SOME ASPECTS OF MOOSE-VEHICLE COLLISIONS IN EASTERN NEWFOUNDLAND, 1973-1985

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Abstract: From 1973 to 1985, the date, sex and age, location and time of moose killed on the Avalon Peninsula in eastern Newfoundland were recorded. Traffic volume patterns, converted to a sunrise-sunset regimen of 8 daily time periods for each month, were related to these moose-vehicle collisions. Throughout the year most moose were killed in the first few hours after sunset, but moose vulnerability to collisions in summer was greatest near sunrise, suggesting moose were more frequent/active near roadways during this time. Males were disproportionately represented in road-kills, and were particularly vulnerable in June, July and October. Yearling proportions in road-kills were highest in June, July, and September, and may be related to dispersal brought on by calving and the rut. The number of female

moose killed in collisions with vehicles each year may presently approach the annual female harvest, primarily due to a conservative harvest strategy which aims for a 3:1 female:male ratio in a growing population. Balancing hunter demand with increasing moose-people conflicts presents a management dilemma not yet investigated in Newfoundland.

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In Newfoundland information on moose-vehicle collisions has been collected by the provincial Wildlife Division since 1973. Objectives have been to: 1. record number of moose killed, 2. identify high-risk sections of roadway, 3. determine circumstances relating to collisions, including date, time, sex and age of moose, traffic conditions, vehicle damage, and human injuries, and 4. obtain various physical measurements of moose, including weight, rumen contents, pregnancy status, and fetal development.

The purpose of this paper is to describe some relationships of season, time, traffic, population characteristics, and harvest of moose to collisions with vehicles on the Avalon Peninsula, as a first step to identify the problem in a management context.

METHODS

Roadways on the Avalon Peninsula with a high incidence of moose-vehicle collisions were chosen for this study: they were the Trans-Canada Highway (Route 1) from St. John's to Route 203, the Southern Shore Highway (Route 10), the Salmonier Line (Route 90), and Argentia Access Road (Route 110). For these roadways (Fig. 1), data on moose killed in collisions with motor vehicles were taken from provincial Wildlife Division records and Royal Canadian Mounted Police (R.C.M.P.) reports for the years 1973 to 1985.

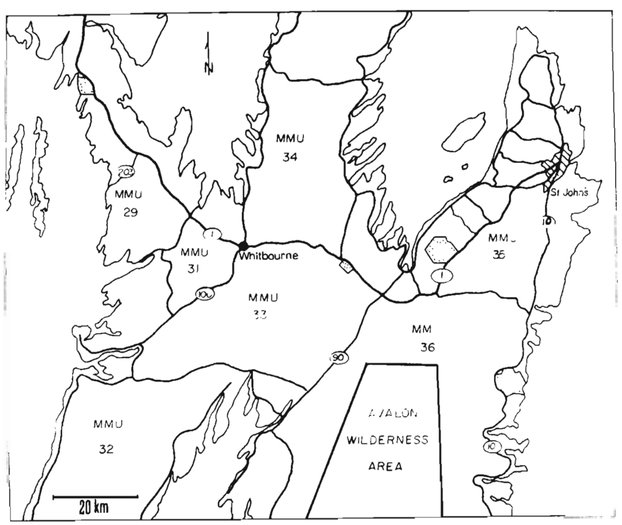

Figure 1. Location of major roadways on the Avalon Peninsula, Newfoundland.

One or more of the variables for 675 confirmed road-kills during the 13 years were date, time, and sex and age of moose. Four hundred and eighty-four kills on a 50 km commuter stretch of Trans-Canada Highway between St.John's and Whitbourne (Fig. 1) were related to 1979 hourly traffic volume data, obtained from a Newfoundland Department of Transportation counter 1 km west of the St.John's city limits.

Traffic patterns, and daily and seasonal distribution of moose-vehicle collisions were analysed by converting each 24 hours to 8 daily time periods for each month, based on local sunrise-sunset curves (Fig. 2). Ages and sex ratios of road-kills were compared to those obtained from aerial classifications and hunter return information. Road-kill mortality was compared to various aspects of the annual moose harvest for the years 1973 to 1985.

RESULTS

Mean daily traffic, and number of moose killed was highest in July and August (Fig. 3). Vulnerability of moose to collisions, expressed as moose killed per vehicle, was disproportionately high during the months May to September. Traffic volume, adjusted to seasonal changes in time of sunset and sunrise, steadily decreased from late afternoon to early morning in both summer (May to October) and winter (November to April), then increased sharply to sustained

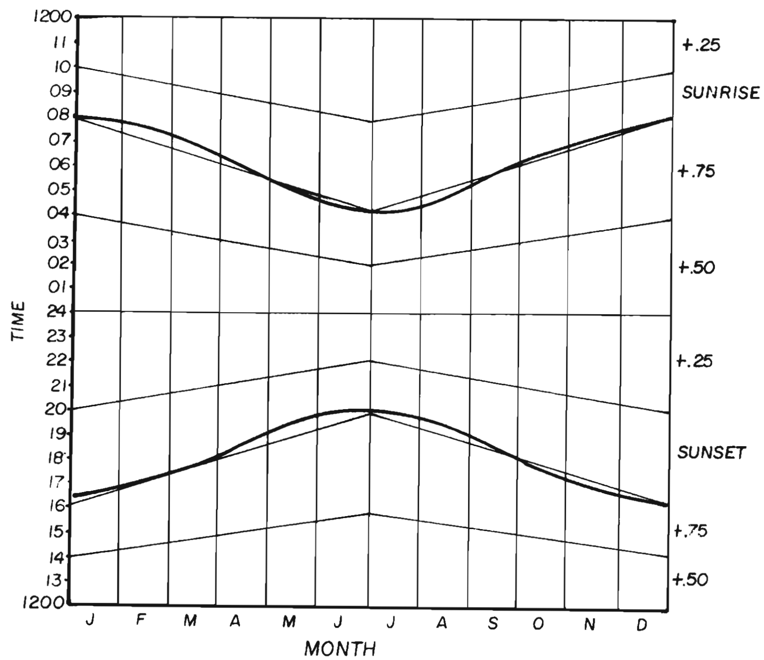

Figure 2. Sunset-sunrise curves and daily time periods for each month used to describe patterns of traffic volume and moose-vehicle collisions on the Avalon Peninsula.

daytime highs (Fig. 4a). Nightime traffic volume was similar in summer and winter.

Moose killed in collisions with vehicles in summer increased near sunset and immediately after, then gradually declined during

the night to a sustained daytime low (Fig. 4b). The pattern of winter kills was similar, but of much lower magnitude. In summer, traffic volume decreased faster than moose killed as the night progressed, to approximately 2-3 hours before sunrise, when traffic volume was lowest, and moose vulnerability was highest (Fig. 4c). This pattern suggests that moose activity was not constant during the night in summer, and moose were more frequent/active near roadways in the 2-3 hours preceding sunrise. Collision rates were similar throughout the night in winter.

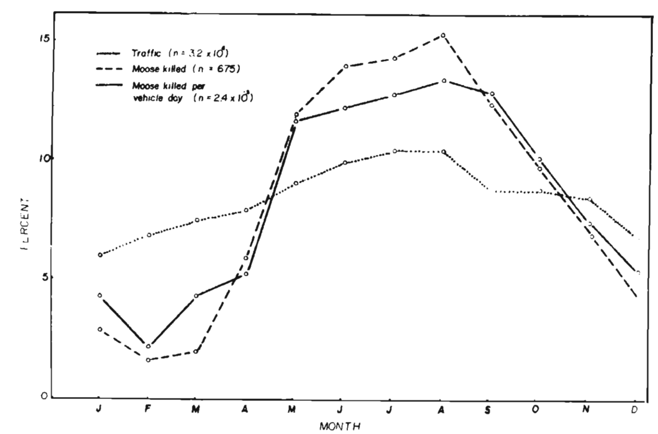

Figure 3. Seasonal distribution of traffic, moose killed, and moose killed per vehicle on the Avalon Peninsula.

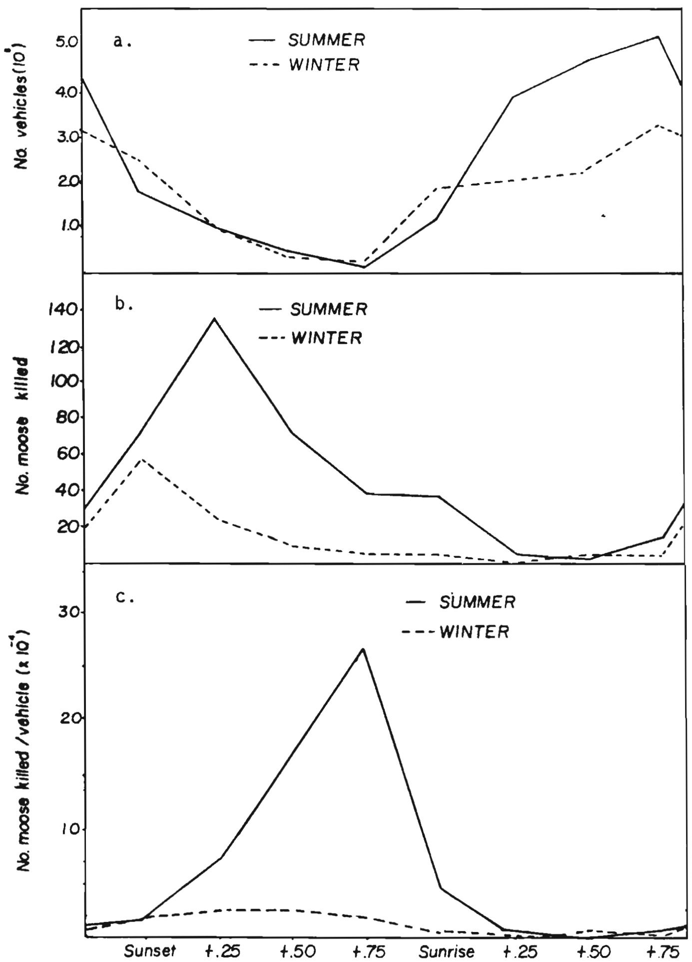

Figure 4. Daily distribution of traffic, moose killed, and moose killed per vehicle in summer (May-October) and winter (November-April) on the Avalon Peninsula.

The proportion of males, excluding calves, in road-kills was significantly greater ($p < 0.05$) than the proportion derived from aerial classifications and hunter returns (Table 1). Collisions with adult females were significantly less ($p < 0.05$) than with adult males in June, and also less, but not significantly in July and October (Fig. 5). Yearling proportions in road-kills, excluding

Table 1. Sex ratio of adult moose on Avalon Peninsula[1] from aerial classifications, hunter observations, and road-kills.

Year	Percent ♂♂ in aerial classifications	Percent ♂♂ seen by hunters	Percent ♂♂ in road-kills
1973	43 (271)[2]	36 (501)	53 (91)[5]
1978	40 (260)[3]	41 (441)	54 (242)[5]
1985	36 (503)[4]	36 (795)	47 (227)[5]

[1] Moose Management Units 31, 33-35; sample size in brackets
[2] Fall classification
[3] Winter classification
[4] Winter classification of MMU 36
[5] Combined years 1973-75, 1976-80, 1981-85 respectively

calves, were highest in June, July, and September (Fig. 6).

Female road-killed moose, as a percent of their annual legal harvest, have since 1977 been approximately double that of males

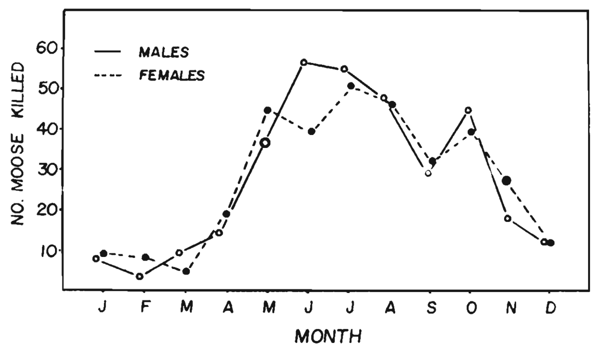

Figure 5. Monthly distribution of adult male female moose killed in collisions on the Avalon Peninsula.

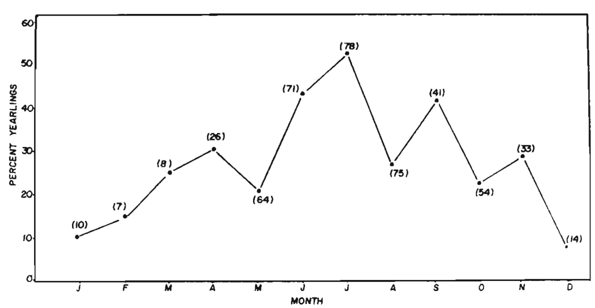

Figure 6. Monthly distribution of proportion of yearling moose killed in collisions on the Avalon Peninsula. Number in brackets is sample of moose of known age, excluding calves.

(Table 2). This has been due primarily to a disproportionate harvest favouring males, and secondarily to the greater number of females in the population (Table 1). The magnitude of road-kills may be substantially larger than indicated, since these figures are based largely on Wildlife Division records.

License sales on the Avalon Peninsula have been reduced since the late 1970's with the intent to increase moose numbers. Hunter return statistics indicate a dramatic population increase since 1982, and improved hunting success has maintained a consistent total harvest (Table 2), even though harvest levels have not kept pace with the growing population.

DISCUSSION

Although for white-tailed deer (Odocoileus virginianus) and mule deer (O. hemionus) roadway mortality appears to be greatest during late autumn (Bellis and Graves 1971, Puglisi et al. 1974, Allen and McCullough 1976), moose mortality is greatest during the summer months (Grenier 1973, Fraser 1979, Damas and Smith 1982, Hardy 1984). In our study, moose vulnerability to collisions was greatest from May to September, suggesting that moose were more prevalent near roadways in summer than winter. Grenier (1973) and Fraser (1979) both implicated road salt as the major factor attracting moose to roadways, but this has not yet been investigated in Newfoundland.

Table 2. Male and female road-killed moose, 1974-1985, compared to various harvest components in Moose Management Units 31, 33-35 on the Avalon Peninsula.

YEAR	LICENSES ISSUED[2]			MOOSE KILLED[3]			ROAD-KILLED MOOSE[4]				HUNTER STATISTICS[5]			POST-HUNT POPULATION	
	ES	MO	TOTAL	MALES	FEMALES	TOTAL	MALES	PERCENT OF MALE HARVEST	FEMALES	PERCENT OF FEMALE HARVEST	SUCCESS RATE	DAYS HUNTED PER SUCCESSFUL HUNTER	MOOSE SEEN PER DAY HUNTED	ESTIMATE[6]	HARVEST PERCENT
1974	324	354	678	171	78	249	20	11.7	12	15.4	37	14.3	0.30	-	-
1975	408	176	584	135	137	272	28	20.7	21	15.3	47	9.1	0.55	-	-
1976	556	135	691	174	184	358	28	16.1	22	11.7	52	7.7	0.60	3254	11.0
1977	420	420	840	246	144	390	26	10.6	25	17.4	46	9.1	0.54	2939	13.3
1978	420	440	860	316	168	484	29	9.2	29	17.3	56	9.1	0.41	2374	20.4
1979	210	290	500	226	103	329	40	17.7	25	24.3	66	9.1	0.52	3109	10.6
1980	220	300	520	268	99	367	31	11.6	21	21.2	71	8.3	0.60	3974	9.5
1981	195	360	555	314	109	423	28	8.9	21	19.3	76	7.7	0.64	4008	10.6
1982	120	290	410	238	62	300	28	11.8	17	27.4	73	6.3	0.92	4554	6.6
1983	150	240	390	232	112	344	27	11.5	33	29.5	88	5.8	0.86	4881	7.0
1984	170	240	410	261	97	358	16	6.1	28	28.9	87	6.3	1.13	6238	5.7
1985	215	220	435	251	120	371	28	11.5	31	25.8	85	5.8	1.08	6949	5.3

1 Moose Management Units 31, 33-35
2 Either-sex, male-only licenses
3 Adjusted for non-response, includes calves
4 Wildlife Division records only; includes calves; data collection inconsistent from year to year
5 Either-sex and male-only licenses combined, adjusted for non-response; includes calves
6 Aerial quadrat surveys for MMU 31,33 (1978); MMU 34,35 (1982) adjusted by "moose seen per day hunted"

Conclusions about ungulate-vehicle collisions can be misleading if observations are not seasonally adjusted to changing times of sunrise and sunset in mid- and northern latitudes. Most studies record traffic patterns and collision times in terms of a standard 24-hour period (Williams 1964, Carbaugh et al. 1975, Allen and McCullough 1976, Sanderson 1983, Hardy 1984), although Grenier (1973), Carbaugh et al. (1975) and Allen and McCullough (1976) related collisions to an unspecified time of sunrise and sunset. In this study we related traffic volume and moose-vehicle collisions to seasonal changes in times of sunrise and sunset.

Traffic patterns in southern Michigan in 1966-67 (Allen and McCullough 1976) were similar to those on the Avalon Peninsula in 1979, in that traffic volume during the day was high and decreased steadily during the night to sunrise. Whereas Allen and McCullough (1976) reported a positive correlation between traffic volume and deer-car accidents from 1800 to 0700 (darkness?) throughout the year, we found that was the case for moose only in winter (November to April). In summer, traffic volume and moose-vehicle collisions were negatively correlated, suggesting that during the hours of darkness moose activity near roadways was greatest several hours before sunrise.

Whether increased moose activity during the early morning hours is a result of less traffic, as Damas and Smith (1982) suggested, or is a behavioural pattern independent of traffic, has yet to be determined. In the absence of traffic data, Grenier (1973) concluded that moose activity was greatest between 2000 and midnight. Others, including McMillan (1954), Denniston (1956), DeVos (1958), and Geist (1963) reported high activity periods at dawn and dusk.

Our data indicate that adult male moose were more vulnerable to collisions with vehicles than females. Male peaks in June and July may be due to females with calves traveling less during the calving and post-calving season. High yearling road-kills in June, July, and September may be related to dispersal brought on by calving, as well as the rut, when yearlings are often displaced by adult animals.

For white-tailed deer Jahn (1959), Bellis and Graves (1971), Puglisi et al. (1974) and Allen and McCullough (1976) reported a preponderance of males in the spring and fall accidents, although for each case the sex ratio in these populations was unknown. In Laurentides Park, Quebec, the road-kill sex ratio was similar to a small aerial sampling of the population (Grenier 1973), and where selectivity for males in the hunt was intense.

Since females account for a relatively small (25-30%) proportion of the annual legal harvest on the Avalon Peninsula, and outnumber males almost 2 to 1 in the population, the number of females killed in collisions each year compared to the annual female harvest is more than double that for males. Wildlife Division records indicate that female road-kills each year are now nearly 30% of the annual

female harvest. Other sources of information, such as Motor Vehicle Accident Reports, suggest that many more moose are crippled or killed by vehicles (Oosenbrug and McNeily 1986), and female moose killed in collisions with vehicles may actually approach the annual female harvest.

This situation presents a dilemma for management, in that hunting demand for moose in this province, and especially in eastern Newfoundland is intense. Our management strategy has been to work toward a 3:1 female:male ratio in the population, by means of a restricted female harvest, and liberal male harvest. The overall harvest has been light to encourage growth of the moose population. Although Wildlife Division road-kill records are inconclusive, hunter return statistics and limited aerial inventory from the last 7 years indicate a substantial increase in moose numbers in eastern Newfoundland. Increasing public perception of moose as a problem for motorists, as well as for farmers and municipalities, presents a conflict situation where lowering moose numbers may soon no longer be an option we will be able to resist.

More desirable solutions involve mitigational procedures, many of which have been summarized by Damas and Smith (1982) and Sanderson (1983). These solutions however require a measure of investigation, which to date has not been attempted in Newfoundland. An understanding of moose activity in the vicinity of roadways, and farms for example, is one line of enquiry essential to any harvest strategy aimed at reducing moose numbers in specific problem areas. Beyond this, a public education program to alert drivers to the times and locations of greater risk may for now be the best overall approach to the problem.

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