MOOSE DIET AND USE OF SUCCESSIONAL FORESTS IN THE CANADIAN TAIGA

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ABSTRACT: An estimate of the winter diet of moose (*Alces alces*) in the taiga was assessed from microhistological analysis of winter-type pellets obtained mostly in summer,1983-87, from 23 locations in northern Canada. *Betula* spp.-bark, mostly *B. papyrifera*, comprised 85% of the fragment densities, excluding one atypical sample in which *Pinus banksiana* accounted for 83% of the fragment densities. *Salix.* spp. and other Betula spp. fragments comprised most of the remainder. Moose pellet group densities at 197 upland sites were highest in regenerating forests 20-40 years after fire; those of barren ground caribou (*R. t. groenlandicus*) highest-in forests >60 years after fire. Without fire, the taiga would support extremely low densities of moose. Lichens comprised 36% of plant fragments in pellets of moose eating arboreal lichens and cratering like woodland caribou (*Rangifer tarandus caribou*) in the same old growth forest in Jasper-National Park. Competition between moose and caribou for arboreal lichens and *Equisetum* spp. potentially exists.

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There are no data on the diet of moose in a vast region of Canada variously known as the Subarctic Ecoclimatic Province, the Taiga Shield Ecozone, the Transitional Forest Zone, the Low Subarctic Ecoregion, the Sub-Arctic Lichen Belt, the Open Lichen Woodland, and the Taiga (Bradley *et al.* 1982). The zone within the study area is relatively flat; is overlain by varying depths of till from little in the west to thick in the east; is characterised by mostly black spruce (*Picea mariana*) east of 108oW and mixtures of spruce and pine (*Pinus banksiana*) to the west; and low shrubs and ground lichens are abundant. Data on moose are scant for the entire region. In the 1960's, Scotter (1971) obtained information on densities of moose pellets in forests of various ages after fire in the southern taiga of Saskatchewan and Manitoba.

From 1982 through 1987, the Canadian Wildlife Service investigated fire-caribou relationships on the winter range of the Beverly herd of barren-ground caribou. Biophysical descriptions of the Northwest Territories (NWT) portion of that area are available (Bradley *et al.* 1982). Information on the diet of caribou and their relative use of forests at various periods after fire were important elements of the fire-caribou range study (Thomas 1990). The scarcity of tall shrubs in most upland forests older than about 60 y and the common occurrence of moose pellets in the caribou habitats led to consideration of some dietary overlap in winter between caribou and moose. Tall shrubs were virtually ignored by caribou in winter but perhaps moose consume lichens, the major forage source for caribou (Thomas and Barry in press), and low shrubs. This report gives the results of analyses of moose pellets for plant composition, provides data on the relative use of forests at periods after fire in the taiga of north-central Canada, and notes potential competition between moose and caribou in Jasper National Park.

METHODS

Between February 1983 and August 1987, winter-type moose fecal pellets were collected at 23 sites ranging from northwestern Manitoba to near Great Slave Lake in the Northwest Territories (NWT). The locations fall into an eastern group (numbers 1-8) centered around Selwyn Lake (NWT-Saskatchewan border at ca. 104oW) and a western group (numbers 9-23) centered around Nonacho Lake. Only 2 of the pellet groups were obtained in the winter by following fresh tracks of moose. Therefore, the timing of

deposition of the others is unknown.

Two pellets from each of 5-10 pellet groups were combined in a composite sample for each location and sent in salt to the laboratory. One sample from moose in Jasper Park was also analysed because of obvious use of arboreal lichens. Black, licorice-like, pellets obtained 15 April 1989 at 1750 m elevation near Excelsior Creek were intentionally analysed rather than the typical brown pellets found at lower elevations. Microhistological analysis was by the frequency method after examining 20 fields in each of 5 slides (Deardon *et al.* 1975, Holechek and Gross 1982a).

Relative use by caribou and moose of forest age classes was assessed by counting pellet groups (minimum of 5 pellets/group) in 2 belt transects (each 100 x 4 m) through 197 forest sites of various ages. The transects were established by running a 100 m tape through representative upland sites from representative starting points. They were unbiased but not based on machine generated random points or directions.

RESULTS

Apparent Diet

Betula spp. bark dominated plant fragment relative densities (PFRD) at 22 of the 23 taiga sites, with *Betula* spp. (other than bark), *Salix* spp., unknown bark, and *Pinus* sp. comprising minor amounts (Table 1). Minor and trace amounts of *Carex* spp., unknown seeds, *Cladonia* spp., *Equisetum* spp., *Picea* spp., and *Ledum* spp. were recorded in 4, 3, 1, 1, 1, and 1 of the samples, respectively. The PFRD of *Betula* spp. bark averaged 85% over all locations, 88% in the east, and 83% in the west, excluding the atypical sample number 13. Excluding that sample, overall average PFRDs for *Salix* spp., *Pinus* spp., unknown bark, and *Betula* spp. (other than bark) were 5, 5, 4, and 2%, respectively.

Pinus sp. accounted for 83% of the fragment densities in sample 13. The sampled moose was feeding mostly on jack pine (*P. banksiana*) as deduced by following its tracks in 55 cm of snow within a 21 y old burn between Noman and Siltaza lakes. The observations, being incidental to obtaining snow measurements and cursory because of a waiting aircraft, shed no information on the physical state of the moose or the availability of other forage species.

The PFRD for the sample from Jasper Park was moss, 41%; *Alectoria/Bryoria*-type lichens, 30%; *Picea* spp., 8%; *Equisetum* spp., 5%; *Cladonia*-type lichens, 4%; *Ledum* spp., 4%; *Abies* sp., 3%; *Peltigera* spp. 2%, and 4 other species combined, 3%.

Use in Relation to Forest Age

Mean densities of moose pellet groups in 20- and 50- y age classes at 197 upland sites indicated relatively high use of forests 20-40 y post fire (Table 2). Similar relationships for moose were found by Scotter (1971) in spruce and birch forests in the southern taiga. In contrast, caribou pellet group densities were relatively low in age classes 1-20, 21-40, and 41-60 y and were about equally common in older classes (Table 2). Maximum densities of moose and caribou pellet groups occurred at sites in age classes 21-40 y and 61-80 y, respectively. Grouping data from all sites resulted in high variability particularly for caribou, whereas stratification by geographic area reduced variability (Fig. 1) (Thomas 1990). For example, use of forests by caribou around Porter and Nonacho lakes was greatest in the 150-200 and 201-250 y age classes.

Mean pellet-group densities were higher for moose than caribou in the 1-20, 21-40, and 41-60 y age classes. Moose are year-round residents whereas caribou are temporary occupants in some years and then for only a small part of the October-April period.

DISCUSSION

The microhistological technique has certain limitations and inherent problems (e.g., Holechek *et al.* 1982) as do all methods of

Table 1. Mean densities of plant fragments in winter-type pellets of moose collected mostly in summer, 1983-87, in the taiga of the Northwest Territories, Saskatchewan, and Manitoba.

Sample		Location		Percent relative fragment density							
				Betula	*Betula*	*Salix*	Unknown	*Pinus*	
no.	Lake	N.lat.	W.long	bark	other	spp.	bark	sp.	
1	Kasba	59 58	101 58	97 (1)^	3 (2)	1 (1)			
2	Thye	60 17	104 27	91 (4)	3 (4)	4 (1)	2 (2)		
3	Selwyn	60 14	104 28	91 (4)		7 (2)	2 (3)	<1	(1)
4	Turner	60 07	104 52	79 (7)	2 (2)	13 (7)			
5	Opescal	60 00	104 59	91 (6)	1 (1)	6 (4)	2 (3)		
6	Burslem	60 07	105 33	86 (6)	1 (2)	6 (3)	6 (4)		
7	Beauvais	60 28	105 36	84 (3)	1 (1)	6 (3)	6 (5)		
8	Marchand	59 45	106 06	88 (8)		3 (4)	9 (6)	1	(1)
9	Porter	66 47	107 52	92 (3)	3 (1)	2 (2)		3	(1)
10	Porter	66 48	107 53	84 (12)	1 (1)	2 (2)	2 (2)	12	(9)
11	Porter	61 42	108 00	91 (3)	3 (4)	2 (2)	3 (4)	1	(2)
12	Gray	61 48	108 42	88 (7)	3 (2)	6 (4)	3 (4)	1	(1)
13	Noman	62 18	109 00	14 (5)	2 (3)		2 (2)	83	(6)
14	Heron	61 14	109 07	77 (10)	2 (2)	6 (3)	14 (8)	1	(1)
15	Nonacho	61 48	109 09	59 (12)		21 (2)	20 (11)		
16	Grampus	60 37	109 13	80 (5)	15 (2)	5 (3)	8 (2)	2	(2)
17	Nonacho	61 47	109 17	93 (2)	2 (2)	1 (1)	1 (1)	2	(2)
18	Nonacho	61 50	109 17	88 (6)	2 (1)	1 (2)	5 (4)	4	(4)
19	Nonacho	61 47	109 18	96 (2)	1 (1)	3 (2)	1 (2)	1	(1)
20	Sparks	60 17	109 40	85 (8)	2 (2)	2 (3)	4 (4)	7	(3)
21	Salmon	60 46	109 46	81 (5)	2 (2)	8 (2)	9 (4)	1	(1)
22	MacInnes	61 17	110 12	75 (12)	2 (3)		1 (1)	19	(4)
23	Rutledge	61 40	110 36	76 (5)		10 (1)	<1 (1)	14	(6)

^ Standard deviations (parentheses) were calculated from fragment densities for each of 5 slides (20 fields per slide).

Table 2. Mean densities of moose and caribou pellet groups in 20- and 50-year post-fire age classes of forests at 197 upland sites in the taiga of northern Canada.

Age	Number	Pellet groups per ha					
		Moose			Caribou		
class (y)	of sites	Mean	SE	Range	Mean	SE	Range
1 - 20	12	42	12	0-125	21	17	0-200
21 - 40	16	181	42	0-650	5	3	0- 50
41 - 60	34	41	8	0-175	17	5	0-150
61 - 80	27	30	8	0-175	72	33	0-750
81 - 100	9	36	10	0-100	64	38	0-275
101 - 150	27	11	3	0- 75	55	14	0-275
151 - 200	37	16	4	0- 75	94	23	0-650
201 - 250	32	20	4	0-100	74	21	0-425
251 - 300	3	17	17	0- 50	75	38	0-125
Totals/ave.	197	38	5	0-650	56	8	0-750
1 - 50	38	102	21	0-650	12	6	0-200
51 - 100	60	34	5	0-175	50	16	0-750

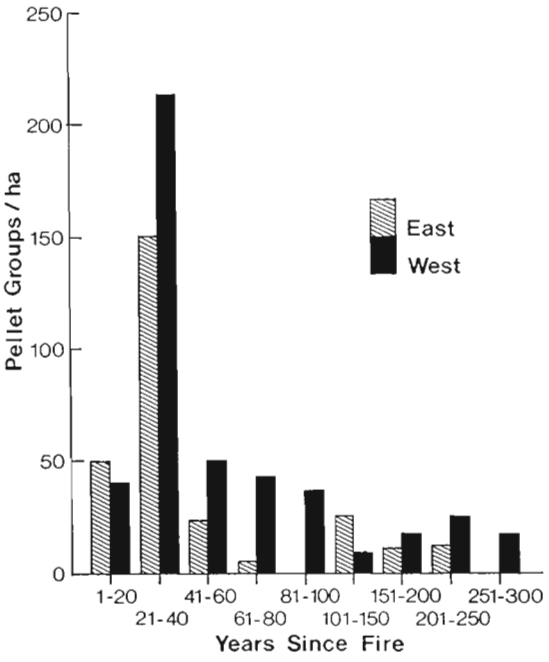

Fig. 1. Densities of moose pellet groups at 20- and 50-year intervals after fire in taiga east and west of 107°W in north-central Canada. Numbers above the bars are number of sites where 2 belt transects each of 100 X 4 m were sampled.

estimating diet. However it is often the most feasible technique. The results of microhistological analysis of winter-type moose pellets provide only crude estimates of proportionate intake. Such is the case for herbivores that consume significant but variable proportions of large stems from shrubs (Holechek and Valdez 1985). Estimates of proportionate intake may be improved by training analysts (Holechek and Gross 1982b) and by adjusting the data according to the relative passage times, relative digestibilities, digestibility coefficients (Pulliam and Nelson 1979, Leslie *et al.* 1983), or the results from feeding mixtures of known weight to captive animals (Deardon et al. 1975).

Regelin *et al.* (1987) encountered shrub misidentification problems when they tested the microhistological technique (employing the same laboratory) against observed forage use within an enclosure. Even when *Betula paprifera* was substituted for *Salix* spp. in the results, they were not satisfied with the analysis. The analysis of only 20 fields per sample, which is inadequate (Holechek and Vavra 1981), may have contributed to the disparate results. The laboratory believed that the unknown bark in the taiga samples was *Salix* spp. It may have been Alnus spp., of particularly abundance at locations 14 and 15 where the unknown bark was of highest estimated density. *Alnus* spp. are little used by moose as forage in many regions, however it was browsed by moose in August in the NWT and in Jasper Park.

Most of the *Betula* in the samples is undoubtedly *B. papryfera* (paper birch) rather than *B. glandulosa* (dwarf birch). The former was extensively browsed and branches broken by moose almost everywhere. Paper birch is found in forests of all ages, however the trees and clumps are large in old stands. Some *Salix* spp. were extensively used by moose in the study area but they are abundant only in lowland areas of young forests. The absence of *Vaccinium vitis idaea* spp. in the diet of the moose is interesting in view of its abundance throughout the taiga and its occasional high use in Alaska (LeResche and Davis 1973).

Moose in Scandanavia and Europe consume large amounts of Scots pine (*P. sylvestris*), considered to be of medium preference (Hjeljord *et al.* 1982). Some secondary compounds appear to leave jack and ponderosa (*P. contorta*) pine soon after it is cut or breaks off. Hare (*Lepus americanus*) will virtually strip felled trees of all leaves within a few days while ignoring the leaves of live trees.

There is little overlap in winter diet between moose and caribou in the taiga. Only a trace of lichens was found in moose fecal samples at one of the sites. Under exceptional conditions, there is potential competition for lichens, particularly long-strand arboreal forms

(*Bryoria* and *Usnea* spp.), in Jasper Park. In old (>300 y) forests on an east slope, both moose and caribou were focusing on arboreal lichens with some cratering in 50-70 cm of snow (70-90 cm in openings) for a sparse cover of ground lichens and *Equisetum scirpoides*. Shrubs were scarse in that habitat and they were heavily browsed. Still, use of this type of habitat by moose may be an exceptional case even in Jasper Park. Moose may not consume arboreal lichens unless they are abundant and in long strands. LeResche and Davis (1973) reported that 23% of the bites of tame moose on browse-depleted range in Alaska were of lichens, primarily *Peltigera* spp. Risenhoover (1987) found that moose on Isle Royale spent considerable time eating arboreal lichens but concluded that ingested biomass was small.

Though the highest moose pellet-group densities in the taiga were in age class 21-40 y, browsing occurs in burns within a year of fire. Roots often remain viable after fire and fresh sprouting of shrubs occurs within months. Colonization of large burned areas is a slow process because of traditional movement patterns (Gasaway *et al.* 1989). The relatively slow increase in moose density in young burns compared with other studies (Gasaway *et al.* 1989) implicates reproduction to a greater extent than ingress into the burn and burn area. The decomposition rate of moose pellets is potentially a factor. Caribou pellet groups were detectible for 2 to 4 years in moist to dry sites, respectively (Thomas 1990).

Based on aerial observations of moose and their tracks in winter, mature (>100 y) or old (>150 y) forests are essential habitat components within the taiga range. Generally only the periphery of large burns were used extensively by moose unless there were large unburned inclusions.

There appears to be 3 main reasons why mature and old forests are important: escape cover, thermal cover, and sometimes better snow conditions. All 3 are considered to be important factors in moose distribution (Telfer 1984). When disturbed in burned habitat the moose often fled to old forest cover. Thus old forests serve as escape habitat and large trees used as a rear guard should assist a moose in defence against wolves. Old forests would provide thermal protection in summer and winter. Winter temperatures of -40 to -50C are not uncommon and summer temperatures reach 30C or higher. Strong winds occur several times during the winter and they may accompany temperatures below -30C. Snow is shallower under tall trees, is not subject to drifting that occurs in young burns, and is less likely to have ice lenses and crusts from warm periods during late winter.

Tall shrubs favored by moose are scarse in mature and old forests in the taiga with willows common only in riparian habitats and paper birch generally are large and infrequent. Therefore, moose and pine in the taiga are virtually fire dependant but paradoxically moose also appear to be dependent on mature or old forests within their individual ranges.

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