PRELIMINARY OBSERVATIONS ON THE TIMING AND CAUSES OF CALF MORTALITY IN AN INTERIOR ALASKAN MOOSE POPULATION

W. C. GASAWAY, Alaska Department of Fish and Game, 1300 College Road, Fairbanks 99701

D. HAGGSTROM, Alaska Department of Fish and Game, 1300 College Road, Fairbanks 99701

O. E. BURRIS, Alaska Department of Fish and Game, 1300 College Road, Fairbanks 99701

Abstract: The moose population in the Tanana Valley increased from the 1940's through the early 1960's, and then rapidly declined to a low level in 1975. Factors contributing to the increase and initial decline are discussed and reasons for the continued decline during the 1970's were investigated. Increasing calf mortality was a major factor limiting moose population growth during the 1970's. The greatest mortality occurred during summer and fall although mortality was also relatively high during winter. Estimated calf mortality rates from parturition to 6 weeks and 6 months of age during 1975 were approximately 40-50 percent and 60-70 percent respectively. Wolf predation was considered to be the most probable cause of high calf mortality, and a program was initiated to reduce the wolf-moose ratio to a value near, but not less than, 1:100. Approximately 60 percent of the wolves was removed from the study area during the winter of 1975-76, leaving a ratio of 1 wolf/30 moose. Calf survival to 6 months of age increased to that observed during previous years when the moose population was increasing. Accordingly, we suggest that excessive numbers of wolves depressed this moose population between 1971 and 1975 to a lower level than it would have otherwise reached.

There has been much concern over the presently low and declining densities of moose (*Alces alces gigas*) in portions of interior Alaska. The most recent moose increase and subsequent decline have been described by Bishop and Rausch (1974) and Coady (1976*a*). In game management unit (GMU) 20A the moose population increased from low levels during the 1940's to very high densities during the mid 1960's apparently as a result of a combination of factors. Moose forage greatly increased following a large number of natural- and man-caused wildfires, while at the same time moose mortality was significantly reduced by the cessation of market hunting, initiation of federal predator control programs, and a long series of mild winters. At their peak density moose numbers likely exceeded the carrying capacity of their range (Rausch 1967, Shepherd, personal communication). A general crash in the moose population was precipitated during the winter of 1965-66 by a near-record snow accumulation and continued during the following severe winter. Winters were relatively mild between 1967 and 1969, and the moose population began to increase slowly. However, during the winter of 1970-71 a record snowfall was recorded and up to 50 percent of the moose may have died. The moose population in GMU 20A and adjacent areas continued to undergo a relatively rapid decline through 1975.

The ultimate reasons for the continued decline after 1971 were not known, but it is apparent that high rates of calf and adult mortality precluded population growth. Increased hunting during the early 1970's certainly accelerated the decline in some areas through the removal of adult animals. Nevertheless, it was not the major factor responsible for low recruitment. By 1975 harvests had been sharply reduced by restricting the hunting season. Moose populations in adjacent lightly-hunted areas and in unhunted McKinley Park were also experiencing poor calf survival and declines indicating the minor role of hunting in regulating these particular populations (Gasaway 1976, Jennings and Gasaway 1976, Wood, personal communication). Range conditions in GMU 20A probably have not contributed to the continued decline of moose during the 1970's because recent studies by Coady (1976*b*) show that forage was not limiting moose populations. Although the influence of disease on interior Alaskan moose populations has not been intensively studied, it appears that meningeal worm (*Parelaphostronaylus tenuis*) and/or other potentially serious pathogens seen elsewhere are not present, and mortality from enzootic diseases has been minimal in recent years (Neiland, personal communication).

Predation by wolves (*Canis lupus*) has been suspected to be 1 of the more influential factors regulating interior moose populations. Wolf numbers were depressed in GMU 20A through predator control programs during the period of major growth of the moose population. Wolf numbers increased significantly with the abundant prey resource available following termination of control programs in 1959 (Bishop and Rausch 1974). They remained abundant during the period 1966-74 as the moose population rapidly declined, resulting in a relatively high ratio of wolves to moose. During the early 1970's alternate food sources, such as caribou (*Rangifer tarandus*), hares (*Lepus americanus*), and sheep (*Ovis dalli*) also declined (Gasaway 1975, Ernest 1974, Heimer 1975), and wolves were forced to rely primarily on moose as a food source. The importance of moose to wolves and the predators' impact on the moose population in GMU 20A were indicated by studies conducted between 1973 and 1974 in which 13-17 percent of 40 radio-collared adult moose were killed annually by wolves (Coady 1976*b*).

The present study was undertaken to determine factors depressing calf survival and therefore regulating moose populations in GMU 20A. Our approach was to evaluate rates of reproduction and initial calf production in relation to years of population increase, determine periods of major calf mortality, and assess the impact of wolf predation on moose calf survival.

We are grateful to the many members of the Game Division who contributed to the study, and to David Kelleyhouse, Kenneth Neiland, Donald McKnight, and John Coady for valuable criticism of the manuscript. This work was supported by Federal Aid in Wildlife Restoration Project W-17-R.

STUDY AREA

The study area included GMU 20A and a small portion of GMU 20C (Fig. 1) totaling approximately 21 000 km^2 (8,000 mi^2). The southern half of the area is dominated by the Alaska Range while the northern half consists of extensive lowlands of the Tanana River drainage. Vegetation in a major portion of the area was described by LeResche et al. (1974) and Coady (1976*b*). Habitat types on the Tanana Flats are a mosaic of herbaceous bog, heath, tall shrub, deciduous forest, and coniferous forest while the mountainous area is dominated by heath, tall shrub, and alpine tundra with forested areas

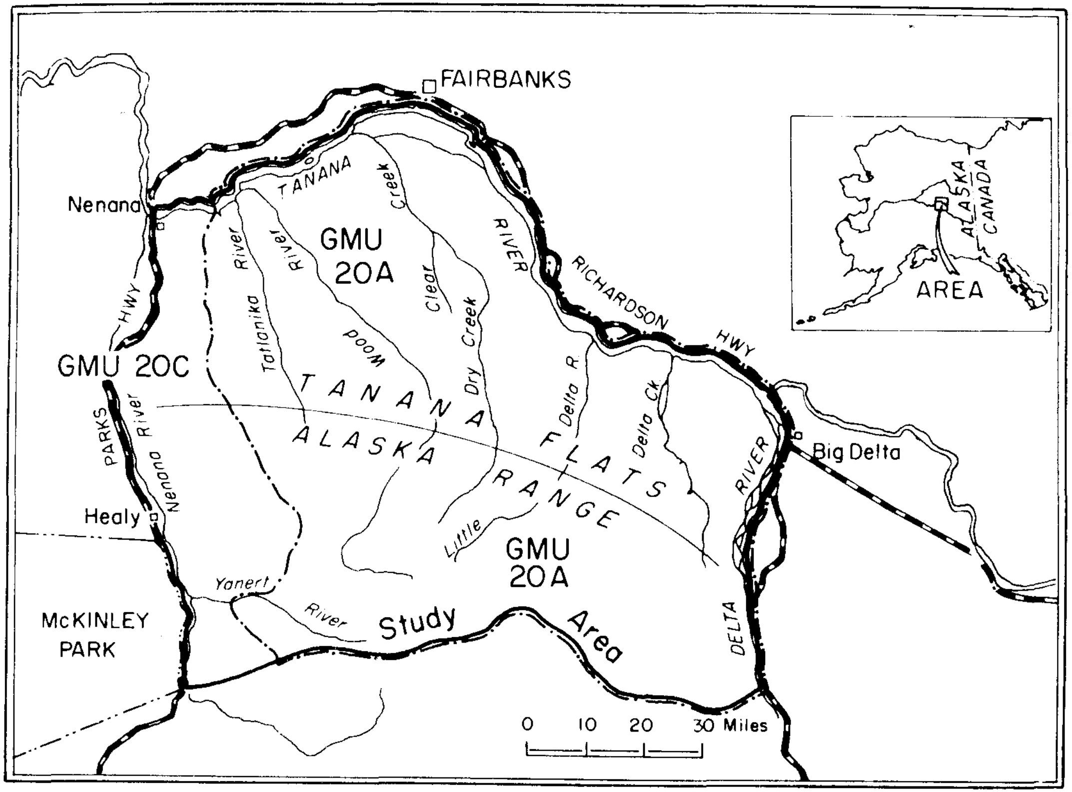


Fig. 1. The study area in interior Alaska.

confined to lower elevations.

MATERIALS AND METHODS

Moose survey data collected from 1960 through 1974 were compiled from Alaska Department of Fish and Game (ADFG) files and previous Game Division reports, and analyzed with respect to calf production and survival. Surveys were conducted to estimate initial production and survival during June, and survival to early winter (late October-early December) and mid May. Surveys were not conducted during these 3 periods in all years between 1960 and 1974. However, sufficient data were available to draw some tentative conclusions regarding calf survival and recruitment. During 1975 and 1976 surveys were conducted during the 3 periods and also early July. Survey methods were relatively consistent throughout the period (1960-76), even though many different biologists were involved. Most surveys were made from 2-place high-performance aircraft with occasional use of 4-place Helio Couriers. In areas with flat terrain, surveys were conducted along parallel transects at approximately 1.3 km (0.8 mi) intervals. In hilly or mountainous areas, flight lines followed contours at approximately 0.8 km (0.5 mi) intervals. During May, June, and July some flights were made specifically to locate collared moose in small portions of the study area. This search effort was more intensive per unit of area and the search pattern consisted of transects and circling. Additional observations of collared animals were made in conjunction with other moose studies in the area.

Initial calf production was estimated in May 1975 from 56 cows which were immobilized and rectally palpated to detect pregnancy. Details of immobilization techniques are reported elsewhere (Gasaway et al. 1977*a*). Since the reproductive rates of cow moose between 1 and 3 years of age varies, it was necessary to compare the age structure in the palpated sample with that in the population to ensure an unbiased estimate of calf production. Therefore the ages of all animals except 1 were determined from an extracted incisor (I_1) following methods described by Gasaway et al. (1977*b*). The resulting age structure of this sample of immobilized animals was then compared to the age structure of cows in the population as estimated from hunter killed cows and aerial surveys of yearlings (Gawaway 1976). Since the age structure of the palpated moose sample was not substantially different from that estimated for the population, the frequency of pregnant females in the sample was considered to be representative of the population. Because the presence of twin calves could not be detected by palpation, the incidence of twins seen during aerial surveys in early June 1975 (10 percent) was used to refine the estimate of total calf production based upon the pregnancy rate.

To improve calf survival and investigate the impact of wolf predation on moose-calf survival, wolf numbers were reduced. The Alaska Department of Fish and Game initiated the wolf reduction program in GMU 20A in February 1976. The goal was to reduce numbers to a ratio approaching but not below 1 wolf/100 moose during early winter. This extrapolates to a minimum desired population of approximately 30 wolves in the control area during the winter of 1975-76. Game Division personnel used fixed-wing aircraft to track and locate wolves, and a helicopter from which to shoot animals and retrieve carcasses. In addition to control efforts by the Game Division, private citizens have trapped and shot 40 to 70 wolves annually, or about 25 percent of the previously estimated wolf population.

RESULTS AND DISCUSSION

The 1st question we asked concerned the initial production of calves. Could the low number of calves observed during winter and spring surveys be attributed to reduced reproductive rates? Previous studies of reproductive biology of moose in Alaska were compared to our observations of reproductive success during 1975. Analysis of 29 reproductive tracts collected during 1963 and 1964 in GMU 20A revealed that 84 percent of the cows 3-years old or older and 68 percent of cows 1-year old or older were pregnant (Rausch 1966). We estimated initial production from pregnancy and twinning frequencies to have been 87 calves/100 females 2-years old or older at parturition. However, this must be considered a minimum value since some reproductive tracts were collected during the rut prior to completion of breeding. Rausch (1959) and Atwell (1963*a*) reported initial productions of 101-109 calves/100 females in south-central Alaska from large samples of reproductive tracts and found 95 percent of the moose greater than 2 years of age to be pregnant. However, Rausch (1967) speculated that initial production in interior Alaska probably did not reach the high levels reported for south-central Alaska.

Moose immobilized and palpated in GMU 20A during May 1975, 1 to 2 weeks prior to parturition, were found to have a pregnancy rate between those reported above for interior and south-central Alaska during the late 1950's and early 1960's when those populations were increasing (Table 1). Based on a twinning frequency of 10 percent observed during surveys in June, initial calf production in 1975 was estimated to be approximately 94 calves/100 females 2 years of age and greater. Therefore low productive rates were probably not responsible for the low proportion of calves observed in the population.

Satisfied that initial production of calves was within the normal range of values for interior moose, the next question to address was the temporal distribution of calf mortality throughout the 1st year of life. Mortality of neonates is difficult to document because of biases causing cow-calf groups to be underrepresented in aerial transect surveys during June (Gasaway et al. 1977*a*). Calf mortality is also difficult to assess because of high variability in the proportion of calves observed in repetitive surveys conducted during June (Bentley 1961, Atwell 1963*b*, Gasaway et al. 1977*a*). Hence a change of 15 to 20 calves/100 females among years may reflect normal sampling errors rather than real changes in calf abundance and survival. In spite of these problems, cow-calf ratios collected approximately 1-2.5 weeks after the peak of calving may serve as a crude relative index of neonate mortality. A ratio of 44 calves/100 females observed during June 1975 was sufficiently close to values (range 36-59, Table 2) collected during a period of population increase in the 1960's

Table 1. The age during last estrous and reproductive status of 55 cow moose captured, palpated and collared 8-14 May 1975 on the Tanana Flats, Alaska.

	Age (yr.)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Mean	Mean including one of undetermined age
Pregnancy rate %	0	25	83	100	87	100	100	100	100	83	100	100	100	100	84	85
Sample size	3	4	7	2	5	8	3	5	4	7	3	2	1	1	n=55	n=56

Table 2. Estimates of moose calf abundance and mortality from aerial surveys in GMU 20A, interior Alaska.

Cohort	Calves/100F Early June	Calves/100F Early July	% mortality June-July	Calves/100F late Oct.-early Dec.	% mortality June-Early Winter	Yrlgs/100 F May	% mortality Early winter-spring	% mortality June-May	Population status
1960	47	-	-	43	9	32	24	32	Population increasing
1961	59	-	-	-	-	-	-	-	
1962	56	-	-	44	21	-	-	-	
1963	-	-	-	44	-	-	-	-	
1968	43	-	-	39	9	26	33	40	
1969	36	-	-	42	gain 17	35	17	3	
1971	-	-	-	29	-	17	41	-	Population decreasing
1972	-	-	-	30	-	21	30	-	
1973	-	-	-	23	-	12	52	-	
1974	-	-	-	18	-	8	44	-	
							WOLF REDUCTION		
1975	44	-	-	14	68	27	gain 93	39	
				WOLF REDUCTION					
1976	45	59	gain 31	42	7	-	-	-	Population increasing

to conclude that neonate mortality was not unusually high.

In reviewing past age composition data from early winter aerial surveys and comparing them with June values, it becomes apparent that an increasing proportion of the calf mortality in the 1970's was occurring during summer and fall (Table 2). The number of calves/100 females in early winter declined steadily during the 1970's to approximately 1/3 the level found during the phase of population growth reflecting increased summer-fall mortality (Table 2). Similarly, indices of overwinter calf survival suggest that mortality has increased during the 1970's over that of earlier years of population increase (Table 2). These indices of mortality serve only as relative indices since each survey period has intrinsic biases which influence the age composition values. For instance, proportions of newly born calves during June surveys are underestimated but overwintering calves (yearlings) may be overestimated during May (Gasaway et al. 1977*a*). Additionally, overwinter survival of calves is closely related to winter severity (Bishop and Rausch 1974, Coady 1974) which complicates the assessment of mortality from other causes during winter. Therefore, mortality data substantially influenced by several severe winters between 1961 and 1971 were omitted purposely from this paper. We believe these omissions do not alter the conclusions, although severe winters have influenced the dynamics of this moose population extensively during the period discussed and have also altered the impact of predation.

Since the greatest increase in calf mortality during the 1970's occurred between the months of June and November, efforts were intensified to define the temporal mortality pattern more precisely (Table 3). The fate of calves produced by 48 pregnant collared cows was determined during summer and fall of 1975 (Table 3). Initial production estimated from rectal palpation was used as a basis for calculating mortality. Repetitive aerial observations conducted 1-2.5 weeks after the peak of calving revealed that initial calf mortality ranged between 23 and 26 percent during that period (Table 3). An additional 17 to 29 percent mortality was

Table 3. Survival of calf moose associated with collared cows in GMU 20A, 1975-1976. Number in parentheses is sample size.

Cohort	Groupings of collared cows	Mid-May	Early June			Late June-Early July			November			Mid-May		
		Estimated fetuses/100F	Calves/ 100F	accum. % mort.	% mort. since last observation	Calves/ 100F	accum. % mort.	% mort. since last observation	Calves/ 100F	accum. % mort.	% mort. since last observation	Yrlgs/ 100F	accum. % mort.	% mort. since last observation
1975	All resighted collared moose	94(56)	70(24)	26	26	50(12)	47	21	31(16)	68	21	34(29)	64	4 gain
	only resighted moose that were pregnant in May 1975	110(48)	85(20)	23	23	67(9)	40	17	36(14)	68	28	42(24)	62	6 gain
	individual cows with calves seen in June and resighted in July	-	100(7)	-	-	71(7)	-	29	-	-	-	-	-	-
						WOLF REDUCTION								
1976	all resighted collared moose	94*	57(28)	40	40	62(21)	35	5 gain	-	-	-	-	-	-
	individual cows with calves seen in June and resighted in July	-	100(11)	-	-	91(11)	-	9	-	-	-	-	-	-

* assumed to be similar to 1975

estimated to have occurred by 6 weeks post-partum (Table 3). Total mortality during the 1st 6 weeks of life appears to have exceeded 40 percent (Table 3). The biases which cause cow-calf groups to be underestimated in the June surveys listed in Table 2 have been reduced but not eliminated in data reported in Table 3 through repetitive observations. Calf mortality by 5 months of age was estimated to be nearly 68 percent (Table 3).

Because factors responsible for increased calf mortality were operative throughout the entire year, but most influential during summer, nutritional limitations on calf survival were difficult to accept as the prime cause underlying mortality. These data lend further credence to the hypothesis that predation was the most significant factor limiting recruitment of calves and therefore growth of the moose population.

There are 4 large predators in GMU 20A: black (*Ursus americanus*) and grizzly bears (*U. arctos*), wolverines (*Gulo luscus*), and wolves. The latter species is numerous in the area and considered to be the major year-round predator of moose. Black bears are common at lower elevations where moose calve and probably prey on some neonate moose. It is thought that black bears were not major predators in GMU 20A throughout the summer and fall although it was likely they may kill some neonate moose. Grizzly bears are uncommon at lower elevations where most moose summer, but are relatively abundant in the mountainous areas used by many moose during the fall and winter. Grizzly bears are known to prey on both adult and calf moose (Crook, Stephenson, Troyer, and VanBallenberghe, personal communication), but their effect on moose populations is unknown. Nonetheless, because the greatest rate of calf mortality appears to have occurred prior to the time when significant numbers of moose move to prime grizzly habitat (Table 3), we must assume grizzlies probably contribute little to summer moose mortality. Likewise, the onset of hibernation in early October minimizes their impact during fall. Although wolverines occur throughout the area no evidence exists to suggest that wolverines are an important predator on moose.

The wolf population in this area was estimated to be approximately 200 animals during February 1975 (Stephenson and Shepherd 1977). Wolves were distributed throughout the range of moose in the study area. The moose population was estimated to number about 3,000 in the same area, or approximately 1 wolf for every 15 moose. Including alternate ungulate prey species of at least 4,100 Dall sheep (Heimer and Smith 1975) and 1,500 caribou (Buchholtz, personal communication) a ratio of about 1 wolf/43 ungulates was present. Sheep and caribou were limited to the southern mountainous half of the area. Therefore, while alternate ungulate species were available year round to wolves inhabiting the mountains, no alternate ungulate prey species were present on the northern lowland half of the area. Investigations of food habits of wolves in interior (Rausch and Ellison 1969) and south-central Alaska (Stephenson, personal communication) indicate that moose calves were a primary year-round food item for wolves and were particularly important during summer. Since alternate foods were limited primarily to small mammals where most moose summered on the Tanana Flats during our study, wolves were suspected as being a major factor regulating moose calf survival during summer as well as being responsible for a significant proportion of the mortality observed during other seasons. Based on studies elsewhere (Mech 1966, Pimlott 1967, Peterson and Allen 1976), the predatory-prey ratio observed in GMU 20A is typical of ungulate populations depressed by wolves.

To improve calf survival and quantify the impact of wolf predation on moose calf survival, about 60 percent of the wolves was removed during the winter of 1975-76 through trapping and hunting by the public, and by a special wolf reduction program carried out by the Alaska Department of Fish and Game (Stephenson and Shepherd 1977). The wolf population was censused during the wolf reduction program and it was estimated that 239 wolves were present during early winter and approximately 90 wolves remained in April 1976 (Stephenson and Shepherd 1977). Post-reduction wolf densities were low on Tanana Flats due to the concentrated hunting and trapping efforts, but moderate densities remained in the mountainous portion. Low wolf densities on Tanana Flats should have minimized mortality of moose calves during summer due to wolf predation and for all moose remaining on the flats year round.

The final question to be answered was the effect of reduced wolf densities on calf survival. The increased survival of calves during 1976 is apparent when compared to former survival indices for GMU 20A and adjacent areas. The index for initial calf survival in June 1976 was similar to that in previous years (Table 2). However, subsequent mortality indices during 1976 demonstrated a lowered rate of mortality. No calf losses could be demonstrated between early June and July, and very little mortality was observed during the period June through November (Table 2). High calf survival through November 1976 was similar to survival rates observed during the early 1960's when the population was in a growth phase (Table 2). The survival of calves with collared cows through summer also improved with lowered wolf densities, and very little mortality was observed between the June and July observation periods (Table 3). Estimated calf survival through early June 1976 (Table 3) appears lower than in 1975 assuming that there was an initial production of 94 fetuses/100 females. This lower survival in 1976 cannot be readily explained except by bias in estimates used to calculate mortality indices.

Mortality indices reported in Tables 2 and 3 occasionally indicate a net gain in calves rather than an expected loss. Since essentially all calves are added to the population before the 1st survey of a cohort in June, these anomalies in mortality values must be caused by sampling error, bias, and differential movement patterns of moose. Because these factors influence the negative mortality values as well, these indices must be considered in light of their inherently high variability. However, they are the best indicators of relative survival available with our present technological and financial constraints.

Early winter calf survival in GMU 20A during 1976 was twice as great as that recorded for McKinley National Park in comparable habitat and terrain, and 2.5 times greater when all surveys for 20A are compared to the park data. We feel that the low calf survival index for McKinley Park (16 calves/100 females, late October 1976, Troyer, personal communication) was indicative of a moose population declining because of poor recruitment.

CONCLUSIONS

The dynamics of moose and wolf populations in GMU 20A have been influenced significantly by man for the past 50 years. Hence, results observed in the present study should be extrapolated to natural or pristine ecosystems with caution. Moose attained greatest density while predator populations were being depressed by man. When predator control efforts ceased wolves increased to high densities while the moose population crashed because of severe winters and overutilization of browse during the mid 1960's, and began a recovery by the late 1960's (Coady 1976*a*). Following the severe winter of 1970-71 it appears that moose numbers and consequently total calf production reached a critically low point at which wolf predation limited calf survival and recruitment to levels which no longer sustained the moose population. It appeared as though the moose population would have continued its decline for a number of years if wolf numbers remained relatively high. At the same time sport hunting of adult moose rapidly increased between 1970 and 1973 resulting in an estimated 15-20 percent of the adult moose killed in 1973 alone. Hunting was sharply curtailed after 1973, but the intensive harvest by man unquestionably hastened the decline of this population to the point that predation by wolves became its primary limiting factor during the mid 1970's.

The moose-wolf relationship seen in GMU 20A probably typifies much of interior Alaska today. It appears likely that moose populations in adjacent areas also have been sufficiently depressed by various factors that wolves now regulate those populations and are causing further declines.

LITERATURE CITED

Atwell, G. 1963*a*. Moose investigations: productivity studies. Job Compl. Rep. Fed. Aid Wildl. Restor. Alaska Fish Game. Pages 25-41.

________. 1963*b*. Moose report. Ann. Proj. Seg. Rep. Fed. Aid Wildl. Restor. Alaska Fish Game. 63pp.

Bentley, W. 1961. Moose data collection - interior and arctic Alaska. Ann. Prog. Rep. Fed. Aid Wildl. Restor. Alaska Fish Game. Pages 145-151.

Bishop, R.H. and R.A. Rausch. 1974. Moose population fluctuations in Alaska, 1950-1972. Naturaliste Can. 101:559-593.

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

________. 1976*a*. Status of moose populations in interior Alaska. Wildl. Info. Leaf. No. 2. Alaska Fish Game. 4pp.

________. 1976*b*. Interior moose and moose disease studies. Proj. Prog. Rep. Fed. Aid Wildl. Restor. Alaska Fish Game. 26pp.

Ernest, J. 1974. Snowshoe hare studies. Final Rep. Fed. Aid Wildl. Restor. Alaska Fish Game. 46pp.

Gasaway, W.C. 1975. Caribou survey-inventory progress report, 1973. Pages 27-32 *in* D.E. McKnight, ed. Ann. Rep. Survey-inventory activities, part 3. Fed. Aid Wildl. Restor. Alaska Fish Game.

________. 1976. Moose survey-inventory progress report, 1974. Pages 145-161 *in* D.E. McKnight, ed. Ann. Rep. Survey-inventory activities, part 2. Fed. Aid Wildl. Restor. Alaska Fish Game.

________, O.E. Burris, and D. Haggstrom. 1977*a*. Preliminary observations of factors influencing sightability of moose during spring and summer aerial transect surveys *in* W.C. Gasaway, D. Kelleyhouse, D. Haggstrom, and S. Harbo. Moose census method development. Proj. Prog. Rep. Fed. Aid Wildl. Restor. Alaska Fish Game.

________, D.B. Harkness, and R.A. Rausch. 1977*b*. Accuracy and precision of moose age determination from cementum layers of incisors. Submitted to J. Wildl. Manage. Jan. 1977.

Heimer, W.E. 1975. Interior sheep studies. Final Rep. Fed. Aid Wildl. Restor. Alaska Fish Game. 155pp.

________ and A.C. Smith. 1975. Ram horn growth and population quality - their significance to Dall sheep management in Alaska. Wildl. Tech. Bull. 5. Alaska Fish Game. 41pp.

Jennings, L.B. and W.C. Gasaway. 1976. Moose survey-inventory progress report, 1974. Pages 162-167 *in* D.E. McKnight, ed. Ann. Rep. Survey-inventory activities, part 2. Fed. Aid Wildl. Restor. Alaska Fish Game.

LeResche, R.E., R.H. Bishop, and J.W. Coady. 1974. Distribution and habitats of moose in Alaska. Naturaliste Can. 101:143-178.

Mech, L.D. 1966. The wolves of Isle Royale. U.S. Natl. Park Serv. Fauna Ser. 7. 210pp.

Peterson, R.O. and D.L. Allen. 1976. Ecological studies of the wolf on Isle Royale. Ann. Rep. Purdue Univ., Dept. For. Nat. Res. 16pp.

Pimlott, D.H. 1967. Wolf predation and ungulate populations. Am. Zool. 7(2):267-278.

Rausch, R.A. 1959. Moose calving studies. Pages 27-41 *in* S.T. Olson, ed. Moose management studies. Job Compl. Rep. Fed. Aid Wildl. Restor. U.S. Fish Wildl. Serv. 57pp.

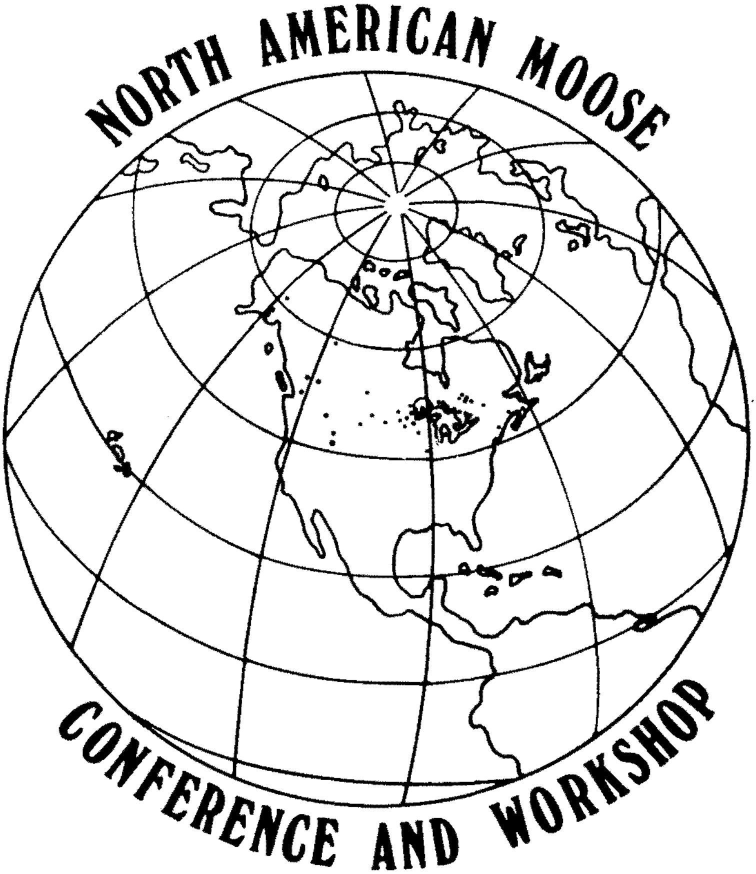
__________. 1966. Alaska Wildlife Investigations: moose studies, 1963-1965. Ann. Proj. Seg. Rep. Fed. Aid Wildl. Restor. Alaska Fish Game. 114pp.

__________. 1967. Report on 1965-66 moose studies. Ann. Proj. Seg. Rep. Fed. Aid Wildl. Restor. Alaska Fish Game. 129pp.

__________ and L. Ellison. 1969. Wolf summer food habits and den studies. Ann. Proj. Seg. Rep. Fed. Aid Wildl. Restor. Pages 1-55.

Stephenson, R.O. and P.E.K. Shepherd. 1977. Wolf report. Final Rep. Fed. Aid Wildl. Restor. Alaska Fish Game.

13th



Jasper, Alberta April 18-21, 1977

100 DELEGATES TO THE 1977 CONFERENCE ATTENDED FROM ALL PARTS OF THE MOOSE RANGE OF NORTH AMERICA