearly as high in the rehabilitated area as the Moose-Chickaloon River Area (Table 7). Population estimates had wide confidence limits because many quadrats contained no moose while others contained up to ten moose. Confidence limits were higher for calves than cows perhaps because of habitat selection by cows to conceal calves, or because

Table 7. Estimates of moose cow and calf numbers and average densities on the Moose-Chickaloon River and Willow Lake calving areas, 1978 and 1979.

Years	Calving area	Date counted	Size of quadrat km^2	Total quadrats counted	Estimated cows $\bar{x} \pm 90\%CL$	Population calves $\bar{x} \pm 90\%CL$	Average density cows/km^2	Average density calves/km^2
1978	Moose River[1]	5-31-78	2.6	5	260±144	104±35	1.95	0.78
		6-16-78	2.6	5	218±183	21±27	1.63	0.16
		6-29-78	2.6	5	156±116	62±81	1.17	0.46
	Chickaloon River[2]	5-31-78	2.6	5	51±49	10±22	0.39	0.08
		6-13-78	2.6	8	134±100	64±51	1.00	0.49
		6-29-78	2.6	5	122±95	10±22	0.94	0.08
	Willow Lake[3]	6-21-78	2.6	3	12±7	8±0	1.17	0.78
1979	Moose-Chickaloon River[4]	6-11-79	10.4	4	119±37	37±17	0.46	0.15
		7-3-79	10.4	4	112±85	31±56	0.44	0.12

[1]Total area 134.7 km^2 (52 mi^2)
[2]Total area 132.1 km^2 (51 mi^2)
[3]Total area 10.4 km^2 (4 mi^2)
[4]Total area 259.0 km^2 (100 mi^2)

calves were more difficult to observe than cows. Counting larger quadrats in 1979 reduced confidence limits by about 23 percent. By assuming a pre-calving 1979 moose population of 3,394 and that 71.4 percent were cows (Kenai National Moose Range unpublished data), an average and maximum of 5 and 8 percent, respectively, of the region's cow population (north of Tustumena Lake) were estimated using the Moose-Chickaloon River Area during the surveys.

Although a moose population estimate was not obtained prior to the 1978 calving period, if one assumes 1979 numbers and herd composition, the 1978 calving area data suggested an average of 11-15 percent and a maximum of 26 percent of the region's cow population utilized the Moose-Chickaloon River Area that spring. Since the approximately 260 km^2 Moose-Chickaloon River calving area comprises about 5 percent of the western Kenai Peninsula north of Tustumena Lake, this area and similar habitats appear to play more than a minor role in the region's moose calving area requirements.

CONCLUSIONS

Moose calving areas on the Kenai National Moose Range are often associated with open, bog-meadow habitats where there is abundant surface water or with islands, peninsulas, and lake shores. These observations and those of others indicate that water may be an important component of birth sites and the habitats selected by cows with young calves. Water could play an important role in the anti-predator stragegy of moose to protect their offspring during the period calves are particularly vulnerable to predation.

Since patterns of productivity and their relationships to potential influencing factors indicated that observed spring twinning rates of moose were closely related to the age of a major habitat disturbance (burn area) and the period of survey, spring twinning rates appeared to be a sensitive indicator of range quality. However, it is important that surveys be conducted during the same periods when making year-to-year or longer comparisons. Since spring calf:cow ratios were not as closely related to habitat condition as twinning rates, spring calf:cow ratios as indicators of range quality, should be viewed with caution.

Reduction of cow densities via human and natural mortality appeared to initiate a reproductive response in moose even though productivity had previously declined and the winter range was deteriorating. The impact of a relatively low average bull:cow ratio of 15:100 on productivity of moose was unknown. A parturition period which extended into at least late June in the 1960's may have been caused, among other reasons, by a suspected large proportion of young cows entering the population. Older cows appeared to produce more twins than young cows, and twins were born earlier in the spring than single calves.

Since estimates of cow abundance on the Moose-Chickaloon River area suggested less than 10 percent of the region's 1979 estimated cow population used the calving area, the majority of the region's cows apparently calved elsewhere in 1979.

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