

REPRODUCTIVE PRODUCTIVITY OF  
MOOSE IN NEW BRUNSWICK

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Abstract: Natality of moose (*Alces alces*) is reported from examination of reproductive tracts from 76 cows found as non-hunting mortality in southeastern New Brunswick. Adult and yearling pregnancy rates were 79% and 39%, respectively. Twinning rates were estimated at 26%. Reproductive productivity of moose in New Brunswick compared favourably with other areas of North America.

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Reproductive productivity is a result of dynamic processes operating in animal populations. Simulation models and life tables combine fecundity and mortality schedules to give insight into the dynamics of populations and rates of increase ( $\lambda$  or  $r$ ). Fecundity and the magnitude of other losses limit the role of hunting in shaping wildlife populations.

Because sexual maturity can be reached at 1.5 or 2.5 years in moose (*Alces alces*), recruitment is usually calculated as yearling females per yearling plus adult female in the

harvest (Simkin 1965). If adult survival is relatively constant, then recruitment is dependent on two proximate factors, the number of calves born the previous year and the number surviving to their second autumn. While recruitment can be an important measure of population performance, it is a statistic which hides important information about causal links. Highly fecund populations with high neonate loss during first winter could exhibit recruitment similar to those that produce relatively few calves which survive well. Selection of an appropriate management strategy to alter recruitment is dependent on understanding which of the two scenarios or intermediate combinations is correct. As part of a population modelling exercise to explore the role of hunting on moose, productivity (number of calves produced per cow) in southeastern New Brunswick was examined.

#### METHODS

Pregnancy rate and litter size were determined from female moose found dead (from vehicle collisions, accidents, and poaching) during 1980-1986. Animals were assigned to three groups: postpartum (10 June-14 Sept.), breeding (15 Sept.-31 Oct.), and pregnant (1 Nov.-9 June). Moose were classed as calves (age class 0), yearlings (age class 1) and adults (age classes 2, 3 and 4+). Calves and yearlings were identified on the basis of tooth wear and replacement (Passmore *et al.*, 1955). Age of adults was determined by cementum annuli of the first molar (Wolfe 1969).

Reproductive tracts and lower jaws were collected year-round from these nonhunting mortalities. Uteri were macroscopically examined for number and sex of fetuses. Ovaries were not collected prior to October 1984. Ovaries of 44 cow moose found between October 1984 and February 1986 were preserved in 10% formalin.

Each ovary was sectioned dorso-ventrally into 1-2 mm thick slices beginning at the anterior pole. Sections were examined with the aid of a six-power hand lens. Size and content of follicles and presence of luteinized structures (Simkin 1965, Markgren 1969) were recorded. Representative cross-sections or structures of interest were trimmed, embedded in paraffin, cut at 4-6  $\mu$ m thick, stained with hematoxylin and eosin, and mounted. Microscopic examination augmented interpretation of macroscopically identified structures. Stages of follicular development, presence of corpora lutea, albicantia, and hemorrhagica (Priedkalns 1976) were tabulated with the animal's age, date of death, and presence of fetuses or milk in the udder.

#### RESULTS

Six calves, 24 yearling and 46 adult females were found as nonhunting mortalities in southeastern New Brunswick between 1980 and 1986. These animals were distributed as follows: postpartum period - 1 calf, 9 yearlings, 9 adults; breeding period - 2 yearlings, 4 adults; pregnancy period -

5 calves, 13 yearlings, 33 adults. Five of 13 yearlings (39%) examined between November and June were pregnant. Adult pregnancy rate was 79% (N=33). Age was determined for 19 of these adults. Incidence of twins was highest in females  $\geq$  age class 3 (Table 1). None of the yearlings and only one of eight (13%) adults in age class 2 carried twins. A twinning rate of 26% (8/31) among cows with calves was calculated from examination of pregnant cows. Male : female ratios of fetuses and neonates appeared close to parity, 13:17 and 6:5, respectively.

Table 1. Numbers of fetuses carried by known age cows examined between November and May in southeastern New Brunswick 1981-1985.

Age Class	N	Number of Fetuses			
		0	1	2	Unknown
1	13	8	5	0	-
2	8	2	5	1	-
3	7	1	3	3	-
4+	4	0	1	1	2

Ovaries of 43 of 44 moose contained both developing and atretic follicles. The exception was a pair of ovaries from a calf killed 8 September. Developing follicles were present in the ovaries of the calf but none were near

maturity and there was no evidence of atretic follicles. Ovaries of five calves killed after 15 December each contained developing and atretic follicles but no evidence of ovulation.

Nineteen moose killed during the postpartum period were examined. Ovaries from the single calf contained neither developing nor atretic follicles. One of seven 2-year-olds was lactating; a corpus luteum was found in one of her ovaries. Two cows  $\geq 3$  years old were lactating; both contained corpora albicantia and one a corpus luteum. Nine yearling cows contained neither corpora lutea nor prominent corpora albicantia, indicating that none had ovulated as calves.

During the breeding period, six cows ( $\geq$  age class 1) were examined. All four females beyond age class 2 were still lactating. Their ovaries contained remnants of corpora lutea which differed macroscopically from corpora albicantia only in being larger in size. Size of corpora lutea scars of earlier ovulation/pregnancies decrease and distortion of scars increases rapidly as breeding season begins (Markgren 1969). Neither of the two yearling cows examined contained corpora lutea of estrus but one did contain a corpus hemorrhagicus indicative of recent ovulation.

Three of six yearling females examined during the pregnancy period were pregnant. Each carried a single fetus, and a well developed corpus luteum of pregnancy was

evident. Two of seven other yearling females were pregnant but ovaries were not collected. Among eight adult cows (age class  $\geq 2$ ) three were carrying single fetuses and one was carrying twins. Prominent corpora lutea were found in one or both ovaries of each pregnant cow. Several ovaries also contained corpora albicantia of varying size. Twenty-two of 25 adult females for which ovaries were not collected were pregnant. Ovaries from five calves contained both developing and atretic follicles.

#### DISCUSSION

Calf production is the product of a complex chain of biological processes including estrous cycles, rutting behavior and breeding, fertilization, prepartum events and parturition. Widespread evolution of iteroparity likely is evidence of a long history of density-dependent population regulation (Hairston *et al.* 1970), implying that fecundity changes with density. Rates of increase and gross productivity were reported to be lowest during periods of high moose density (Blood 1974), reflecting the fundamental process of inversivity. Moose fecundity may be inversely related to density as moose affect their food supply, as has been documented for red deer (*Cervus elaphus*) on poor quality range (Mitchell and Brown 1974) and for moose in Norway (Saether and Haagenrud 1983). While a general inverse relationship of fecundity to density-induced

reduction of resources is predicted (Skogland 1986), the relationship remains unquantified for moose in southeastern New Brunswick. Concomitant with the comparatively mild maritime climate of southeastern New Brunswick, the impact of winter weather on productivity was considered to be minimal.

Productivity of moose in southeastern New Brunswick as reported here compared favourably with that reported elsewhere (Table 2). Adult pregnancy rate was near the midpoint of the range of reported values. Twinning rates were similar to the 22% recorded in "poor" quality habitat at Kenai, Alaska (Franzmann and Schwartz 1985). Geist (1974) speculated that selection pressure should favour twins on optimum range. Twinning rates in adult cows and yearling pregnancy rates are the most "flexible components" of reproductive performance in moose (Blood 1974). The signals are somewhat mixed in southeastern New Brunswick: yearling female pregnancy rates were high in this study while twinning rates were not. A low twinning rate is not, in itself, evidence of overpopulation and associated diminution of range quantity; rather, it may reflect some "qualitative" characteristic of the range (Franzmann and Schwartz 1985). Comparisons in twinning rates between populations must be made cautiously. However, chronic changes in twinning rates are indicative of changes in demographic vigor within populations, important information for wildlife managers.

Table 2. Productivity data on moose reported in other studies.

Area	Source	N	% Pregnant		Fetus Per Female		% Twinning Rate		Comments
			Yrlg	Adult	Yrlg	Adult	Yrlg	Adult	
British Columbia Wells Gray Park	Edwards & Ritcey (1958)	95	0	76	0.00	1.16	0	23	Fetus per female from Blood (1974).
Newfoundland	Pimlott (1959)	317	46	81	0.47	1.00	2	14	Fetus per female from Simkin (1974).
Montana	Peek (1962)	18	0	71	0.00	0.71			Fetus per female from Blood (1974).
Northwestern Ontario	Simkin (1965)	99	17	87	0.17	1.13	0	29	Microscopic examination of scars (1957-61).
Sweden Boda Bruk	Markgren (1969)	97					0	37	Proportion twins in cow/calf groups recorded in the National forests (1961- 1967).
Hamra		17					0	12	

Table 2. (cont'd.)

Area	Source	N	% Pregnant		Petus Per Female		% Twinning Rate		Comments
			Yrlg	Adult	Yrlg	Adult	Yrlg	Adult	
Montana	Schladweiler & Stevens (1973)	95	32	86	.32	1.00	0	16	Macroscopic examination of uteri.
Alberta Elk Island Park	Blood (1974)	454	29	85					Combination of high and low population densities.
Rochester	Rolley & Keith (1980)	283			1.06	41			Combined for yearlings and adults.
Alaska Kenai Peninsula 1977-78	Frantzmann & Schwartz (1985)	49				22			Poor hab. tat.
1982-83		102				70			Good hab. tat.
Maine	Morris (pers. comm. 1985)	355	41	71					Lactating females in harvest (1980, 82, 84).
New Brunswick	Present Study	46	39	79	0.39	1.12	26		

Bishop and Rausch (1974) speculated that low bull densities may be responsible for decreased production, by reducing conception rates or prolonging the breeding season resulting in a wide range of calf birth dates and, perhaps, increasing mortality for late born calves. Most cow moose come into estrus at the same time, with up to four cycles in autumn (Edwards and Ritcey 1958). Courtship rituals require a bull to tend a cow for several days. It is reasonable that the population of males can be reduced from parity by only a finite amount before impairment to breeding success occurs. The critical sex ratio (% males) below which calf production is reduced likely varies inversely with population density. Crête *et al.* (1981) proposed that at least 40 adult bulls were needed to successfully breed 60 adult females in Quebec; densities were slightly higher than in the New Brunswick area. Males comprise an estimated 40% among adults in southeastern New Brunswick (A.H. Boer unpubl. data). While reproductive impairment is not evident in pregnancy rates, the adult sex ratio is speculated to be at or near the threshold level.

An even sex ratio appears normal for un hunted moose populations (Peterson 1955). In Fundy National Park where moose are not hunted, just south of the current study site, a 50:50 sex ratio occurred in both sighting records and carcasses found (Kelsall 1963). Disparity in adult sex ratio in the current study site probably is the consequence of differential hunting mortality, in which harvesting



occurs during the rutting period; 65% of the adult harvest in New Brunswick is male (A.H. Boer unpubl. data). Since adult sex ratios below some threshold level are causally linked to reduced breeding success male vulnerability to hunting has consequences for natality rates and ultimately, population dynamics. Wildlife managers require both an understanding of how adult sex ratio responds to alternate hunting strategies and an ability to predict consequences of various adult male:female ratios on calf production.

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