IMPORTANCE OF SCAVENGING ON MOOSE BY WOLVES IN ALGONQUIN PARK, ONTARIO

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ABSTRACT: This paper addresses the importance of winter scavenging on moose(*Alces alces*)by gray wolves (*Canis lupus*) in Algonquin Provincial Park, Ontario. A high incidence (83%, n=30)of scavenging on moose was recorded in mid to late winter 1987-1990. Moose fed on by radio-collared wolf packs and winter wolf food habits (n=892 scats)are related to sources ofnon-predatory mortality in the Park,namely winter tick (*Dermacentor albipictus*), train kills, and human hunting. Food habits of wolves imply that seasonals cavenging on tick-related moose carcasses is important to this wolf population during periods oftick infestation.
The role of scavenging is discussed in the context of a relativelysmall-sized predator (the Algonquin type of *Canis lupus lycaon*) limited to a large-sized preyspecies, the moose. Incidences of wolf scavenging in other studies are also presented.

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Numerous studies have documented the extent of wolf predation onwintering moose and the role of predator density and consumption rates in the regulation of moose populations (see Boutin 1992). Significant amounts of scavenging by wolves on moose has not been reported. Most wolf-ungulate studies cite incidental observations of scavenging by wolves on prey species (Kolenosky 1972, Kuyt 1972) or the role of wolf predation in providing for other species of scavengers in the community such as mustelids, ravens, and smaller canids (Mech 1970, Pimlott *et. al.* 1969, Peterson and Allen 1974).

This paper documents a significant degree of utilization of non-predated moose by wolves in Algonquin Park and presents evidence that, in this wolf-ungulate system, scavenging on moose may be important to wolf population survival in winter.

STUDY AREA

The research was conducted in Algonquin Provincial Park (46°N, 78°W), located in central Ontario between Georgian Bay and the Ottawa River. Elevation in the 7571 km park ranges from 180 to 380 m in the eastern half of the Parkand up to 580 m on the Algonquin Dome, a raised section of the Precambrian Uplands.Total annual snowfall ranges from 203 to 254 cm with greater amountsin the west (Wilton 1987). Average air temperature is -11.5 degrees °C in January (Brown *et al.* 1980).

The heavily forested Park exists asa transitional zone between the Boreal Forest Region and the Algonquin Highlands portion of the Great Lakes / St. Lawrence Forest Region (Rowe 1972). The region contains large amounts of deciduous forest and is therefore atypical of the more prevalent boreal habitats. Two major forest types cover Algonquin pine/ poplar (*Pinus spp. Populus spp.*) forests in the east and tolerant hardwood (*Acer saccharum-Betula alleghaniensis*) forests to the west. Three major prey items - moose, white-tailed deer (*Odocoileus virginianus*) and beaver (Castor canadensis) are fed on by Algonquin wolves, but their winter availability varies considerably. Moose densities in the Park have risen in the past decade from an estimated 0.12 to 0.18/sq.km. in 1974 and 1975 to 0.44/square km in winter 1986-87 (Wilton and Pashuk 1982, O.M.N.R. Aerial Survey Records, Huntsville). During the period of this study (1987-1990), moose densities are roughly estimated to be 0.35 to 0.39 /sq.km. (ibid.). The number of deer available to Park wolves in winter has changed from virtually none in the early 1980's to periodic pockets of

small numbers during the study period. Since the mid 1980's deer have been increasing in summer over most of the Park. Deer then migrate to deer concentration areas outside of Algonquin in mid-late December and return in late April (L. Swanson, unpub. data). Mid-winter aerial surveys indicated that in winter 1989-90, an estimated 80-100 deer stayed in the eastern section of the Park within the territories of four wolf packs. Wintering deer were not present, or were in extremely low numbers, in winter 1987-88 and 1988-89 (Forbes and Theberge, unpub. data). No accurate census data are available on beaver, but the species is common throughout the Park. The availability of beaver in winter is difficult to assess as sections of the Park contain ephemeral open-water (fast flowing creeks, rivers) and beaver may be active in such places.

METHODS

The importance of moose in the winter (Dec. 15 to March 31) diet of wolves was determined through scat collections and carcass searches. Wolf scats (n=892) were collected on the extensive road networks in the Park as soon as snow melted, as well as during the course of winter ground tracking. Scats near winter carcass sites were not collected. The scats were analyzed following guidelines in Adorjan and Kolenosky (1969). Three randomly-selected hairs were identified per scat, on the basis that in less than 3% of the scats did analysis of a fourth hair result in the identification of an additional prey species (Swanson 1989). Data are presented as percent frequency of occurrence of food items.

Moose carcasses (n=38) were located by aerial and ground radio-tracking of wolves. Since 1987, 56 wolves have been fixed with radio-collars as part of an ongoing wolf-ungulate research study. The collared wolves, and their 22 respective packs, cover much of the Park's geographic area. Winter telemetry flights were followed by ground searching for prey carcasses. To determine whether moose were killed by wolves or died of other causes, we followed criteria of Haynes (1982) and Stephenson and Johnson (1973) where by scavenged carcasses typically exhibit: collapsed body position with legs folded under body, lack of evidence of chase (blood stains, hair clumps) and/or struggle (broken branches), lack of blood-soaked hair near the anus, legs, belly, and throat. In addition, we found a predeliction for carcasses to be found in heavy cover, and have an intact, frozen rumen still in the body cavity. In several cases, the moose carcass was frozen into the ground and dug out by wolves. In contrast, wolf-killed carcasses typically exhibited opposite characteristics: splayed legs, evidence of chase and struggle, and strewn rumen contents.

Analysis of fat content in the bone marrow of femurs was conducted on 24 moose after methods described by Verme and Holland (1974). Supplemental data on an additional eight moose carcasses from winter 1990-91 and 1991-92 are also included.

RESULTS

Wolf food habits from all packs in winters 1987-88, 1988-89, 1989-90 indicate heavy use of moose, beaver, and deer (Fig. 1). Use of moose varied from 22% to 44.7% during the three year study. Other species found in smaller amounts (<5% total) included snowshoe hare, red squirrel, Cricetinae spp. and black bear.

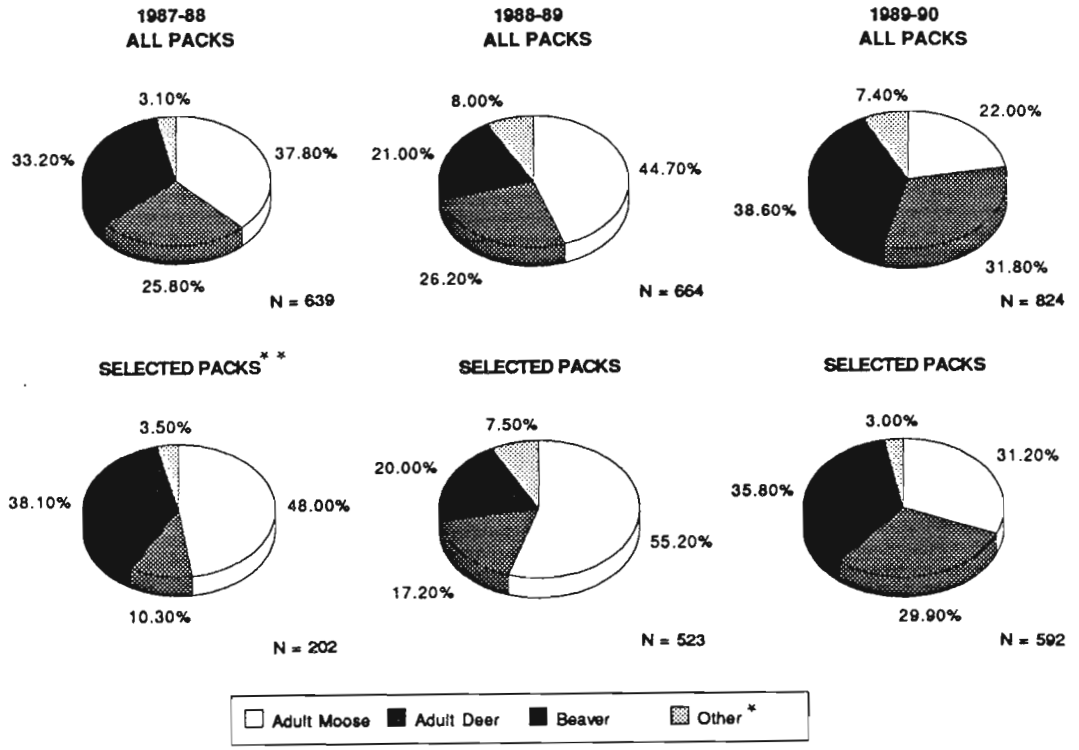
These results are heavily influenced by the food habits of two packs located in the southern section of the Park where deer over wintered in all three winters (G. Oram, pers. comm.). Their situation was atypical of most of the 22 packs studied because deer were rare to uncommon elsewhere in the Park. Excluding data from these two packs permits a more representative indication of winter food habits for the entire Park, and results in an increase in the importance of moose to 31.2%-55.2% in the three years (Fig. 1).

In 1989-90, the year of lowest moose use,

deer over wintered in a third of the radio-collared wolf territories. In that winter, the proportion of moose declined to 31.2% while deer increased significantly to 29.9% (Z=6.96, p=0.05), a level almost equal to moose.

Carcass data indicate that, throughout much of the study period, the great majority (83%) of the carcasses examined were scavenged after dying of non-wolf related causes (Table 1). This observation represents a killed to scavenged ratio of 1:6. In certain years, the amount of scavenging was extensive - all carcasses found in 1987-88 and all but one in 1988-89.

Over the three years, the proportion of scavenging declined as deer increased in the diet, and less significantly, as moose-kills in the diet increased (Fig. 2). Supplemental data from winter 1990-91, though the sample size is small, supports this trend with four examined moose having been killed. In 1991-92, the situation became more complex; one moose was killed and another three were killed by humans (apparently natives), with the remains being scavenged by a number of wolf packs. The cause of death in 21 of 25 (84%) of the scavenged moose is suspected to be related to infestations of winter tick (*Dermacentor albipictus*). Winter ticks have been implicated in moose mortality through hair loss and the subsequent negative energy balance and starvation (Samuel *et. al.* 1986, McLaughlin and Addison 1986). The extent of hair loss on each tick-related death is presented in Table 1 and indicates that all of the scavenged moose exhibited moderate to severe hair loss. Moderate hair loss equals patches of skin greater than one-quarter of the body. The winters of



* Species totalling < 5%

** Does not include data from 2 atypical packs containing winter deer yard

Fig. 1. Percent frequency occurrences of winter wolf food habits for all packs and selected packs, 1987 - 1990.

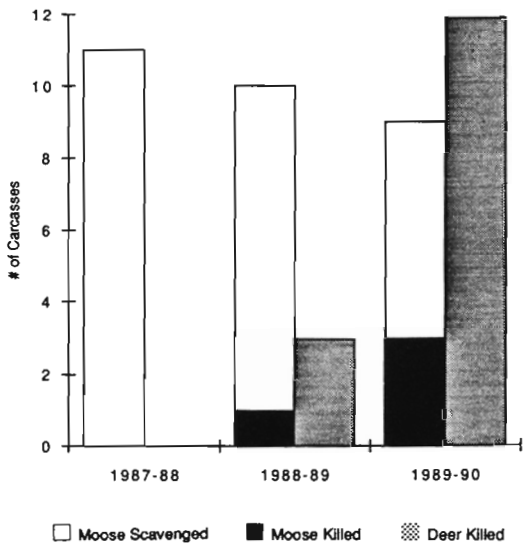


Fig. 2. Number of moose scavenged compared with moose and deer killed by wolves, 1987-1990.

1987-88 and to a greater degree, 1988-89, were believed to be severe tick years based upon sightings of hairless, "ghost" moose and reports of dead moose given to Park staff in spring 1989.

Starvation may occur at fat levels below 10% (Peterson *et. al.* 1984), and Messier and Crete (1985) selected any value below 20% to indicate significant malnourishment.. The fat content of 24 moose are presented in Table 1. The average fat content for tick-related carcasses was 44.3% and more than one third (35.7%) of these moose possessed bone marrow fat levels less than 20%. By contrast killed carcasses exhibited lower fat levels averaging 33.4% with over half (57.1%) of the moose below 20%. The fat content in three moose shot by humans was higher at 83.9%, with no levels below 20%.

DISCUSSION

In the literature, the value of scavenging by wolves is of limited or secondary importance. It has been generally documented that all wolf populations exist by killing most of their food intake (Mech 1970). Scavenging has been described as incidental due to a possible irregularity of available carcasses. Wolves, like many predators, are typically opportunistic scavengers. The 1:6 killed to scavenged ratio in this study strongly suggests that scavenging in mid-late winter supplies a large proportion of the winter food intake of Algonquin wolves during the study period. Other wolf-moose systems have also exhibited substantial scavenging by wolves. In Quebec, Messier and Crete (1985) found that scavenging varied in importance depending on available prey. High density areas had killed to scavenged ratios of 6:1 but scavenging increased to 1.33:1, and in one lower prey density area reached an even ratio of 1:1.

Most wolf studies include data on the proportion of moose that die from causes other than wolf predation. A 10 year summary of moose mortality on Isle Royale indicated that in cases where cause of death was known, 19% of 74 carcasses were not killed by animals (Wolfe 1977). In an Alaskan study, 49% of 204 moose carcasses were not killed (Gasaway *et. al.* 1987). Assuming even a part of this natural mortality was scavenged by wolves would imply a considerable source of potential food for wolves.

There is evidence that scavenging on sources other than dead moose is important to some wolf populations. On the coast of Labrador, Andriashek *et. al.* (1985) suggested that scavenging by wolves on newborn seal pups and remains of seals killed by polar bears is significant to seasonal survival. In addition, Crete *et. al.* (1981) stabilized wolf-moose oscillations in a discrete-time model by incorporating the scavenging at a nearby garbage dump during periods of low moose density.

Scavenging may affect calculations of predation rates and the interpretation of regulatory impacts on prey populations. The loss for wolves of food to other species of scavengers or aggressive competitors may promote a compensatory increase in predation (Ballard 1982, Wilton 1986). However, when wolves

Table 1. Data on winter moose carcasses showing prevalence of ticks and percent fat content, 1988-1992.

MOOSE CARCASS DATA, WINTER 1988-1990									
SEX	AGE	DATE OF DEATH	CAUSE OF DEATH	SCAVENGED	WOLF PACK	TICKS	HAIR LOSS	FAT CONTENT	COMMENTS
M	AD	1/9/88	STARVED?	YES	SOURCE	YES	HEAVY	12.8%	COLLAPSED BODY, FROZEN IN SNOW
M	AD	3/10/88	STARVED?	YES	SOURCE	YES	HEAVY	66.0%	
M	AD	3/14/88	STARVED?	YES	NAHMA	YES	MODERATE	7.7%	COLLAPSED BODY IN CONIFERS
F	AD	3/16/88	STARVED?	YES	TRAVERS	YES	HEAVY	48.5%	
M	AD	3/17/88	STARVED?	YES	TRAVERS	YES	MODERATE	11.3%	COLLAPSED BODY IN CONIFERS
		3/17/88	PRED. UNLIKELY	YES	GRAND	YES	HEAVY	47.9%	NO SIGN OF CHASE, FROZEN RUMEN
F	AD	3/19/88	STARVED?	YES	EAST GATE	YES	HEAVY	63.5%	COLLAPSED BODY, FROZEN IN SNOW
F	AD	3/19/88	STARVED?	YES	GRAND	YES	MODERATE	64.0%	
F	AD	3/21/88	STARVED?	YES	EAST GATE	YES	HEAVY	13.7%	
M	AD	3/25/88	UNDETERMINED	?	TRAVERS	YES	?	DESSICATED	CARCASS IN SPRING, TICK SHELLS
M	AD	4/20/88	TRAIN	YES	GRAND	NO		FLY LARVAE	
M	AD	1/29/89	PRED. UNLIKELY	YES	ANNIE BAY	NO			INTACT BODY FROZEN IN SNOW
		2/14/89	HUMAN	YES	ANNIE BAY	NO		77.0%	
F	AD	2/26/89	STARVED?	YES	ANNIE BAY	YES	MODERATE		INTACT BODY FROZEN IN SNOW
F	?	3/10/89	STARVED?	YES	TRAVERS	YES	MODERATE	68.5%	
M	AD	3/11/89	STARVED?	YES	FOYS	YES	MODERATE	68.0%	
M	AD	3/12/89	PREDATED	YES	RATRAP	YES	HEAVY	62.5%	EVIDENCE OF CHASE, SICK ANIMAL
F	AD	3/12/89	STARVED?	YES	GRAND	YES	MODERATE	74.3%	
F	AD	3/16/89	STARVED?	YES	CHARLES	YES	HEAVY		
M	AD	4/1/89	STARVED?	YES	EAST GATE	YES	HEAVY	DESSICATED	
M	AD	4/2/89	PRED. UNLIKELY	YES	JACK PINE	YES	HEAVY	DESSICATED	COLLAPSED POSITION IN CONIFERS
F	AD	2/21/90	PREDATED		GRAND	NO			EVIDENCE OF CHASE
		3/14/90	PREDATED		CHARLES	NO			EVIDENCE OF CHASE
F	AD	3/20/90	PREDATED		ANNIE BAY	YES	MODERATE	10.4%	
M	AD	3/-/90	UNDETERMINED	YES	MATHEWS	YES	?	DESSICATED	
F	AD	3/-/90	PRED. UNLIKELY		LAVIELLE	YES	?	FLY LARVAE	COLLAP. BODY IN CONIFERS - SPRING
M	AD	4/8/90	STARVED?	YES	RATRAP	YES	HEAVY	63.1%	
M	AD	4/14/90	STARVED?	YES	CHARLES	YES	HEAVY	11.0%	COLLAPSED BODY FROZEN IN SNOW
		4/-/90	PRED. UNLIKELY		GRAND	YES	?	FLY LARVAE	COLLAP. BODY IN CONIFERS - SPRING
		4/-/90	PRED. UNLIKELY		FOYS	YES	?	FLY LARVAE	COLLAP. BODY IN CONIFERS - SPRING
SUPPLEMENTARY MOOSE CARCASS DATA, WINTER 1991-1992									
M	AD	3/10/91	PREDATED		FOYS	NO		10.6%	
F	<2YR	3/13/91	PREDATED	YES	MAT.- E.GRAND	NO		61.8%	PRED. BY MATHEWS, SCAVEN. BY E. GRAND
M	CALF	3/15/91	PREDATED		EAST GATE	NO		59.4%	
F	CALF	4/6/91	PREDATED		GRAND EAST	YES	LOW	16.1%	PREDATED - SICK MOOSE
M	AD	11/15/91	SHOT (NATIVE?)	YES	JACK PINE	N/A	?	FLY LARVAE	REMAINS OF SHOT MOOSE
M	AD	12/19/91	PREDATED		TRAVERS	NO	MODERATE	12.8%	BARE SKIN PATCHES
		12/28/91	SHOT (NATIVE?)	YES	BASIN DEPOT	N/A	?	89.8%	REMAINS OF SHOT MOOSE
		12/27/91	SHOT (NATIVE?)	YES	JACK PINE	N/A	?	84.8%	REMAINS OF SHOT MOOSE

are the scavengers, food consumed by them may serve to lessen overall predation rates if more food is freely available, or increase predation rates if wolf numbers increase from scavenging. Clearly, the interpretation of predator effect based on scat data could be biased without a strong estimate of the proportion of non-killed sources.

There are only a few records other than those reported here of wolves killing moose in Algonquin Park (M. Wilton pers. comm.) and the apparent degree of scavenging may be related to the size of the predator. The Algonquin type of Canis lupus lycaon averages only 28 kg for adult males and 25 kg for females (Pimlott *et. al.* 1969). This size is considerably smaller than other wolves in North America (Mech 1970). Moose in Algonquin belong to the americana subspecies and average 410 kg, a weight comparable to, or greater than moose weights elsewhere in North America (Quinn and Aho 1989) where wolves are larger.

In addition to the availability of carcasses from tick-related mortality, other sources of carcasses exist in Algonquin. Approximately 40-50 moose may be killed annually along the railway line running through the Park (B.

Mason, train conductor, pers. comm.). And a recent agreement between the Provincial government and members of the Golden Lake Natives allows up to 100 moose and 150 deer to be shot annually. In 1991-92, a minimal count of 46 moose were reported shot within the Park. On three occasions in 1991-92, wolves were radio-tracked to the remains and gut piles of human-killed moose. The native hunting season runs from November to mid January and maybe come an important food source in the early winter period when tick-induced mortality is relatively uncommon. With the addition of human hunting, and the scavenging of the remains, a new factor isdeveloping in the ecology of wolves, and their impact on moose, in Algonquin Park.:

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