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The diet of woodland caribou populations in west-central Alberta

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Abstract: The diet of woodland caribou (*Rangifer tarandus caribou*) populations in the foothills and Rocky Mountains of west-central Alberta was estimated by microhistological analyses of feces collected in winter and summer. In winter, terrestrial lichens averaged 60-83% of fecal fragment densities in both areas. In the mountains, decreasing proportions of terrestrial lichens and increasing proportions of conifer needles and moss indicated decreasing accessibility of forage because of deeper/harder snow. Apparent diets in summer were dominated by *Salix* spp., sedges, and lichens. However, forb inflorescences and stems were largely undetected by the microhistological technique and results for summer samples must be interpreted accordingly. We conclude that the conservation and management of forest ecotypes of caribou must include options of lichen-rich habitats as a major component of management plans.

Key words: alpine, boreal, cordillera, forestry, subalpine, microhistology, *Rangifer tarandus caribou*

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Introduction

Knowledge of diet is fundamental to definition of a species niche, habitat, and ecology. Dietary information for woodland caribou is scanty in boreal and cordilleran forests of western Canada east of the Continental Divide. Such information is needed to help conserve caribou in the southern commercial forest, which will be permanently altered by forestry and other developments. The primary habitat concern is reduced proportions and sizes of post-rotation forests and fragmentation. Furthermore, managers of protected ecosystems, such as Jasper National Park, are responsible for vegetation management that affects food supplies of caribou and the ecology of all species. What sorts of habitats should be safeguarded? Are lichens essential to the viability of forest-alpine ecotypes of caribou in western Canada?

Our primary objective was to assess and compare the winter diet of populations of caribou in west-central Alberta in relation to season, snow characteristics, and geographic location. One group of fecal samples came from winter ranges on the "east slopes" of the Rocky Mountains and are termed the "foothills" group. In winter, there are two subpopulations within each population of mountain (forest-alpine) and woodland (forest) ecotypes of caribou in the foothills (Edmonds, 1988) (Fig. 1). The forest-alpine ecotype migrates into alpine areas of the Willmore Wilderness, northern Jasper National Park, and adjacent British Columbia to calve and spend the summer. In addition, composite samples were obtained from a forest ecotype that occupies habitat year-round in the boreal forest. The second group of samples came from caribou wintering in the Rocky Mountains, mostly in watersheds of Jasper National Park. These caribou, in three subpopulations, traverse alpine, subalpine, and montane regions over short distances.

We also examined feeding craters dug in the snow by caribou in both areas. The purpose was to obtain independent information on diet by examining plant species present at feeding sites. Another objective was to obtain insights into forage selection by caribou by comparing data from the microhistological technique with the relative frequency of plant species found in feeding craters. Additionally, we checked the accuracy of the microhistological technique on plant species mixed by dry weight in proportions that simulated winter diet. We also assessed the ability of the technique to detect plants in the summer diet.

Methods

Pellets were obtained throughout the year from several locations on the ranges of the caribou populations. Fresh pellets from 5-30 groups were pooled into a composite sample by taking about equal amounts (2-

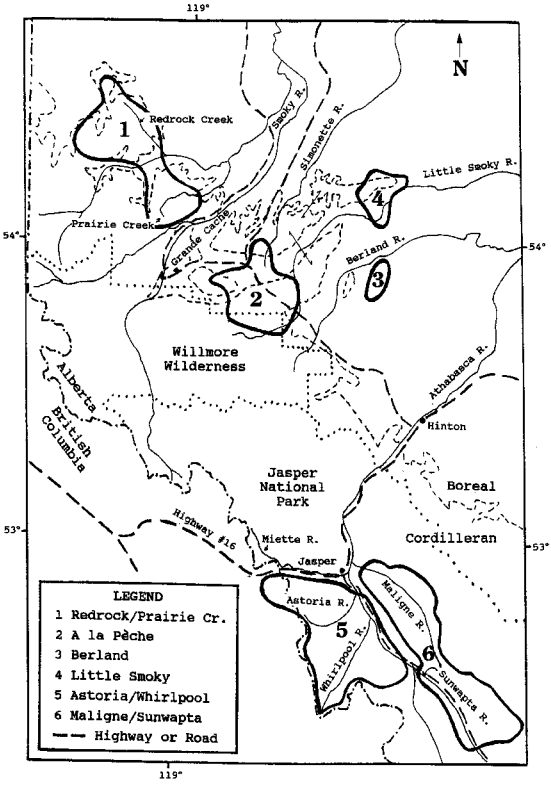

Fig. 1. Locations where fecal samples were obtained for this study of caribou diet.

Table 1. Plant fragment densities in caribou fecal pellets collected in winter from 1979-80 through 1982-83 in the Alberta foothills[a].

	Fragment densities (%)			
	1979-80	1980-81	1981-82	1982-83
No. of samples	7	23	37	12
Ave. snow depth: openings	60	<45	91	<45
Ave. snow depth: craters	41	15	62	25
Terrestrial lichens[b]	60	71	79	72*
Arboreal lichens	<1	<1	2	<1
Graminoids	6	5	3	4
Conifer (*Pinus & Picea*)	22	16	14	13
Equisetum spp.	<1	1	1	NA[c]
Shrubs	6	5	1	4
Moss	2	<1	0	2
Other species	3	1	0	4

[a] A la Peche, Prairie Creek, and Little Smoky River regions.
[b] *Cladonia*-type, *Cetraria*-type, and *Peltigera* spp. lichens.
[c] Data not available.
* indicates significant variation in row (Chi-square $p<0.05$).

5 pellets depending on size) from each group. Microhistological analyses at the Composition Analysis Laboratory in Fort Collins, Colorado, consisted of 20 fields in each of 5 slides. Percent relative densities of discerned plant fragments was shortened to "fragment densities" in this report, and termed "apparent diets" to facilitate presentation of results.

Plant species present at the bottom of snow craters dug by caribou were recorded and converted to frequency of occurrence. Those data reveal little about relative consumption of forages by caribou. However, inferences can be made about plant selection by comparing occurrence in craters with fecal analyses and by observing plant composition in craters and peripheral to them. Snow depths and hardness were recorded at a minimum of 10 points at crater peripheries and in openings in the forest. Caribou were observed feeding in summer and the frequency occurrence of grazed plants (parts removed) were tallied. Two mixtures of plants with dry weights that simulated winter diets were sent to the laboratory and the results compared.

All comparisons of plant species composition in fecal samples among seasons, areas, and years were tested using Chi-square and Kruskal-Wallis tests. Data for months, years, and locations were pooled where there was no statistical difference ($p>0.05$) between or among them. Comparisons between the two major study areas were made after results were adjusted by the amount of conifer needles and moss. We assumed that both of those plant groups were ingested incidentally with lichens and diet comparisons were best made on species selected by caribou.

Results

Apparent Winter Diet in the Foothills

Seventy-nine composite fecal samples were obtained from the A la Peche, Prairie Creek, and Little Smoky River drainages (Fig. 1) throughout the winters (October-April) of 1979/80 through 1982/83 (Edmonds & Bloomfield, 1984). The apparent diets were almost identical for all three areas and winter months. Therefore, data were pooled. The apparent diet of caribou on winter ranges in the foothills varied little over four winters in spite of pronounced differences in snow depth (Table 1).

Winter diet in the Rocky Mountains

Apparent diets were similar among years within watersheds (Thomas, 1993) but species composition

Table 2. Plant fragment densities in caribou fecal pellets collected from October through April, 1988-89 and 1989-90, in the Rocky Mountains[a].

	Fragment densities (%)						
	Early winter				Late winter		
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr
No. samples	7	7	8	6	8	9	8
Terrestrial lichens	79	78	83	79	71	70	67
Arboreal lichens	1	1	1	1	1	1	1
Graminoids	5	2	2	2	1	1	2
Conifer needles	4	7	6	9	13	12	18*
Equisetum spp.	3	2	2	2	0	1	2
Ledum spp.	3	4	3	4	6	7	5
Moss	2	3	3	2	7	6	4
Other species	3	3	0	1	1	2	1

[a] Maligne, Astoria, and Sunwapta river valleys of Jasper National Park.

* indicates significant variation in row (Chi-square $p<0.05$).

changed over the winter (Table 2). In comparisons of early and late winter, proportions of terrestrial lichens, graminoids, and *Equisetum* spp. declined while proportions of conifers, *Ledum* spp., and mosses increased.

Variations in apparent diets were slight in early winter among three regions in the mountains: Maligne, Astoria, and Sunwapta watersheds (Fig. 1). In late winter, plant species compositions were similar in caribou feces from those watersheds. However, proportions of terrestrial lichens were lower in two watersheds (Miette & Whirlpool, Fig. 1), near the Continental Divide, and in areas south of Jasper National Park. Increased proportions of *Ledum* spp. and moss accounted for most of the difference.

Winter dietary information for the Rocky Mountains (Table 2) excluded results from two areas where atypical foraging occurred in winter. Caribou foraged on the Medicine Lake drawdown delta, where fresh pellets collected during the winter contained mostly fragments of *Equisetum variegatum*. At a second location of the Maligne Valley, caribou fed mostly on arboreal lichens (*Bryoria* spp. and *Alectoria* spp.) in forests older than 400 years and with an easterly exposure. Long-strand lichens grew on widely spaced large and tall fir (*Abies lasiocarpa*) and spruce (*Picea englemanni*). That protein-poor diet (Nieminen & Heiskari, 1989) was supplemented with *E. scirpoides*.

The two species of horsetails that were eaten by caribou in winter were winter-green forms. Samples of *E. variegatum* and *E. scirpoides* obtained in July contained 10.2% and 9.2% protein, respectively. Three samples of *E. scirpoides* collected in March in Saskatchewan contained 6.8% protein.

Table 3. Mean relative densities of plant fragments in winter feces of two populations of caribou in Alberta and the densities adjusted by the proportion of conifer needles and moss.

	Foothills[a]			Rocky Mountains[b]		
	Unadjusted		Adjusted[c]	Unadjusted		Adjusted[c]
Plant group	Mean	SD	Mean	Mean	SD	Mean
Terrestrial lichens	69.9	(10.4)	85	74.3	(11.7)	87
- *Cladonia* type	41.1	(8.7)	50	69.7*	(11.6)	82
- *Cetraria* type	25.0	(6.3)	30	2.5*	(2.2)	3
- *Peltigera* spp.	3.8	(5.6)	5	2.0	(3.3)	2
Arboreal lichens	1.1	(1.1)	1	0.9	(1.0)	
Low shrubs	4.4	(2.9)	5	5.5	(7.8)	6
Graminoids	4.7	(3.2)	6	2.0	(2.3)	2
Equisetum spp.	0.7	(0.7)	1	1.2	(1.9)	
Other species	1.4		1	1.2		3
Conifer needles	17.1	(7.9)	10.7	(7.6)		
Moss	0.7	(1.4)	4.2	(4.9)		

[a] A la Peche, Prairie Creek, and Little Smoky River watersheds (n=79 composite samples).

[b] Maligne, Astoria, and Sunwapta valleys (n=53 composite samples).

[c] Adjusted by the proportion of conifer needles and moss to reflect forages selected by caribou and not consumed incidentally with lichens.

* Significant difference (Chi-square and *t* test).

Alpine areas with adequate food supplies were used in the foothills and the mountains in winters when the slopes were windswept. *Dryas* spp. was the most consistent item in the diet. In a sample from northern Jasper National Park, *Vaccinium* spp. (mostly berries) and *Dryas* spp. comprised 88% of the fecal fragments.

Apparent diet in the foothills and the Rocky Mountains

There was no statistical difference in the results for major forage groups between the two major wintering areas (Table 3). There were significant differences within plant types, such as less *Cladonia*-type lichens and more *Cetraria* spp. and conifer needles in the foothills samples. Other differences not reflected in Table 3 were more *Vaccinium/Empetrum* and less *Ledum* spp. in fecal samples from the foothills compared with those from the mountains.

Frequency of occurrence of plant species in craters

Frequency of occurrence (presence-absence data) in craters revealed high occurrences of *Cladonia* spp.,

Table 4. Frequency of occurrence of abundant plant species in snow craters dug by caribou throughout winter in the foothills and Rocky Mountains.

Species or group	Frequency of occurrence (%) in craters[a] Foothills (n=478)	Maligne (n=105)	Cavell (n=132)	Sunwapta (n=79)	Poboktan (n=52)
Cladonia type	63	90	89	92	67
Cladina mitis	64	79	86	28	19
Peltigera spp.	19	71	45	61	56
Stereocaulon spp.	12	20	19	3	2
Graminoids	23	30	4	42	94
Ledum spp.	52	36	43	11	12
V. vitis idaea	61	75	64	58	25
Moss	47	66	58	65	71

[a] 50% means that the plant was detected in half of the craters examined. These are presence-absence data.
Note: Variation significant (Chi-square, $p<0.05$) in rows except moss.

Cladina mitis, *Peltigera* spp., moss, *Ledum* spp., and *Vaccinium vitis-idaea* (Table 4). There was significant regional variation in the proportion of *Cladonia*-type lichens and a major component, *C. mitis*. The consistency of winter diet (Table 3) in contrast to the significant variation in major vegetation species in the craters (Table 4) indicated that caribou were selecting for *Cladina*-type lichens and selecting against low shrubs and moss.

Summer diet in the Rocky Mountains

Terrestrial lichens, *Salix* spp., and graminoids comprised 84-91% of apparent diets of the mountain populations of caribou (Table 5). Proportions varied significantly over the 3 months, reflecting changing preferences and, perhaps, dietary variation among groups of caribou. Sedges were eaten as early as mid-April in valley bottoms. Forb meadows, in seepage areas and along alpine streams, were used extensively in summer. In mid-August, caribou consumed at least 19 species of forbs in alpine areas that went undetected in the fecal samples collected concurrently

Table 5. Plant fragment densities in caribou feces collected from June through August, 1989-90, in alpine areas of the Rocky Mountains.

Month	Fragment densities (%) June	July	August
No. comp. samples	3	10	10
Terrestrial lichens[a]	55	29	40
Salix spp.	16	45	25
Graminoids	14	10	26
Conifer needles	7	<1	3
Moss	3	5	2
Equisetum spp.	1	4	2
Ledum spp.	2	3	2
Arboreal lichens	1	<1	<1
Other	1	3	0

[a] *Cladonia*, *Cetraria*, and *Peltigera* types.
Note: These data are biased by absence of forbs (see text).

Table 6. Percent composition (dry weight) of plant species in two mixtures simulating the apparent diet of caribou in the mountains in early and late winter and microhistological ("micro") fragment relative densities of the undigested mixture.

Plant species	Composition (%) Sample #1 Mixture	Sample #1 Micro	Sample #2 Mixture	Sample #2 Micro
Cladonia type[a]	75	75.8	65	70.5
Cetraria nivalis	3	2.3	2	0.3
Bryoria spp.	1	3.1	1	6.0
Usnea spp.	0	1.0	0	0.1
Peltigera apthosa	2	2.2	2	2.6
Ledum spp.	4	5.6	6	7.2
Pinus contorta	6	0.9	12	4.3
Picea englemanni	1	0	2	0
Carex spp.	3	2.7	3	1.1
Poa spp.	0	0.9	0	0.2
Pleurozium schreberi	3	4.4	6	6.5
Equisetum scirpoides	2	1.1	1	1.0

[a] Proportions (%) in samples 1 & 2, respectively: *Cladina mitis* 40, 34; *C. rangiferina* 10, 9; *Stereocaulon* spp. 10, 9; *Cladonia uncialis* 5, 4; Other *Cladonia* spp. 10, 9 (*Cladonia cornuta* and *Cladonia ecmocyna* in a 1:1 ratio).
[b] Dead, brown needles in the litter.

(Thomas, 1993). Therefore, apparent diets in summer may be highly biased using the microhistological technique, as cautioned by others (e.g., Boertje *et al.*, 1985).

The only data for the population that wintered in the foothills was for August in alpine areas north and northwest of Jasper National Park. There, the apparent diet was 54% terrestrial lichens, 38% shrubs, 5% graminoids, 2% forbs, and 1% arboreal lichens (Edmonds & Bloomfield, 1984). By late September and October, in the same area, the lichen component increased to 73% and shrubs decreased to 16%.

Plant proportions versus fragment relative densities

The microhistological results for two non-digested mixtures that simulated diet revealed close correspondence except for Pinus contorta needles and *Bryoria* spp. (Table 6).

Discussion

The winter diet of caribou in west-central Alberta did not change appreciably, either spatially or temporarly, provided the snow cover was soft, regardless of depth. The differences in apparent diet among locations in the mountains reflected, for the most part, variations in relative forage availability caused by deep snow containing hard layers, including ice. High evergreen shrub and moss content in the winter diet were indicators of poor range condition or poor availability, as found in Alaska (Boertje, 1984).

The diet of three subspecies of caribou that winter in boreal and cordilleran forests, where soft snow generally is <60 cm deep, were remarkably similar (Thomas & Barry, 1991; Russell *et al.*, 1993, this study). This similarity points to caribou "lichenophilia" and a high degree of consistency in surface vegetation under mature and old-growth pine forests over wide geographic areas.

The genus *Rangifer* is a lichen specialist although other herbivores eat lichens opportunistically. Caribou can survive on graminoids, forbs, and low shrubs in certain environments. These generally are insular, non-migratory populations not subject to much predation or severe insect harassment. The large herds of caribou exploit terrestrial lichens without exception. All species except *Peltigera* spp. occurred more frequently in caribou craters than in random snowplots used as controls (Edmonds & Bloomfield, 1984). Paradoxically, the other lichen genus with high protein content, *Stereocaulon*, is eschewed by caribou where it is abundant (Thomas, 1994).

Terrestrial lichens, when damp and where available, are consumed in summer by caribou (rev. by Boertje, 1984; Thomas, 1993). They are a high energy source and their continued use in summer may be necessary to maintain a microflora that is efficient at digesting them.

Winter-green forms of *Equisetum* spp. are selected by caribou in winter as indicated by high use of *E. variegatum* on the Medicine Lake delta and cratering for the sparse, wiry *E. scirpoides*. Moose (*Alces alces*) also cratered for the same species. *Equisetum* spp. generally have protein levels of 8% to 10% (range 5% to 15%) and are rich in minerals (Nieminen & Heiskari, 1989). Winter-green grasses and sedges are also important sources of protein in winter.

Management implications

Caribou dietary information and field observations in the study areas indicated the need for winter habitats where terrestrial lichens were relatively abundant. These generally were open, pine-dominated forests older than 80 and 100 years in the Foothills and Rocky Mountains, respectively. In winters with deep and crusted snow, some caribou moved to areas of more-favourable snow. Those were old spruce/fir dominated forest (>130 years in the Foothills and >200 years in the mountains) with high arboreal lichen biomass; alpine ridges with little snow cover; or subalpine and montane valleys with relatively shallow snow.

Alternative wintering areas may become important or critical to caribou in only 1 winter of 10 or 20. There are at least three reasons why caribou need optional areas to forage at regional and local scales. (1) They need optional regions to travel to when environmental conditions are unfavourable in parts of the traditional winter range. (2) They need alternate areas to prevent overgrazing and to allow grazed areas to recover lichen biomass. Caribou appear to rotate use of winter range by using one area for several winters and then shifting to another area. (3) They need optional habitat types locally when snow precludes them from using other types. These options must be left open for caribou in planning their habitat needs in managed forests.

Conclusions

The apparent winter diet of caribou populations was similar among foothills and Rocky Mountain regions in spite of significant regional variation in the vegetation at feeding sites. Diet changed involuntarily as vegetation became increasingly inaccessible because of thick snow containing icy layers.

Summer diet was dominated by graminoids, *Salix* spp. (leaves), terrestrial lichens, and an unknown proportion of forbs that went undetected by the microhistological technique.

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