

Seasonal Diets of the Denali Caribou Herd, Alaska

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ABSTRACT. Food habits of the Denali (formerly McKinley) herd of barren-ground caribou (*Rangifer tarandus granti*) were studied during 1978-80 in Denali National Park, Alaska, with emphasis on diets of adult females. Data from fecal analyses, field observations, and forage digestibilities were combined to estimate diets. Spring (late May to July) diets contained primarily *Salix* leaves (41%), lichens (25%), forbs (16%), and graminoids (12%). Summer (mid-July to mid-August) diets were similar, containing about 46% *Salix* leaves, 17% lichens, 10% forbs, 10% graminoids, and 12% mushrooms. In contrast, autumn (mid-September to mid-October) diets consisted primarily of lichens (43%) with less proportions of forbs (9%), graminoids (14%), mushrooms (10%), and mosses (5%). Winter (mid-November to early May) diets consisted largely of lichens (62%) and small proportions of *Vaccinium vitis-idaea* (6%), forbs (7%), graminoids (11%), and mosses (10%).

Key words: caribou, Denali National Park, diets, fecal analysis, food habits, *Rangifer*

RÉSUMÉ. Les habitudes d'alimentation du troupeau Denali (autre-fois nommé McKinley) de caribous des landes (*Rangifer tarandus granti*) furent étudiées entre 1978 et 1980 dans le parc national Denali, en Alaska, avec une attention particulière portée sur le régime des femelles adultes. Des données tirées d'analyses fécales, d'observations sur le terrain et de la digestibilité du fourrage furent combinées en vue d'évaluer les régimes. Les régimes printaniers (fin mai à juin) contenaient surtout des feuilles de *Salix* (41%), des lichens (25%), des herbes folles (16%) et des graminés (12%). Les régimes d'été (mi-juin à mi-août) étaient semblables, comptant environ 46% en feuilles de *Salix*, 17% en lichens, 10% en herbes folles, 10% en graminés et 12% en champignons. En contraste, les régimes d'automne (mi-sept. à mi-oct.) consistaient surtout de lichens (43%) avec des proportions moins élevées d'herbes folles (10%) et de mousses (5%). Les régimes d'hiver (mi-nov. au début-mai) consistaient en grande partie de lichens (62%) et de proportions peu élevées de *Vaccinium vitis-idaea* (6%), d'herbes folles (7%), de graminés (11%) et de mousses (10%).

Mots clés: caribou, parc national Denali, régimes, analyse fécale, habitudes d'alimentation, *Rangifer*

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INTRODUCTION

During 1978-80, the nutritional status of the Denali (formerly McKinley) caribou (*Rangifer tarandus granti*) herd was studied. Data on seasonal diets were used in modeling the herd's forage and nutrient requirements (Boertje, 1981).

Bergerud (1977) summarized results of several studies on caribou food habits. More recent studies are by Sulkava *et al.* (1983) and Thomas and Edmonds (1983). Caribou diets generally contain large numbers of plant species, and diets vary greatly among herds, presumably depending on the availability of palatable species. Several major factors may alter the seasonal diets of a caribou herd, including winter snow conditions, the timing of snowmelt, the timing and degree of insect harassment, plant phenology, and variations in migratory movements.

This paper reports year-round estimates of the diets of a caribou herd with emphasis on diets of adult females.

STUDY AREA

The present range (about 5220 km²) of the Denali caribou herd is centered within Denali National Park at 63°30'N latitude and 150°30'W longitude (Fig. 1). Treeline is about 760 m, and trees (primarily spruce, *Picea* spp.) are common along the river drainages at this elevation. The caribou are usually at higher elevations, except on the western wintering grounds. At mid-elevations (760-1220 m) on the Cantwell calving ground and summering range, mosaics of sedge tundra (*Carex* spp.) and shrub tundra (*Salix* spp. and *Betula nana*) dominate. At mid-elevations on the rutting ground, Stampede

calving ground, and eastern wintering area, tussock tundra (*Eriophorum vaginatum*) dominates the landscape, although small ponds and drainages are commonly surrounded by *Carex* spp., grasses, and shrubs (mostly *Salix* spp.). The western wintering area is largely a spruce forest with tussock, shrub, and sedge tundra occurring in the eastern portion in the Kantishna Hills. Lichen mats are well developed only on the summering range and the western wintering area.

METHODS

Collection and Analysis of Fecal Samples

Composite fecal samples were collected following Hansen and Gold (1977) and contained 25 fecal pellets, one from each of 25 different fresh-pellet groups. Samples from adult female caribou totaled 27; eight were collected periodically throughout spring (26 May-25 June), five in summer (20 July-18 August), four in autumn (20 September-11 October), and 10 in winter (20 November-9 May). Calf fecal samples (N=2) were collected on 23 June and 28 July; those of bulls (N=3) on 12 July, 28 August, and 9 September. Samples were collected in all available habitat types following observations of caribou activity. Collection of the feces of a tame reindeer was made 30-48 hours following grazing trials in August.

Analysis of fecal samples (Sparks and Malechek, 1968) was conducted at the Composition Analysis Laboratory at Colorado State University, Fort Collins. The relative density of plant fragments was based on 100 fields per sample. Student's t-tests were used to test for differences among fecal samples collected from adult male and female caribou.

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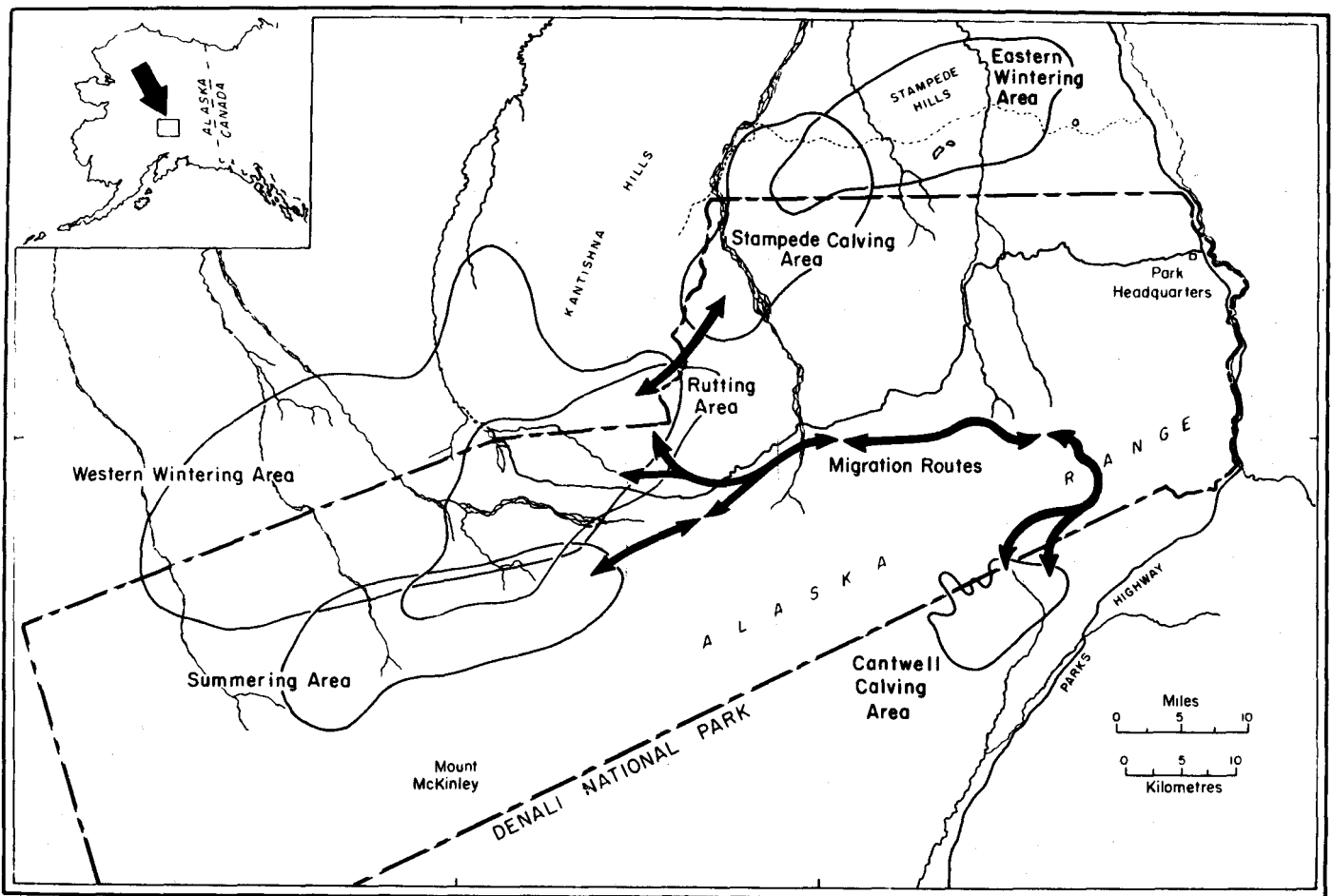


FIG. 1. Seasonal caribou ranges in Denali National Park, 1978-80.

Field Observation Techniques

Field observations were most useful in spring and summer when significant quantities of highly digestible forbs were consumed but did not appear in the fecal analyses. Direct observations of caribou forage selection were made on 190 different days. Methods included searching for grazed plants in areas intensively grazed by caribou, and observing feeding caribou at close range with binoculars (10×50) or a zoom spotting scope ($20 \times -60 \times$).

Investigations of grazed areas involved estimating percent cover of individual plant species and recording plant species found grazed and the relative amounts of the species selected. It was readily apparent which plant species were preferred by caribou. Preference denotes that plant species were selected in greater proportions than they were available in the environment (Petrides, 1975). Palatability is defined as plant characteristics or conditions which stimulate a selective response by animals (Young, 1948).

Observations of grazing caribou at close range indicated that certain plant species were grazed by caribou and not by other animals. Continuous observations usually lasted only for short periods, often less than two or three minutes, either because the caribou detected me and ceased feeding or because I could not detect which plants were being selected.

Grazing trials with a tame reindeer involved counting bites

of each forage species. Bites contained approximately equal amounts of dry matter, and bite counts were assumed to approximate the reindeer's diet.

TABLE 1. Percent plant composition of the diet and feces of a tame reindeer, Denali National Park, August 1978

Plant genus or group	Estimated dietary composition*	Fecal composition
<i>Salix</i>	40	54
Lichens	23	31
Forbs	13	1
<i>Vaccinium</i>	10	6
<i>Dryas</i>	7	7
Mushrooms	5	0
Graminoids	2	1

*Based on bite counts

Derivation of Diets

Fecal analyses often inadequately estimate diet composition (Dearden *et al.*, 1975; Vavra *et al.*, 1978; Samuel and Howard, 1983) as was found in this study (Table 1). Therefore, to derive diets, fecal analyses (Table 2) were altered by correction factors derived from an integration of observational and digestibility data. Details are described in Boertje (1981).

TABLE 2. Average percentages (\pm s.d.) of discerned plant fragments in fecal samples collected from adult female caribou, Denali caribou herd, 1978-79

Plant genus or group	Season			
	Spring (26 May- 25 Jun) N=8	Summer (20 Jul- 18 Aug) N=5	Autumn (20 Sep- 11 Oct) N=4	Winter (20 Nov- 9 May) N=10
Lichens	38 \pm 21.0	28 \pm 17.5	68 \pm 12.0	66 \pm 13.4
<i>Salix</i>	50 \pm 22.0	56 \pm 23.6	8 \pm 7.0	1 \pm 1.5
Mosses	3 \pm 2.1	2 \pm 1.2	13 \pm 8.2	18 \pm 10.1
<i>Carex</i>	5 \pm 4.1	4 \pm 2.5	1 \pm 0.6	2 \pm 1.7
<i>Vaccinium</i>	2 \pm 1.7	1 \pm 1.3	2 \pm 1.7	8 \pm 2.5
Mushrooms	0	6 \pm 9.7	4 \pm 1.9	1 \pm 1.7
<i>Equisetum</i>	1 \pm 1.3	<1	2 \pm 1.3	1 \pm 1.0
<i>Festuca</i>	1 \pm 0.5	1 \pm 0.9	<1	<1
<i>Hierochloe</i>	<1	<1	1 \pm 0.9	1 \pm 0.6
<i>Dryas</i>	0	1 \pm 0.8	1 \pm 0.1	<1
<i>Ledum</i>	<1	0	<1	1 \pm 1.3

RESULTS AND DISCUSSION

Spring

Most adult females occupy the Cantwell calving ground (Fig. 1) during spring. The early spring diet in this area was dominated by lichens and, to a lesser extent, overwintering berries, *Salix* catkins and buds, and partially green graminoids (Table 3). Caribou intensively used local areas of early phenological development in late May and early June, during which highly diverse deciduous shrub species constituted about 45% of the diet. Intensive feeding on the new leaves of *Vaccinium uliginosum*, *Betula nana*, *Arctostaphylos* spp., and *Salix* spp., particularly *Salix pulchra*, was observed during the first week of June. Only *Salix* spp. were grazed intensively following this period. This temporary intensive use of new leaves from a wide variety of species is attributed to their relatively high nutrient content (Chapin *et al.*, 1980) and their low content of plant defensive compounds (Rhoades and Cates, 1976).

TABLE 3. Approximate percentages of major foods* in the seasonal diets of adult female caribou, Denali caribou herd, 1978-79, based on fecal analyses, field observations, and forage digestibilities

Plant group	Season			
	Spring (26 May- 25 Jun)	Summer (20 Jul- 18 Aug)	Autumn (20 Sep- 11 Oct)	Winter (20 Nov- 9 May)
Lichens	25	17	43	62
Deciduous shrubs	45	48	14	1
Graminoids	12	10	14	11
Forbs	16	10	9	7
Mushrooms	0	12	10	2
Mosses	0	0	5	10
Evergreen shrubs	0	1	2	7
Berries	2	2	3	0

*Plant parts selected included almost exclusively leaves from shrubs and the upper portions of forbs, graminoids, and lichens.

Several species of forbs were heavily grazed during early phenological stages, including *Anemone*, *Artemisia*, *Boykinia*, *Dodecatheon*, *Equisetum*, *Mertensia*, *Pedicularis*, *Petasites*, *Potentilla*, *Stellaria*, *Streptopus*, and *Valeriana*. Young shoots of *Epilobium angustifolium* and *Sanguisorba stipulata* were most important. Forbs composed 16% of the spring diet (Table 3), comparable to spring diets of caribou in Newfoundland (Bergerud and Nolan, 1970; Bergerud, 1972). Graminoids were heavily grazed at times, particularly the young fast-growing shoots of *Carex podocarpa* in alpine herb meadows, and, to a lesser extent, *Eriophorum vaginatum*, *E. angustifolium*, and *Festuca altaica*.

Summer

My estimate of 17% lichens in the summer diet of the Denali caribou (Table 3) is comparable with Palmer's (1926) estimate of 15% lichens in the summer diet of reindeer along the western Alaskan coast. Likewise, Bergerud (1972) found that summer rumen samples of caribou in Newfoundland contained 22% lichens, and Bergerud and Nolan (1970) found 15% lichens in the summer diet of hand-reared caribou. Summer rumen samples collected near Prudhoe Bay, Alaska, where lichens are extremely scarce, contained only 3% lichens (White *et al.*, 1975). The summer range of the Denali herd (Fig. 1) contains an abundance of lichens, in contrast to Skoog's (1968) finding that lichens were scarce on the summer ranges of Alaskan caribou.

Forbs contributed about 10% of the summer diet (Table 3). The decrease from spring forb percentages was attributed to decreased palatability and availability. Bergerud and Nolan (1970) and Bergerud (1972) noted a comparable seasonal decrease in Newfoundland. Caribou rumen samples collected near Prudhoe Bay, Alaska, contained 10% forbs in July (White *et al.*, 1975).

Graminoids (10%) (Table 3) included *Carex podocarpa*, *C. bigelowii*, *Festuca altaica*, and *Hierochloe alpina*, in agreement with Skoog's (1968) data for the Fortymile and Nelchina caribou herds. Upland *Carex* spp. and *Hierochloe alpina* were particularly important when caribou were restricted to ridgetops and upper slopes by insect harassment.

Deciduous shrubs contributed about 50% of the summer's total food intake (Table 3). Prostrate willows, including *Salix arctica*, *S. reticulata*, and *S. rotundifolia*, made up a major portion of the *Salix* component of the diet, especially when the caribou retreated to high slopes and wind-exposed ridgetops when harassed by insects. *Salix pulchra* and *S. alaxensis* appeared to be the most palatable willows throughout the spring and summer, but these species predominate at lower elevations. Although *S. alaxensis* is highly palatable to caribou, it often forms tall thickets along drainages, and adult females, particularly those with calves, exhibited alarm behavior when traveling through these thickets. Bull caribou were much less apprehensive of grazing among tall willows.

My estimate of 12% mushrooms in the summer diet (Table 3) is low compared with other studies; however, mushrooms were relatively scarce until early to mid-August. Skoog (1968)

found that fungi composed about $45\% \pm 23$ (s.d.) of the total volume of 19 rumen samples from caribou of the Fortymile herd killed in late August 1954. Fungi composed about 25% of the volume in 14 caribou rumen samples in summer in Newfoundland (Bergerud, 1972).

Mushroom fragments were identified in all fecal samples collected after the first of August, and identified periodically throughout the winter until early May. Large mushrooms of the genus *Boletus* occurred most frequently in the diet, followed closely by the genera *Lactarius* and *Russula*. *Amanita* was avoided although it was abundant. Karaev (1968) stated that *Amanita* produced signs of poisoning in reindeer.

Skoog (1968) and others have reported the ingestion of berries by caribou. I observed the use of berries from *Vaccinium uliginosum* and *V. vitis-idaea*. An indication of the berry component of the diet was substantiated through analysis of the tame reindeer's feces (Table 1).

Autumn

As availability and palatability of summer forages declined due to frosts in early autumn, an increase in proportions of winter foods occurred in the diet, predominately lichens (43%) (Table 3). *Stellaria longipes*, which remained partially green, and *Equisetum* spp. were the major "forbs." *Salix* fragments in autumn fecal samples declined gradually, until *Salix* failed to be detected in the 11 October sample. However, caribou were observed grazing for brief intervals the brown, persistent leaves of *S. pulchra* throughout late autumn and winter. *Carex aquatilis*, *Festuca altaica*, and *Hierochloe alpina* remained partially green and were grazed intensively. Through analysis of rumen samples, Skoog (1968) documented increasing use of graminoids by the Fortymile caribou as autumn progressed.

Winter

The 62% lichens in the winter diet (Table 3) is comparable with results of other studies (Scotter, 1967; Skoog, 1968; Gaare and Skogland, 1975; Skjenneberg *et al.*, 1975).

Evergreen *Equisetum variegatum* was grazed repeatedly in wet sedge meadows, while *E. arvense*, a non-evergreen species, was frequently eaten by caribou in shrub communities. Green stems of *Carex aquatilis* and other *Carex* spp. were also sought repeatedly in wet sedge meadows in winter. *Festuca altaica*, *Hierochloe alpina*, and *Stellaria longipes* also retained some green tissue in winter. Karaev (1968) summarized ideas related to the importance of green winter foliage.

Evergreen shrubs were used by caribou only during winter, and *Vaccinium vitis-idaea* was the only species consistently identified in the feces. It had relatively high *in vitro* digestibilities (44%) compared to other evergreen shrub species (6-11%) (Boertje, 1981). Karaev (1968), Skoog (1968), and Steen (1968) agree that evergreen browse species, including *Vaccinium vitis-idaea*, *Ledum palustre*, and *Empetrum nigrum* are not preferred foods of *Rangifer*, because of their relatively low palatability (Nagy and Regelin, 1977)

and digestibility (Boertje, 1981). Relatively high use of certain evergreen shrubs and mosses by caribou probably indicates poor range conditions.

TABLE 4. Average percentages of discerned plant fragments in fecal samples collected from calf and bull caribou, Denali caribou herd, 1978-79

Plant genus or group	Calf samples		Bull samples		
	23 Jun	28 Jul	12 Jul	28 Aug	9 Sep
Lichens	65	46	1	6	40
<i>Salix</i>	29	41	97	87	15
Graminoids	6	7	1	1	4
<i>Vaccinium</i>	0	0	0	1	19
Mushrooms	0	0	0	5	8
Mosses	0	3	0	0	8
<i>Dryas</i>	0	2	0	0	3
Forbs	0	1	1	0	3

Diet Composition of Calves and Adult Bulls

Two calf samples collected in spring and summer (Table 4) contained 50-100% more lichen fragments than samples from adult females collected on the same date and from the same group of caribou. Through analysis of rumen samples, Bergerud (1972) found that young caribou calves consumed large proportions of lichens and mosses and that intake of deciduous shrubs was significantly lower ($p < 0.001$) in calf diets compared with diets of adult females. I found no increased use of mosses by calves. This difference may be due to differences in the accessibility of lichens on the two ranges, since incidental intake of mosses would probably increase on a range where lichens were scarce.

Two fecal samples were collected from bulls in summer (Table 4). Both samples had significantly ($p < 0.001$) more fragments of *Salix* (averaging 92%) compared with samples from adult females (averaging 56%) for the same period.

SUMMARY AND CONCLUSIONS

Fecal analyses were useful in comparing use of lichens, shrubs, and mosses between seasons and between age and sex classes. Fecal analyses alone, however, inadequately estimated seasonal diets, and field observations or other techniques are essential to determine species and approximate proportions of green forbs and mushrooms in the diet.

Preferred foods of caribou in Denali National Park include lichens, mushrooms, willows, horsetails, and green forbs. Spring diets contained primarily *Salix* leaves (41%), lichens (25%), forbs (16%), and graminoids (12%). Summer diets were similar, containing about 46% *Salix* leaves, 17% lichens, 10% forbs, 10% graminoids, and 12% mushrooms. In contrast, autumn diets consisted primarily of lichens (43%) with lesser proportions of forbs (9%), graminoids (14%), mushrooms (10%), and mosses (5%). Winter diets consisted largely of lichens (62%) and small proportions of *Vaccinium vitis-idaea* (6%), forbs (7%), graminoids (11%), and mosses (10%).

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