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SUMMER FOOD HABITS OF WOLVES WITH THE EMPHASIS ON MOOSE IN RIDING MOUNTAIN NATIONAL PARK

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Abstract: Analyses of wolf scats collected in summer in Riding Mountain National Park, Manitoba, show that moose are a relatively rare prey item. This immunity extends to the calves, and a fall classified count has shown a ratio of calves:100 cows of 64.6. Predation pressures are absorbed by less well defended species: elk and beaver are abundant and are heavily preyed upon.

An important, and often controversial aspect of the ecology of ungulates is the predation pressure on the new-born. Theoretically, young defenceless animals are more vulnerable to predation, and if the food requirements of a carnivore at a certain time of year are completely, or partially, satisfied by young, it can be assumed that the impact of predation on an ungulate population is greater than if the predation falls on the adults.

Recruitment of young into the reproductive cohort is a key factor in the status of an ungulate population; hence, wolf (Canis lupus) predation on calves can have a significant influence on the available harvestable surpluses of moose (Alces alces) for human consumption. The present study was carried out in an area without human harvest of moose, although ungulates are hunted in areas surrounding the park.

Wolves in Riding Mountain National Park have available a number of potential prey species. The research was directed towards long-term park management programs as implied by National Parks Policy and forms part of a more comprehensive large mammal system study (Carbyn 1976). This paper analyzes data emphasising predation by wolves on moose calves during the post-natal period up to the age of about 3 months.

Immediately after birth, moose calves generally remain with the cows (follower type), in contrast to elk calves which are "hider type". This allows the cow to defend its young (defender type) agains predation (Stringham 1974). Calves remain with cows for about one year and are usually weaned just before the birth of the next calf, but often may remain with the cow for 1½ years (Stringham 1974). As the calves grow they become more mobile, and the mid-winter observations have shown a very definite defensive strategy of cows protecting calves (Peterson 1977). A healthy moose cow can be a formidable foe in staving off wolf predation, but her effectiveness theoretically decreases in late winter with deeper snow and harder crusts.

Questions remain as to how effectively cows can defend new-born calves when they are being harassed by a number of attacking wolves. These events are seldom observed for moose, as opposed to some other species, such as barren-ground caribou which occupy more open habitat with better visibility.

More direct evidence can be obtained from an examination of wolf scats or through the use of mortality transmitters. Presented in this paper are summer scat collections of a three year predator/prey study in Riding Mountain National Park, Manitoba. Collection of wolf and coyote (Canis latrans) scat form the basis for this report.

Problems associated with using scats as an indicator of food preference are:

a) Difficulty in accurately identifying prey species from faecal remains (Carbyn and Kennedy unpubl. data).
b) Difficulty in inferring numbers of prey taken from scat identifications.
c) The fact that scavenging cannot be separated from predation.

Experimental work has been carried out on the second problem (Floyd, Mech and Jordan 1978), and their conclusions indicate that remains of small prey species occurred in greater proportion relative to the prey's weight and in lesser proportion to the number than was the case for larger prey species.

The degree of scavenging by wolves can indirectly be tested by simultaneously collecting scat samples from a known scavenger i.e. coyotes which are common in the park, thereby indirectly providing another check on calf mortality.

Riding Mountain National Park is an ecological island completely surrounded by agricultural land, and covers an area of 297,849 ha (1,159 sq mi). The moose population in recent years has been stable (about 2,200 animals), despite widely fluctuating wolf numbers. A historical perspective on moose population fluctuations was presented by Rounds (1977). A major increase occurred between 1966 and 1969 and a peak was reached in 1971; there was a decline from 1971 to 1974. Another increase that began in 1975 (Rounds 1977) continued to 1978. In addition to moose and elk (Cervus canadensis), white-tailed deer (Odocoileus virginanus), beaver (Castor canadensis) and snowshoe hare (Lepus americanus) are common prey species in the park. The hare cycle is expected to reach a peak around 1981.

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METHODS

Predator and scavenger scat samples were collected at least three times a month along all major park trails during June, July and August. Regular nocturnal howling surveys were carried out during these months in order to locate rendezvous sites. Once located, regular auditory contacts were maintained until the wolves vacated their sites. All scat samples were collected from rendezvous sites and separated by size into adult and pups. Size criteria for pups vs adult was $\leq$1.5 cm. Summer field work did not start until 1 June so that samples from early denning activity are not included. Hence this paper does not include early (post-natal) moose calf mortality due to wolf predation.

Samples were stored in plastic bags and frozen for storage. Hair impressions were made in the laboratory and analysed, based on cuticular pattern, size and colour. A special area-specific key was used for final

identifications (Kennedy and Carbyn unpubl.). Specific test runs were made to identify problem areas in identifications, particularly in identifying young cervids (moose, elk and deer) to species (Carbyn and Kennedy unpubl.). Reference collections were obtained from captive animals used in game ranching studies.

Relative abundance data on moose and elk were obtained from midwinter fixed wing aerial surveys (Carbyn 1977). A 25 percent systematic sample of the entire park was obtained by flying transects 1.6 km apart at an altitude of approximately 122 m, and counting animals on strips extending 200 m from either side of the plane. A classified count from a fixed wing aircraft in the fall of 1977 yielded a cow:calf ratio for moose.

An explanation of the methods used in data analysis is as follows. Occurrences of prey items in scat were converted to an approximate weight consumed using the formula obtained by Floyd et al. (1978), and the number of individuals consumed was then derived using available data on species weights. The composition of the diet by numbers was compared with the available information on the structure of the prey population in the park to give relative predation rates. The weights consumed gave estimates of the relative importance of different species in the diet of wolves.

A similar calculation was also approached from the other direction: from the population sizes, and the weights of the ungulate species, the expected ratios of their frequencies of occurrence in scat were calculated. These were then compared with the ratios actually obtained.

The poor visiblity of deer in aerial surveys biases the estimate of the deer population downward, and the deduced relative predation rate upward. Intensive ground and aerial work in connection with winter browse and resource partitioning studies have led to an estimate that deer are one-half to one-third as abundant as moose (G. Trottier, pers. comm.). The calculations described above were re-run assuming a deer population one-half as big as the moose population. This is a probable upper bound on the deer population, and hence gives a lower bound on the relative predation rate.

RESULTS AND DISCUSSIONS

Table 1 lists results of the identification of remains in wolf scat samples collected in June, July and August 1976, 1977 and 1978. Data are separated out for samples collected along trails and at rendezvous sites.

Out of a total of 1,006 identifications 2 percent were moose, of which calves were one-third. Elk, beaver and deer were the more important prey items.

The size of the park population of each ungulate species, obtained from the aerial surveys (Table 2) was combined with an average adult weight to give a theoretical park biomass. These calculations are speculative and are included only to estimate the scat ratios which would have been available had all ungulates been equally vulnerable (Table 3).

The calculations of both Table 3 and Table 4 show moose to be relatively immune from predation. Both deer and elk show higher predation rates. If the population estimates given by the aerial survey correctly reflect actual numbers then deer are much more heavily preyed upon than elk or moose with relative predation rates being 1:12:38 for moose, elk and deer. If the more heuristic estimate of deer population size is used, deer and elk occupy similar positions in the spectrum of prey species and relative predation rates are 1:12:7. In Jasper National Park (Carbyn 1975) deer were found to be the preferred of six prey species with very different densities.

Another source of error is inherent in the assumption that a food item in a scat sample is equal to a whole scat with one food item. Experimental work by Floyd et al. (1978) did not take into consideration several food items within the same sample. However, we have as yet no method of applying a correction for this.

There seems to be no problem in identification of young versus adult cervids, but separation and correct identification of moose calf, elk calf and deer fawn hairs does present difficulties. On trial runs, using ten inexperienced investigators each identifying ten samples of 15 potential prey items (including young of above), the accuracy of hair identification was checked. Young ungulates were misidentified 50 percent of the time. Elk calves were easier to identify (62% accuracy) while moose calves and

deer fawn were more often confused (61% of the time the young were misidentified), (Carbyn and Kennedy unpubl.). Accuracy in identifications is expected to be higher for experienced workers, on which results in Table 1 are based.

If all the 'deer fawn' occurrences were misidentified moose calves, the sample predations per thousand from Table 3 would be moose 0.59; elk 2.74; deer 3.33; and the relative rates of predation 1:4.64:5.64. If all the 'deer fawn' and all the 'elk calf' occurrences are called moose calves, then moose show a higher predation rate than elk, but elk calves are more reliably identified and this occurrence is unlikely.

Table 1 shows a higher proportion of adult elk in the scat samples than calves. Based on calculations of total weight per scat (Floyd et al. 1978) results indicate that more calves than adult elk were killed in two out of three summers (Table 3). Observations indicated that bull elk were more often killed in summer than cows. This is based on a small sample size and is inconclusive.

Scat samples were used to identify incidence of moose predation in other studies. Peterson (1974) reported a high mortality of moose calves on Isle Royale (31% to 17%) not all of which was wolf-related. In 1973, 56 percent of non-winter wolf scat collected on the island contained moose calf remains (Peterson 1974). In Algonquin Provincial Park, an area with both moose and deer, deer were the more common prey. Only 8 percent of the scat were of moose, and further analyses showed 88 percent of the moose remains to be calf (Pimlott, Shannon and Kolenosky 1969).

The overall conclusion, based on scat collection, is that moose and their calves in Riding Mountain National Park did not contribute substantially to the food of wolves during the June-August periods in 1976 to 1978. This does not include consideration of immediate post-natal wolf induced mortality which may be a factor. Gasaway et al. (1977) believed that wolf predation could account for high calf mortality up to 6 months of age in the Tanana Valley, Alaska. Subsequent studies on the Kenai Peninsula, Alaska, however, using mortality transmitters, indicated that wolf related moose calf mortality was low and black bear predation accounted for much of the neonatal calf mortality (Franzmann and Peterson 1978).

The low predation rate on moose in Riding Mountain National Park is probably due to the availability of alternative and more vulnerable prey. Wolfe (1974) has pointed out the role that beaver, for example, play as a buffer species and beaver are a summer prey item in the park; however, it appears from our results that elk are currently the staple year-round food for wolves, and absorb the bulk of the predation pressure. From Table 3, 80 percent by weight of wolf prey is elk; beaver at 9 percent, is in second place and restricted to summer months.

Availability of moose as carrion in summer was tested by collecting coyote scat samples. The coyote is a carnivore/scavenger which generally is not considered a predator of moose calves (Wolfe 1974). Results of coyote scat analysis indicate low utilization of moose. Microtines were the most common food item (21% frequency occurrence). Similarly black bear scat samples were analyzed. From a sample of 91, 32 percent contained animal matter, none of which was identified as moose; 6 percent contained elk remains.

Segregation counts conducted in November 1977 on moose resulted in 104 calves per 161 cows (64.6 calves per 100 cows). LeResche (1968) recorded 30 calves per 100 cows in October within a study area in Alaska. Gasaway et al. (1977) recorded a decrease in moose calf numbers from 44 to 14 per 100 cows in Central Alaska. Our composition count provides evidence of high moose calf survival which supports the evidence of low wolf predation as gained from the scat analysis.

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Table 1. Food items as determined from analyses of wolf scats collected in Riding Mountain National Park in June-August 1976, 1977 and 1978.

	Moose				Elk				Deer				Beaver		Muskrat		Squirrel		Hare		Porcupine		Microtine		Other		Total
	Ad		Juv		Ad		Juv		Ad		Juv																
	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	
1976	1	-	-	-	5	-	18	-	-	-	-	-	14	-	4	-	3	-	-	-	5	-	1	-	5	-	56
1977	-	-	-	-	8	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9
1978	-	-	-	-	-	-	-	-	-	-	-	-	6	-	3	-	-	-	3	-	1	-	2	-	-	-	15
1976	4	2	-	-	50	30	32	19	6	5	2	7	39	31	15	3	1	2	4	3	6	-	7	-	16	4	288
1977	1	-	3	-	15	2	18	4	9	-	11	-	19	36	5	-	6	-	8	-	2	-	31	-	11	-	181
1978	3	-	-	-	8	7	-	-	-	-	-	-	7	-	8	-	-	-	6	-	1	-	3	-	2	-	45
1976	-	2	-	-	20	50	7	7	1	-	3	-	16	5	7	2	2	1	-	2	4	-	9	-	1	14	153
1977	-	4	2	1	13	18	5	11	5	1	5	1	16	45	7	-	7	-	6	-	11	-	36	-	12	8	214
1978	-	-	-	-	6	7	8	2	1	1	1	1	2	9	2	2	-	1	-	-	-	-	1	-	-	-	45
Total B	17		6		239		132		29		31		245		58		23		33		30		90		73		1006

T=Park Trails
R=Rendezvous site

Table 2. Ungulate populations[4] within Riding Mountain National Park, as determined from mid-winter fixed wing aerial surveys.

Year	Winter	Moose	Elk	Deer[1]
1975	Mild	1888	2496	--
1976	Mild	2252	4048	228
1977	Moderate	2344[2]	3628[3]	136
1978	Moderate	2696	3780	312
Mean		2295	3488	225

[1]Deer are hard to see from the air, and these estimates are low. Intensive surveys on a small study block indicate a correction factor of between 3.4 and 5.1, based on these adjusted values as shown in Table 4.

[2]A 95% confidence interval on this moose population is ±9%.

[3]A 95% confidence interval on this elk population is ±17%.

[4]No visibility correction has been applied to any of these population estimates.

Table 3. Calculations of prey consumed, as represented by samples of wolf scat collected from 1 June to 31 August 1976, and 1977 and 1978 in Riding Mountain National Park.

Year	Prey Species	Weight of prey (kg) and reference	Weight of prey consumed per scat (kg) (a)	Number of identifications	Total kg of prey (b)	Number of individuals (c)
1976	Moose	302 Peterson 1974	6.42	9	57.58	0.19
	Moose calf	58 Peterson 1974	1.54	-	-	-
	Elk	247 Blood 1966	5.32	155	824.60	3.34
	Elk calf	30 Johnson 1951	0.98	83	81.34	2.71
	Deer	64 U. of A. Museum	1.66	12	19.92	0.31
	Deer fawn	20 Floyd et al.	0.78	12	9.36	0.47
	Beaver	12.5 Floyd et al. 1978	0.63	105	66.15	5.29
	Muskrat	1.5 U. of A. Museum	0.41	31	12.71	8.47
	Squirrel	0.8 Floyd et al.	0.39	9	3.51	4.39
	Hare	1.2 U. of A. Museum	0.40	9	3.60	3.00
	Porcupine	10 U. of A. Museum	0.58	15	8.70	0.87
	Microtine	.04 U. of A. Museum	0.38	17	6.46	161.50
1977*	Moose		6.42	5	32.10	0.11
	Moose calf		1.54	6	9.24	0.16
	Elk		5.32	56	297.92	1.21
	Elk calf		0.98	39	38.22	1.27
	Deer		1.66	15	24.90	0.39
	Deer fawn		0.78	17	13.26	0.66
	Beaver		0.63	116	73.08	5.85
	Muskrat		0.41	12	4.92	3.28
	Squirrel		0.39	13	5.07	6.34
	Hare		0.40	14	5.60	4.67
	Porcupine		0.58	13	7.54	0.75
	Microtine		0.38	67	25.46	636.50
1978	Moose		6.42	3	19.26	0.06
	Moose calf		1.54	0	-	-
	Elk		5.32	21	111.72	0.45
	Elk calf		0.98	17	16.66	0.56
	Deer		1.66	2	3.32	0.05
	Deer fawn		0.78	2	1.56	0.08
	Beaver		0.63	24	15.12	1.21
	Muskrat		0.41	15	6.15	4.10
	Squirrel		0.39	1	0.39	0.49
	Hare		0.40	10	4.00	3.33
	Porcupine		0.58	2	1.16	0.12
	Microtine		0.38	6	2.28	57.00

(a) Calculated from regression equation y - .02x (Floyd et al. 1978).
(b) No. of identifications x kg/scat.
(c) Kg eaten/prey wt.

*Margin of error expected due to possible misidentification of wolf and coyote scat.

Table 4a. Comparison of food analysis in scat collected with proportions expected from biomass ratios of prey species.

	Source	Moose	Elk	Deer	Total
(1) Mean population	Table 2	2295	3488	225	
(2) Weight (kg)	Table 3	302	247	64	
(3) Total biomass (tonne)	(1)x(2)/1000	693	861	14	
(4) Kg food/collectible scat	Table 3	6.42	5.32	1.66	
(5) Potential collectible scat ('000)	(3)/(4)	108	162	8	249
(6) Expected percentage (%)	(5)/Σ(5)x100	38.8	58.3	2.9	100
(7) Expected number collected (of a total of 454 collected)	(6)xΣ(8)/100	175.2	264.7	13.2	454
(8) Actual number collected	Field data	23	371	60	454
(9) Actual as % of expected	(8)/(7)x100	13.1	140.2	454.5	

Table 4b. Comparison of food analysis in scat collected with proportions expected from biomass ratios of prey species; visibility correction applied to deer population.

	Source	Moose	Elk	Deer	Total
(1) Mean population (from Table 2)	Table 2	2295	3488	1148[1]	
(2) Weight (kg)	Table 3	302	247	64	
(3) Total biomass (=(1)x(2) (tonne)	(1)x(2)/1000	693	861	73	
(4) Kg food/collectible scat (from Table 3)	Table 3	6.42	5.32	1.66	
(5) Potential collectible scat ('000)	(3)/(4)	108	162	44	314
(6) Expected percentage (%)	(5)/Σ(5)x100	34	52	14	100
(7) Expected collection (of 454 collected)	(6)xΣ(8)x100	154	236	64	454
(8) Actual collected	Field data	23	371	60	454
(9) Actual as % expected	(8)/(7)x100	15	157	94	

[1]This represents a deer population subjectively estimated at its highest plausible level as 50% of the moose population (Trottier, pers. comm.; see p. 4).