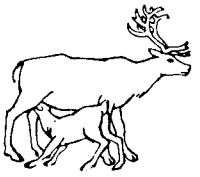

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Executive summary

Introduction

The large Porcupine Caribou Herd of Grant's caribou (*Rangifer tarandus-granti*) migrates annually from summer range on the arctic coastal plain of Alaska and Yukon to winter in the forested valleys and plains of north-central Yukon and western Alaska. Concern for the well being of the herd in response to existing and proposed developments within their range, and the need for more knowledge on the range ecology of the species prompted this study. The work was conducted primarily by the Canadian Wildlife Service, initially as a joint project with the Yukon Department of Renewable Resources and continued from 1979 to 1987. We have divided the report into three major chapters, covering the winter, the late spring and the summer. Throughout these chapters we refer to 15 periods in the annual life cycle of the herd. In the final chapter, we discuss the energetic implications of our findings.

Winter

Characteristics of the range

The Yukon portion of the winter range of the herd occupies an extensive area in the north-central Yukon, from just north of Dawson City in the south, to the Beaufort Sea in the region of the Richardson Mountains in the north. This region was largely unglaciated during the last ice age and offers a wide diversity of habitats, from the sheltered valleys of the Ogilvie and Hart Rivers, to the mountainous terrain of the Richardson Mountains and to the lichen-rich habitats of the Eagle Plains, Whitestone and Miner Rivers.

The herd appears to occupy the core wintering regions on a rotational basis, using the Ogilvie/Hart region for a few years and then occupying the Richardson Mountains (Russell *et al.* 1992b). These two regions receive less snow than adjacent areas. Two major storm systems affect the area. The Pacific system moves north from the Gulf of Alaska and deposits considerable snow on the southern flanks of the Ogilvie Mountains, forming an effective barrier to southward expansion of the winter range. The other system, originating in the Bering Sea, moves eastward, gradually depositing snow as it swings around the Nahoni Range and across the Eagle Plains, leaving the Ogilvie/Hart basins in the snow shadow of both systems.

The Richardson Mountains, although appearing to receive normal snowfall for the region, are characterized by strong winds. Many portions of the Richardson Mountains are blown free of snow for the major part of the winter. We recognized nine snow regions within our study area, based on snow courses along the Dempster Highway and extensive spring snow surveys.

For the 118 stands used to document vegetation characteristics (described in Russell *et al.* 1992a) we sampled lichen biomass, which varied between 0 and 500 g/m^2 with a mean of 65 g/m^2. Among the genera, *Cladina* and *Cetraria* were the major contributors. The Eagle Plains had significantly greater lichen accumulations than other regions, comparing favourably with winter ranges of other herds.

Sixty-eight of the stands were sampled for fire history and a mean interval between fires of 120 years was determined. Lichen biomass tended to decline with stand age for all genera except *Cetraria*. Shrub communities tended all to be in a young age class. The tundra (graminoid communities) were not sampled.

Food habits

Fecal pellets were collected during five periods in each of three winters. The composition of the fecal samples remained remarkably constant from late September through early May. Fruticose lichens predominated (64%), followed by evergreen shrubs (11%), moss (8%), horsetails (6%), foliose lichens (5%), graminoids (3%), deciduous shrubs (2%), forbs (< 1%) and mushrooms (< 1%). Feeding trials with captive animals suggest that those proportions are a reasonable estimate of the ingested diet except for fruticose lichens (71%) and evergreen shrubs (4%). Snow conditions did not have a major influence on the diet although increasing snow cover over winter may have caused decreased use of horsetails and increased use of evergreen shrubs and forbs.

Activity

The activity of the Porcupine Caribou Herd was documented from October to April for the three years of the study (1979–80 to 1981–82). Activity pattern, the alternation between active and rest cycles, was tuned to sunrise and sunset. Animals were most active at sunrise and sunset resulting in one lying period in late fall, early and mid winter, two in early fall and late winter, or three in spring. Mean length of the active/lying cycle decreased from late fall (298 min) to early winter (238 min), increased to a peak in mid-winter (340 min) then declined in late winter (305 min) and again in spring (240 min). The mean length of the lying period increased through the winter from 56 min in early winter to 114 min in mid-winter and 153 min in late winter.

Winter activity budgets (the proportion of the day spent in various activities) reflected season, daylength and snow conditions. Although daylength was the main factor influencing the proportion of the day in which caribou were inactive, lying also increased under adverse snow conditions. The proportion of time spent moving (walking, trotting and running) tended to be greatest in October-November and April, likely related to seasonal migration, and was least during periods of adverse snow conditions. Feeding intensity (the proportion of the active period spent feeding) tended to be least in October-November and greatest during periods of adverse snow conditions. It is suggested that the increased lying time and feeding intensity, and decreased mobility of the animals that were observed at times of adverse snow conditions, reflected a decrease in forage availability rather than forage quality. We propose methods of using activity budgets as a means of assessing range quality for caribou herds.

Cratering dynamics

Cratering dynamics were examined under mild (1980–81), moderate (1979–80) and adverse (1981–82) snow conditions. In the mild snow years, animals dug many small craters in a day. Forage selectivity, assessed by the amount of cratered area animals fed upon per second of feeding time, was low. In the moderate snow year caribou dug an average number of large craters and were highly forage selective. In contrast, during the adverse snow year, caribou dug a few, large craters and exhibited forage selectivity similar to the mild year. A logarithmic relationship was determined between the energy cost of digging a crater and the number of craters dug per day.

While in the crater, caribou spent most time feeding and least pawing in the mild snow year (89% and 5%, respectively) compared to the moderate snow year (83% and 15%) and the adverse snow year (70 % and 25%) . Average searching time, time spent between craters, varied from a mean of 18 sec in the mild year to 54 sec in the moderate year and 63 sec in the adverse year.

Displacement of one caribou by another from craters was related to snow conditions and the energy cost of digging craters, although the relationship differed in each winter, indicating that animal condition may have been a complicating factor.

Late spring

Characteristics of the range

The period from mid-May to the end of June is the most dynamic time of year in northern Yukon. Snow is melting rapidly and new green vegetation is changing quantitatively and qualitatively. These changes

occur at a time when caribou, migrating north from their winter ranges, are in the poorest physical condition in their annual cycle and during the period when lactating females face the highest energetic demands of the year. The Porcupine Caribou Herd uses the foothills and southernmost portion of the coastal plain during the critical calving period, with repeated use concentrating in the Jago uplands of Alaska and along the adjacent foothills and coastal plain of the Yukon north slope.

We conducted a three year study of the range ecology of female caribou on the Yukon north slope from 1979 to 1981. This area spans two distinct ecoregions; (1) the Northern Mountains ecoregion, including the foothills of the British Mountains and (2) the Coastal Plain ecoregion, with low elevation and subdued relief. There were marked differences in the weather among years; in 1979 spring was generally cool and wet with a relatively warm calving period; 1980 was the warmest year with temperatures during calving similar to 1979; 1981 had a cooler calving and a warmer and windier post-calving period than in 1979.

We used eight range types to stratify most of our sampling; alluvial willow, alluvial gravel, alluvial heath, wet sedge meadows, tussock meadows, sedge heaths, dwarf shrub heaths and alpine barrens. The warmer 1980 resulted in advanced phenological development in most range types. Alpine barren communities were the most advanced. Foothills were generally 10 days earlier than coastal communities.

Biomass sampling, although not intensive, showed that deciduous shrubs contributed most to new green annual growth followed by graminoids. Biomass change of graminoids peaked by 25 June, forbs by 5 July and shrubs after 12 July. We also documented the relative biomass of the major plant groups in the range types.

Our study area contained tussock densities comparable to those in other studies. We noted an annual variation in mean tussock flower production, confirming suggestions made by others that flower production in a given year is greatly influenced by the weather of the previous summer. In 1981, following the warm summer of 1980, we measured significantly higher *Eriophorum* flower production than in the previous two years.

The nutrient concentrations of the major plant groups showed a similar trend toward rapidly changing quality in the vegetation at this time of year. All the factors that we documented to characterize the calving grounds of the herd pointed to the importance of the two week period following calving. Most of the dynamics of the vegetation occurs between 4 June and 24 June. The region chosen for calving offers a diverse complex of range types, providing a wide array of available habitats in various stages of phenological development.

Habitat selection

Over the three years of the study, more than 50% of the animals used the tussock meadow community, particularly in the pre-calving and calving periods. Wet sedge meadows (especially in the post-calving and movement periods), alluvial heath and sedge heath were the only other types used in greater than 10% of our scan observations. We noted significant shifts in use of communities in response to early phenological development (1980) and abundant resources (*Eriophorum*, 1981). Avoidance of certain communities was attributed to both avoidance of predators (alluvial willow) and low vegetative cover (alpine barren).

Food habits

In all years, fecal fragment density switched from predominantly moss/evergreen shrub/graminoid in the pre-calving and calving periods to primarily deciduous shrub in the post- calving and movement periods. Feeding trials from captive caribou indicated that fecal fragments in late spring tend to overrepresent evergreen and deciduous shrubs at the expense of forbs and lichens.

We observed shifts in diet among years, with animals taking advantage of early phenology in 1980 and abundant *Eriophorum* in 1981.

Activity

Total cycle lengths (active+bedded) increased from the pre-calving to the post-calving period and then declined sharply in the movement periods. The percent of time spent feeding declined in the movement period (38%) from earlier stable values (55% average). The proportion of time spent walking was highest in the pre-calving (21%) and movement periods (29%) and lowest in the calving period (7%). Walking and feeding in the pre-calving period appeared to occur at the expense of time spent lying while in the movement period, increased walking reduced time spent feeding.

Based on continuous observations of focal animals, adults spent a significantly higher percent of their active time grazing than calves while calves spent a higher proportion of their active time running. Nursing bout frequency declined from pre- calving to post-calving while an increase in the duration of bouts was noted from calving to post-calving.

The period of calving was characterized by a reduction in movement, smaller group sizes and an increase in lying time. The post-calving period was marked by a further increase in lying time, a reduction in movement rates and a further increase in the median length of the active and bedded cycles. Activity budgets did not differ between the calving and post-calving periods. The movement period showed the most dramatic change in the activity of the animals. Group sizes increased dramatically, the proportion of time and rate of walking increased significantly, the proportion of time spent feeding declined significantly and the alternation between active and rest cycles was significantly reduced.

Late spring range use by bulls

By late May 1983 the bulls and non-productive females were distributed south of the mountains, where snowmelt was more advanced than farther north. Caribou used tussock meadows, dwarf shrub heaths and alpine barrens but avoided low-lying wet sedge meadows and alluvial willow thickest where snowmelt was slower. Diet consisted primarily of lichens and evergreen shrubs which were widely distributed in the habitat types used. By early June, as snowmelt progressed south of the mountains and on the eastern coastal plain, males moved northward to those areas. Intermountain basins, where snowmelt was retarded, were avoided. As the season progressed, males continued to use, and avoid, essentially the same habitat types but there was less use of dwarf shrub heaths. They continued to feed on lichens and began to use *Eriophorum* as it came into flower. In mid-June, males moved into intermountain basins as snowmelt there progressed. Caribou used tussock meadows and alluvial willow thickets as the diet shifted to *Eriophorum* and *Salix*. At that time, large aggregations of caribou formed in intermountain basins and they spent more time lying, less time walking, and had a lower rate of movement than in other periods. By late June, males began to use the tussock meadows, wet sedge meadows and alluvial willow thickets of the western coastal plain. *Salix*, which was common in all three habitat types, predominated in the diet. At that time, *Salix* on the coast was at a similar phenological stage to inland sites two weeks earlier when it was not used as heavily as *Eriophorum*. However, by late June, *Eriophorum* was in seed and therefore not as desirable a food for caribou. In late June average band size increased significantly and rate of movement was greatest as males moved westward towards Alaska. The mean length of active/rest periods decreased by about one-third. This sharp decrease may reflect both the high availability and high digestibility of young willow leaves.

In general, the distribution of male caribou followed the pattern of snowmelt and plant phenology and diet reflected both preference and phenological stage. Activity and movements were not related to snowmelt, plant phenology or diet appearing to follow a temporal pattern.

Summer

Our study was conducted from 1984 to 1986 with the objective of determining what role insect harassment played in the summer ecology of the Porcupine Caribou Herd.

Movements and distribution

Historical and recent movements and distribution of the herd pointed to the importance of the Richardson Mountains and the Muskeg Basin regions of northern Yukon during the summer insect season. Radiotracking relocations during the study showed that frequent fracturing and reformation of large aggregations occurred throughout the insect season.

Insects and weather

Wind and, to a lesser extent, temperature were the primary factors dictating mosquito activity. Mosquitoes were relatively inactive at wind speeds greater than 6 mps and temperatures less than 7°C. A wind/temperature index is provided to predict levels of activity. Others factors influencing insect activity were region, time and date.

Climate and weather patterns

The study area is influenced by two interacting regional climates; the subarctic continental climate, characterized by warm summers and a rapid transition from winter to spring, and the arctic coastal climate, characterized by cold long winters and cool moist summers. The line between these two systems shifts, depending on the relative strengths of the two air masses supporting these climates. To determine the weather patterns among the three permanent stations within the study area, we established nine temporary stations in 1986. These stations allowed us to classify the study area based on regional weather patterns. Sites in the Richardson Mountains were significantly cooler and moister than other stations.

Caribou response to insects

Groups tended to be larger earlier in the season but denser during conditions favourable to insects. While in these dense groups, animals displayed similar responses to insects, regardless of sex and degree of coat shedding. The responses increased in frequency as conditions favouring insect harassment improved. At low wind speeds, it was advantageous to be in the centre of the group rather than the periphery. At higher wind speeds, the opposite was true.

Activity, food and habitat

The effects of insect harassment showed not only in the formation and maintenance of large aggregations, but also in activity budgets, diet and habitat selection. During our study, animals moved an average of 10.9 km/day.

Based on scan observations, the activity budgets between1984 and 1985 were similar, except for a higher proportion of walking in 1985. When insects were active there was a significant decrease in time spent feeding and an increase in the time spent standing. Feeding intensity, the proportion of the feeding period spent ingesting food, was 14% lower when insects were active. Based on focal animal observations, the proportion of time spent moving (walking, trotting, and running) increased when insects were active.

Caribou responded to increases in insect activity either by moving to higher, and presumably windier, locations of the same habitat or choosing habitats with less «risk», based on moisture and vegetation cover.

Remains of deciduous shrubs were, by far, the most frequent in the fecal analysis. However, based on correction factors obtained from diets of captive caribou, deciduous shrubs and forbs were equally important. Samples collected after extended periods of harassment were not significantly different in composition from samples collected after no insect harassment. It appears either that diet remained relatively stable or rumen turnover time increased greatly during insect harassment, thus dampening the effect of diet shifts. Near the end of the mid- summer period, we noted a shift toward more lichen in the diet.

Energetic implications

Using a computer simulation model that combines rumen function with energy allocation, we explored the energetic implications of our results. The peaks in metabolizable energy intake and energy requirements coincided in early July, pointing to the crucial importance of the timing of calving. The annual trends in digestibility, fat deposition or mobilization and energy balance are also presented. One application of the model that proved quite useful was to «force» a pregnant female to follow the spring strategy of bulls, remaining on the winter range late into spring and tracking the phenological changes in vegetation in the pediments and intermountain basins of northern Yukon. Conversely, we «forced» an adult bull to stay with the pregnant females, migrating early to snow – covered calving grounds. In both instances the animals entered the insect season at higher body weights if they followed the strategy they would normally employ (although differences for bulls were slight). Pregnant females can survive on the poor late spring diet, and take advantage of forage allowing high metabolizable energy intake when the vegetation flushes. Bulls on the other hand, must obtain a higher energetic intake constantly to meet the high maintenance energy requirements that their large body size demands.