TRENDS IN NATALITY AND CALF MORTALITY OF MOOSE IN SOUTH CENTRAL ONTARIO

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Abstract: Spring and winter occurrence of twin moose calves (*Alces alces*) were determined from 1981-1985 in Algonquin Provincial Park, south central Ontario. A technique is described for determining calf production by parturient cows in heavily forested habitat. Occurrence of cows with twins in spring and the following winter varied from a high of 78% and 25% respectively in 1982 to a low of 16% and 4.5% respectively in 1984.

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Popular indicators of reproduction in moose include corpora in ovaries and embryos in uteri (Pimlott 1959, Simkin 1965, Markgren 1969), natality rates, calf-cow or yearling-cow ratios at various times of year (Van Ballenberghe 1979, Bailey and Bangs 1980, Rolley and Keith 1980, Hauge and Keith 1981, Mytton and Keith 1981, Gasaway et al. 1983, Franzmann et al. 1984) and pregnancies in yearlings or yearlings with calves observed during winter surveys (Pimlott 1959, Simkin 1965, Saether and Haagenrud 1983). While most of these methods can provide accurate postpartum calving rates, many require aerial surveying which is difficult to utilize in heavily canopied forested areas.

The present study documents natality rates in Algonquin Provincial Park, Ontario by using a ground survey technique for estimating natality rates in a heavily forested area. In addition postpartum twinning rates are used in conjunction with subsequent winter twinning rates as indicators of calf mortality.

STUDY AREA

Algonquin Provincial Park is located in south central Ontario between Georgian Bay and the Ottawa River (45°39'N, 78°39'W) and is approximately 7,314 km^2 in area. Observations for this study were confined to the western half of Algonquin Park excluding Clyde and Bruton Townships. The study area is of irregular topography with mixed forest over granitic bedrock. It is within the Algonquin-Pontiac Section of the Great Lakes - St. Lawrence Forest Region (Rowe 1972). Hunting of moose has been prohibited within the study area since 1886 (see Addison 1974).

Densities of timber wolves (Canis lupus) in south central Ontario range from 1 wolf/60 to 1/130 km^2 (Kolenosky 1981). Densities in the park, however, may be lower. Black bear (Ursus americanus) densities within a hunted population in south central Ontario vary from 0.2 to 0.65/km^2 (Kolenosky, pers. comm.), but may be higher within the study area where bears are not hunted. Moose densities increased from 0.12 to 0.18/km^2 in 1974 and 1975 (Wilton and Pashuk 1982) to 0.5/km^2 in 1984.

METHODS

A total of 145 islands in 34 lakes were surveyed from May 6-31, 1981. Survey teams consisted of 2-5 people and 1-2 Norwegian elkhounds. Dogs were used only in 1981. Researchers surveyed whole islands by walking parallel transect lines within site of adjacent staff. Communication using 2-way radios helped maintain a coordinated search line. The dogs were allowed to run free. Most islands were surveyed within 30 minutes with larger islands sometimes requiring approximately 2 hours to complete. Fresh signs of moose (pellets, tracks, bedding sites, afterbirths) were recorded as were the number and sex of moose observed.

Techniques were generally similar in subsequent years with searching being conducted within the last three weeks of May. Fewer islands were checked than in 1981 but searches included weekly monitoring of all islands used previously for calving. Radio-collared cows in mainland habitats led to increased searching of mainland areas from 1982 to 1984 (Table 1). Two cows were radio-collared in May, 1982

and 6 in May, 1983. An additional 13 cows were radio-collared from a helicopter when the moose were feeding in deep water during June, 1983. No cows were immbolized in 1984. All calves were removed from each of 9 and 7 cows in May 1981 and 1982, respectively, for experimental studies on the health of captive moose.

Winter twinning rates were established in the years 1981-82 through 1984-85 by flying randomly located non-overlapping transects, using rotary wing (3 years) and fixed wing (1 year) aircraft. Cows were located and checked for the presence of calves. Mean survey dates were as follows: December 29, 1981; February 10, 1983; January 16, 1984; February 8, 1985.

Trends in calf mortality are determined by calculating differences in postnatal and winter twinning rates and comparing these differences between years. The occurrence of twins (twinning rate) is expressed as the number of cows with twins divided by the number of cows with calves times 100. The G-test was used to test for independence of twinning rates between years. Sources of heterogeneity were identified using a replicated test for goodness of fit (pgs. 728-730 in Sokal and Rohlf, 1981).

RESULTS

The occurrence of cows with twins in spring and during the following winter varied from a high of 78% and 25% respectively in 1982 to a low of 16% and 4.5% respectively in 1984 (Table 1). Twinning rate changed over years for both spring and winter surveys ($P<0.05$)(Tables 1 and 2). In spring, incidence of twins were similar from 1981 to 1983

($\underline{P}>0.05$) but dropped sharply in 1984 ($\underline{P}<0.05$)(Table 2). Data for 1983 appeared intermediate in both spring and winter (Table 1).

The majority of postpartum cows encountered in May were not previously radio-collared (Table 1). Most postpartum cows were observed on islands during the first 3 years but 7 of 24 cows in 1984 were found in mainland habitats (Table 1).

Spring and winter records of the number of calves for specific radio-collared cows were too few to warrant calculation of changes in calf:cow ratios.

DISCUSSION

A ground census for natality in moose has both advantages and disadvantages when compared with aerial censuses. Advantages include the ability to survey moose in heavily forested areas. In addition, information on the location of calving sites and postpartum beds and browsing in the area of beds can be documented. The technique, however, is labour intensive, time consuming, calves which are hiding may still be missed and the technique is likely to provide small sample sizes. For these reasons an effective ground search for the incidence of newborn calves may only be realistic in areas where moose are abundant such as the western half of Algonquin Park.

Neither ground nor aerial surveys census equally for those cows with and without calves. Forty-seven parturient cows or cows with neonates were found on islands during the present study (Table 1), yet yearling cows, barren adults and bulls were rarely seen. It is for this reason that twinning rates among cows with calves rather than calf-cow

ratios are used to compare natality between years or studies (areas) and to compare losses of calves over time within a year.

Our ground survey method may have biased estimates of twinning. If islands are preferred calving sites, and cows in superior condition are more likely to have twins, then cows observed on islands might have a high twinning rate. There are few data to indicate whether this may or may not be true. However the 1984 data do not support this logic: on islands there were 1.18 calves per cow (n=17), while on the mainland there were 1.14 calves (n=7). More data from years with higher incidence of twinning will be required to accurately compare twinning rates from islands and mainland sites. While early removal of neonatal calves from cows in 1981 and 1982 might have resulted in better nutritive condition and higher ovulation rates in cows (see Verme 1965, 1967, 1969), we saw no evidence of increased twinning in those cows the following years. Survival rate of calves may also have differed between island and mainland calvings. Comparison of survival rates cannot be done because calves were not radio-tagged and because of the few radio-tagged cows in the sample (see Table 1).

Our surveys occurred early in the calving season and were limited later as leafout reduced visibility. Our results might be biased since there may be an indirect relationship between fetal biomass and gestation period and since total fetal weight of twins is usually greater than for single fetuses (see Verme 1965). We saw no evidence that twins were more frequent early in calving, but since our surveys lasted only 2-3 weeks, and we did not know exact birth dates, we were unlikely to observe such an effect. The low twinning rate observed in

1984 probably would not be a result of bias, since the surveys were conducted at comparable times in all 4 years and start of calving period seemed consistent (May 10-16) between years. Even if surveys could have continued to the end of the calving period, results might have been misleading. An increasing number of calves are lost to predation and other causes of death with increasing time postparturition (Van Ballenberghe 1979). Wolves and black bears have been identified as predators of moose in south central Ontario (Voigt et al. 1976, Wilton et al. 1984). Predation likely had little effect on the trend in twinning over the 4 years, however, since there were no signs of wolves or bears having been at any of the 55 calving areas examined, and all spring surveys were conducted during the initial stages of calving each year.

Twinning rates for Ontario moose previously calculated using other techniques were much lower than postnatal twinning rates observed in Algonquin Park in 1981 and 1982. Twinning rates in northwestern Ontario as determined from corpora in ovaries from 1957 to 1961 were 29% (of those cows pregnant) (Simkin 1965) while a twinning rate of 54% was recorded for cows killed by autos in winter in north central Ontario (Snider 1979).

Postnatal twinning rates in 1981 and 1982 in Algonquin Park were high when compared to rates reported elsewhere in North America (Tables 1 and 3). Higher spring twinning rates in 1981 and 1982 of the present study, as compared to most other studies may in part be due to a reduced impact of predation because of the completion of our survey by the end of May. Most surveys for neonates extend into June (Table 3). In

addition, it is possible that more calves would be missed in an aerial survey (see Hauge and Keith 1981) (particularly with fixed-wing aircraft) than during a ground survey. Even with consideration of variations in survey techniques between studies, the postpartum twinning rates in Algonquin Park in 1981 and 1982 were high. High spring twinning rates in North American moose comparable to those in Algonquin Park in 1981 and 1982 have been documented only for moose near Rochester, Alberta and moose on the Kenai Peninsula, Alaska (Table 3).

The decline in postnatal twinning rate from 1981 and 1982 through to 1984 in the present study may be influenced by our survey techniques as well as a complex of biological factors. One factor which influences ovulation rates in ungulates is the nutritional condition of females. White-tailed deer held experimentally on a high plane of nutrition demonstrate higher ovulation rates than do deer on a low plane of nutrition (Verme 1965, 1967, 1969). Twinning in moose in good habitat may be higher than in moose on poor quality range (Franzmann and Schwartz 1985). It seems unlikely that twinning in the herd in the western half of Algonquin Park would have been so high in the springs of 1981 and 1982 without abundant reasonable quality food being available. However, it is perhaps equally unlikely that the rapid decrease in spring twinning could be attributed only to changes in moose densities and the quality of the range. The age structure of the herd (see Perovsky 1974) may be of particular importance in influencing changes in fecundity of expanding moose herds such as the Algonquin herd.

An alternative explanation to the decline in postnatal twinning rate is that in spite of the statistical support for suggesting a decline, it was more perceived than real as influenced by the small sample of data. However, the decline in winter twinning rate supports the view that the decline in postnatal twinning rate was real.

Measures of natality not only provide indicators of population trend but also of the magnitude of postnatal mortality when accompanied by subsequent surveys. There was a 68-89% decrease in the occurrence of twins in cow-calf groups during the first 7-9 months during the present study (Table 3). In Alaska Gasaway et al. (1983) observed a 56-72% decrease in occurrence of twins within the first 6 months in 1977 and 1978 from an initial postnatal twinning rate of 32%. Proportional decrease in twinning may exceed the total calf loss in the herd if a cow with twins is more likely to lose one of her two calves to predators or other threats than is a cow with a single calf. Thus, changes in twinning rate may reflect trends, but not absolute values, of calf mortality.

Estimates of the condition of populations require measures of population trend and mortality in addition to population indices (Caughley 1974). Additional emphasis should be placed on obtaining data on natality and calf mortality.

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Table 1. Occurrence of moose calves as twins in spring[1] and winter surveys, Algonquin Park.

Year	Calving Location		Parturient Cows collared previously (collared/total)	Twinning Rate[2]		Loss of twin groups[3]
	islands	mainland		spring(n)	winter(n)	
1981-82	11	0	0/11	72.7(11)	14.7 (34)	79.8
1982-83	8	1	3/9	77.8(9)	25.0 (32)	67.9
1983-84	11	0	2/11	45.4(11)	4.8 (21)	89.4
1984-85	17	7	7/24	16.7(24)	4.5 (44)	73.1

[1] All moose observed between 11 May and 31 May.

[2] Number of cows with twins/number of cows with calves x 100.

[3] Spring twinning rate - winter twinning rate/spring twinning rate x 100.

Table 2. Results of G-test of independence of twinning rates between years[1]

Survey period	Years of survey			
Spring	1982	1981	1983	1984
Winter	1982	1981	1983	1984

[1] Years not underscored by the same line are significantly different ($\underline{P}$<0.05).

Table 3. Early postnatal twinning rates determined by aerial census of North American moose poulations

Type of survey: Locality	Time	Year	Twinning rate[1] (%)	Reference
Alaska, Kenai	23 May-19 July	57-71	4-38	Bailey and Bangs (1980)
Alaska, Kenai				
1947 burn	late May-early June	77-98	22	Franzmann et al. (1985)
1969 burn	late May-early June	82-83	70	Franzmann et al. (1985)
Alaska				
interior	May-June	77-78	32	Gasaway et al. (1983)
south central	May-June	57-64	30	Rausch and Bratlie (1965)
south central	31 May-1 June	65	16	LeResche (1968)
Alberta				
northeastern	21 May-22 June	76	22	Hauge and Keith (1981)
	17 May-22 June	78	35	Hauge and Keith (1981)
Rochester	late May	76	88	Mytton and Keith (1981)

[1] Number of cows with twins/number of cows with calves x 100. Rates from some studies are for adult moose ($\geq$ 3 years of age) only, others for unaged moose.