Twenty-four hour behaviour patterns and budgets of free-ranging reindeer in winter.

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Abstract: Activities of free-ranging reindeer *(Rangifer tarandus)* on the Seward Peninsula, Alaska were studied to determine 24-hour behaviour patterns and budgets in winter. Use of daytime active-rest data to predict nighttime behaviour resulted in as much as 37% underestimate of nighttime resting and 37% overestimate of nighttime activity. Three active-rest cycles occurred daily, synchronous with photoperiod.

Key words: Rangifer, reindeer, behaviour budgets, 24-hour behaviour patterns.

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Collins, W. B. & Smith, T. S. 1989. Vapaana laiduntavan poron vuorokautinen käyttäytyminen ja budjetti talvella.

Sammendrag: Aktiviteter hos fritt beitende reinsdyr *(Rangifer tarandus)* på Seward Peninsula, Alaska ble undersøkt for bestemmelse av 24 timers adferdsmønster og -budsjett om vinteren. Bruk av dagtids data for aktivitets-hvile til å forutsi nattlig adferd resulterte i 37% underestimering av natt-hvile og 37% overestimering av natt-aktivitet. Tre aktivitet-hvile cykler inntraff daglig, synkront med fotoperiode.

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Yhteenveto: Vapaana laiduntavan poron *(Rangifer tarandus)* aktiivisuutta tutkittiin Sewardin niemimaalla Alaskassa määrittämällä 24 tunnin käyttäytymismallit ja budjetit talvella. Käyttämällä päiväajan aktiivisuus - lepo -tietoja yöajan käyttäytymisen ennustamiseen ne alittivat jopa 30%:lla yöllisen lepoajan ja ylittivät 40%:lla yöajan aktiivisuuden. Päivittäin esiintyi kolme aktiivisuus - lepo -sykliä samanaikaisesti valojaksojen kanssa.

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Introduction

Rangifer exhibit a cyclic behaviour pattern alternating between activity and rest. Erriksson et al. (1981) stated that the behaviour pattern in reindeer is characterized by a short-term rhythm of feeding and ruminating and a diel rhythm related to changes in light condition. Boertje (1981), Roby (1978), Segal (1962), and Erriksson et al. (1981) stressed the importance of obtaining behaviour budgets for reindeer, considering them to be important indicators

of range quality and herd nutritional status. Roby (1978) and Thing (1977) noted the lack of nighttime data, emphasizing its importance to conclusions regarding *Rangifer* behaviour and energetics.

Boertje (1985) hypothesized that behaviour budgets based on single active-rest cycles should represent the proportion of time spent in various behaviours throughout the 24 hour period. If true, there would be less need for nighttime observations. Segal (1962) observed that lengths of active-rest cycles of penned reindeer were relatively constant during 24 hour periods. However, Thomson (1973) warned of potential errors when calculating mean behaviour percentages for 24 hours without having data for long winter nights. Twenty-four hour data from this research were utilized to test Boertje's hypothesis.

Study area and population

Reindeer were observed approximately 17 km north-northeast from the coastal village of White Mountain on the Seward Peninsula, Alaska. The study area contained 2 major physiographic components: inland plains/low hills and uplands. The plains are generally low and wet, dissected by numerous meandering rivers and sloughs and creeks. Vegetation is predominantly sedge tussock and sphagnum. Dwarf and low shrubs are found on drained microsites. Lichens are relatively scarce. Low hills (less than 50 m elevation) occur on some parts of the plains. These hills are covered with dense stands of white spruce (*Picea glauca)* where soil is better drained. Low hills also have more lichens and low shrubs.

Uplands are rolling hills ranging from 400 to 600 m elevation. Ridges are poorly vegetated debris from weathered rock, whereas hillsides and valleys have total vegetation cover over poorly drained, fine-textured soils. Sparse ridgetop vegetation consists of scattered grasses and sedges, few lichens and dryas *(Dryas integrifolia).* Hillsides are covered with a mix of sphagnum, sedges, dwarf shrubs, and lichens. Low shrubs are abundant on some sites, and white spruce dominates on northwest slopes.

The study herd consisted of approximately 400 animals descended from Siberian reindeer transplanted to Alaska in the late 1800's (Stern et al. 1977). Though introduced to the area as livestock, in recent years the reindeer had seldom been herded and were accustomed to selecting their own range.

Methods

Herd activity was observed for 96 h at each of 3 field sites: uplands (site 1), 13.–16. Feb. 1985; plains/low hills (site 2), 22.–26. Feb 1985; and uplands (site 3), 7.–11. Mar 1985. Reindeer were observed from a tent-like shelter mounted on a 3.2 m sled that could be towed behind a snowmobile. A small oil stove was used to keep the shelter at approximately 10° C.

The herd was observed during daylight with the aid of a 15–60 x spotting scope. Nighttime observations were with the aid of a starlight scope, an instrument which amplifies existing light through a battery-powered photomultiplier. Daytime observations were from 30–1000 m, but most nighttime observations were made from 30–100 m, since the starlight stope did not magnify field of view.

Behaviour patterns (frequency and timing of behaviours) and behaviour budgets (sums of specific behaviours expressed as percentages of total observations) were determined using the instantaneous scan method (Altmann 1974). The behaviours of 20 randomly selected individuals were logged on a multiple tally counter every 15 minutes over 3 periods of 96 hours each. Behaviours of each individual were placed in one of 6 categories – bedding, feeding, walking, standing, trotting, and cratering. These behavioural categories are described in detail by Jingfors et al. (1982). Observations were not distinguished according to age and sex because nighttime resolution was insufficient.

The following supplemental observations were recorded at 30-minute intervals: temperature, wind speed and direction, cloud cover, precipitation type, herd position, slope, exposure, and direction of movement.

After each 96 hour observation period, the types of vegetation in areas used by the reindeer were noted. During a snow-free period in 1986, the vegetation was described in greater detail (Smith 1987).

Snow depth and hardness were recorded at each site used by reindeer. Snow depths were

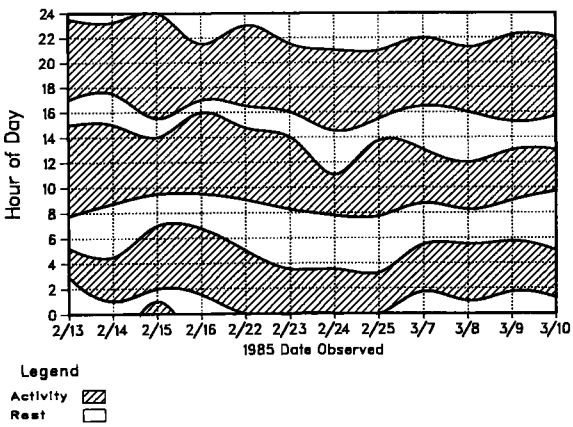

Figure 1. Periodicity and rhythmicity of reindeer activity. The predominant activity (>50 %) at each 15 minute scan was used to designate activity or rest.

measured at 10 randomly selected points. Snow hardness was measured at the same points within each feeding site using a ramsonde penetrometer (Benson 1962).

Results and discussion

Environmental conditions

Mild winter weather prevailed during periods of observation. Mean temperature was -17.5° C, and the coldest temperature, -29° C, was well within the range described by Zhigunov (1968) as «ineffective» in inducing behavioural changes in reindeer. Mean wind speed was 4.8 km/h and seldom moved snow; therefore wind did not directly effect reindeer behaviour. Snow cover was 100 %, but snow depths (typically 10 to 35 cm) were below critical limits for inhibiting movement (Telfer and Kelsall 1984) or cratering (Baskin 1970, Henshaw 1968, LaPerriere and Lent 1977).

Behaviour patterns

Behaviour patterns followed a short-term, polycyclic rhythm of alternating activity and rest, and a 24 hour (diel) rhythm attuned to the «set points» of sunrise and sunset. These resulted in periods of activity and rest occurring at the same time daily, a pattern noted by others (Duquette 1984, Erkinaro et al. 1983, and Skogland 1984).

Herd behaviour was highly synchronous, having distinct periods of activity and rest (Fig. 1). Most of the herd switched from grazing to resting within 5 minutes, and all of the herd within 30 minutes. The herd had three active and three rest periods per 24 hours (Fig. 1), average daylight being 9.75 h. Conversely, Erriksson et al. (1981) reported four to six activity periods during days having 6 hours daylight, but a gradual shift to six to nine activity periods per day during summer (continuous daylight). Baskin (1970) and Segal (1962) reported five to six relatively evenly spaced active-rest cycles. Roby (1978) reported four cycles of activity and rest per day among Alaska caribou during mid winter.

Onset of morning activity coincided with beginning of twilight. Twilight began earlier, relative to sunrise, in period 1 than in period 3, since twilight was detectable one hour prior to sunrise in period 1, but only 30 minutes before sunrise in period 3. At sunrise, very few deer were still resting (Fig. 2). The first activity period lasted 5.5 to 7.0 h. Mid-day, the deer began a rest period which lasted for

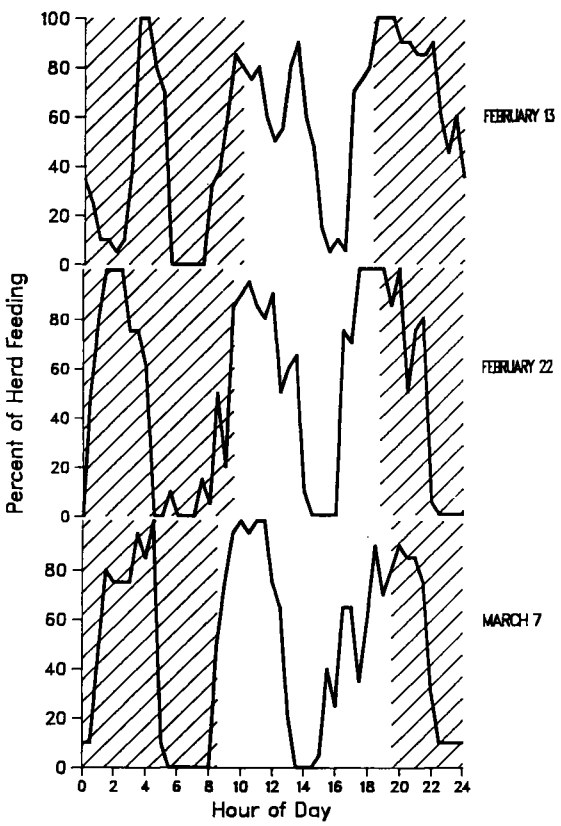

Figure 2. Synchronization of feeding activity to photoperiod.

approximately 2 hours. Then feeding resumed, continuing into darkness. The evening activity period appeared less cued to onset of darkness than the morning period to beginning of twilight.

Distinct nocturnal activity peaks were observed (Fig. 2). By contrast, Thomson (1973) hypothesized that lack of visual contact between herd members would prevent distinct activity periods during periods of darkness. Peak nocturnal feeding was of lesser duration (4.5 to 5.0 h) than peaks of daytime feeding (6.0 to 6.5 h).

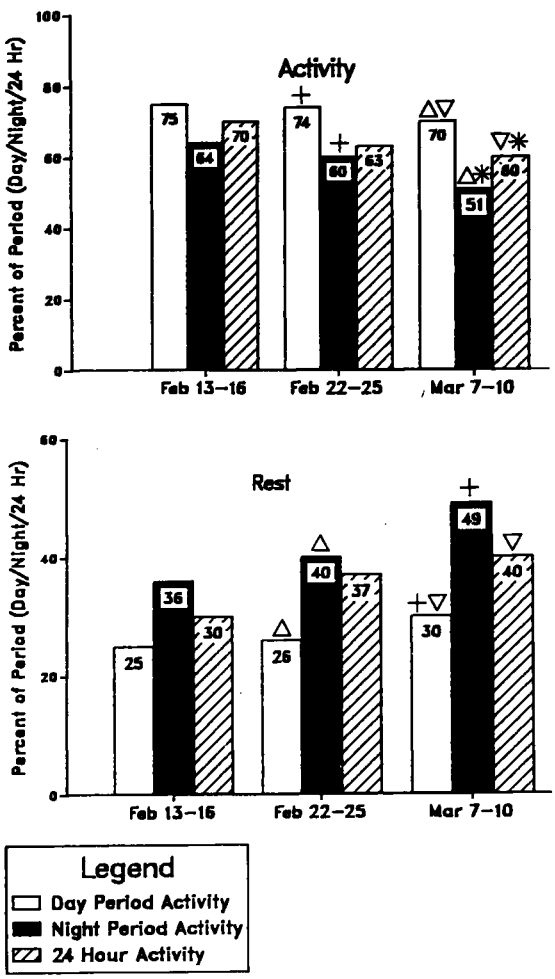

Figure 3. Time allocations for activity and rest during day, night and 24-hour periods. Same symbol over bars indicates significant differences ($p < 0.05$) between labelled values.

Behaviour budgets

A trend of decreasing activity and increasing rest was noted across the three periods (Table 1, Fig. 3). Clutton-Brock et al. (1982) suggested that reduced intake helps to reduce energy expenditures in situations where either the quantity and/or quality of forage is inadequate for individual daily requirements. Similarly, McEwan and Whitehead (1970) concluded that when intake of metabolizable energy declines, caribou respond by reducing metabolic rate and energy expenditure. Alternatively, increased rest could be ascribed solely to lengthened rumen turnover time associated with decreased forage quality. Data were not collected to test these hypotheses.

Time allocated to the various behaviours differed consistently between day and night (Table 1). Sunrise and sunset times, taken from the Nautical Almanac, were used to subdivide the 96 h, continuous observations into corresponding day and night periods. Resolution of the night vision scope was frequently inadequate to distinguish cratering from feeding activity during darkness. Therefore, the decrease in cratering activity at night (Table 1) was probably more a result of poor observer vision than an actual reduction in cratering activity. A brief summary of herd behaviour is as follows:

Feeding – the principal activity of the herd was consistently close to 50 % of total time. Increases in feeding presumably occurred at the expense of bedding, standing, and to a lesser degree, walking (Fig. 4). Cratering and trotting remained relatively constant throughout the study, apparently unaltered by changes in feeding activity.

Cratering – represented 1.4 to 7 % of reindeer activity (Fig. 4) and appeared unaffected by other activities. All snow types encountered in this study were too hard for reindeer to push through with their muzzles to obtain forage.

Bedding – ranked second among activities (Table 1, Fig. 1). It included ruminating as well as lying still.

Standing – time spent standing varied greatly (Table 1), ranging from 2 to 16 %. Standing activity included a significant amount of sparing and trashing of shrubs by antlered deer.

Table 1. Time allocation by reindeer during three periods of observation, 1985. Subdivisions of each period (24 h, day, night) reveal differences in diel patterns. *(Standard deviations (s.d.) reflect the variation between the four days comprising each period).

Observation period	Date	No. of deer in all scans	No. of 15. min. scans	No. of active-rest cycles	Division of data	Mean percentage ± S.D.* Feed	Bed	Stand	Walk	Trot	Crater
1	2/13–17	7680	384	12	24 hour	51±6	30±6	8±2	4±.9	.4±.4	6±1
					Day only	46±7	26±8	16±1	4±1	.5±.3	7±2
					Night only	52±7	35±8	5±1	4±1	.3±.4	5±1
2	2/22–26	7680	384	12	24 hour	53±7	37±7	5±2	2±1	.2±.2	3±1
					Day only	60±3	28±5	6±3	1±.3	0	5±2
					Night only	48±10	44±8	4±2	2±1	.3±.4	1.4±.7
3	3/7–11	7680	384	12	24 hour	43±1	40±3	11±4	2±1	.2±.2	4±1
					Day only	47±10	31±5	15±6	5±7	0	5±2
					Night only	40±1	49±4	6±4	2±2	.2±.4	3±1

Some standing may have been in response to recurrent presence of lynx in the vicinity. Boertje (1981) hypothesized that caribou respond to long winters by reducing energy expenditure through increased lying and feeding, and decreased standing and walking. Feeding declined, bedding increased, but standing and walking remained relatively constant.

Walking – represented 0.4 to 5% of total time. Increases in bedding were accompanied with decreases in walking and standing.

Trotting – was observed in 54 of 23040 observations, or less than 1% of total time. Thomson (1973) reported that reindeer spend little time trotting. He observed that reindeer generally trotted only in response disturbances, in decent of snow-covered slopes, or in play. Moen (1973) likewise predicted that wild ruminants would spend 1% or less of their time running or trotting.

Day versus night behaviour

We tested Boertje's (1985) hypothesis that time allocation within one active-rest cycle should approximate 24 hour time partitioning, by contrasting actual 24 hour behaviour percentages with those predicted from one complete daytime active-rest cycle within the same 24 hour observation period (Table 2). Significant differences ($p<.05$) resulted between actual and predicted values (Fig. 3), because the deer did not allocate time in the same proportions during night as during day.

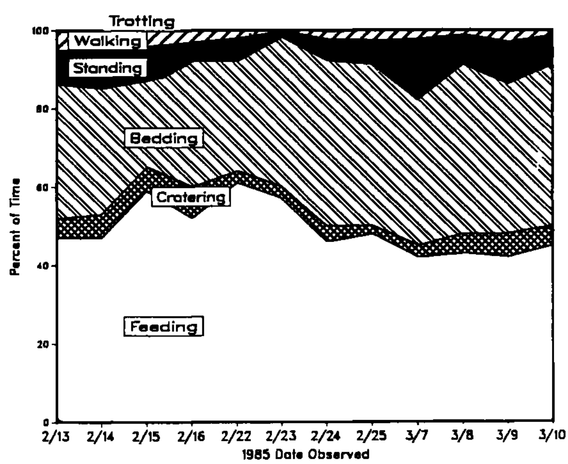

Figure 4. Allocation of time to various activities by Seward Peninsula reindeer, 1985.

Table 2. Behaviour budgets based on one daytime active-rest cycle versus an entire 24-hour observation.*

Date	Length of observation period (hr)	Mean percent Feed	Bed	Stand	Walk	Trot	Crater	No. of cycles
3/8/85	24.00	43.4	43.1	8.0	1.0	0.1	4.5	3 observed
3/8/85	8.50	42.4	31.7	17.2	1.6	0.1	6.9	3 predicted
% difference		2	26	115	60	0	53	
3/9/85	24.00	42.4	37.4	11.4	3.32	0.4	5.6	3 observed
3/9/85	9.75	49.3	28.2	10.6	2.7	0.0	9.2	3 predicted
% difference		16	25	7	18	100	64	
3/10/85	24.00	44.7	41.0	8.3	1.2	0.1	4.8	3 observed
3/10/85	6.25	52.4	39.0	7.2	0.6	0.0	0.8	4 predicted
% difference		17	5	13	50	100	83	

* Observation periods were selected at random from the third period of observation.

Reindeer rested more during night than day. Calculation of activity and rest, based solely on daytime observations, would have overestimated nighttime activity by as much as 37% and underestimated nighttime resting by as much as 37% during at least one of the observation periods (Fig. 3). Those behaviours occurring at low frequency (i.e. standing, walking, trotting and cratering) showed the greatest percent error estimation, although differences were not significant.

Conclusions

The behaviour pattern of *Rangifer* has been described as a short-term, polycyclic rhythm of alternating periods of activity and rest. Unlike many other studies, this study of activity patterns was conducted on a 24 hour basis and revealed that there are distinct day and night phases in reindeer activity/rest.

Although single daytime active-rest cycles of reindeer may approximate actual 24 hour behaviour budgets, feeding will likely be overestimated and rest underestimated. Reindeer may be 37 % more active during day than night and may rest 37 % more during night than day. Thus, energetics modelling and behaviour budgets based only on daytime observations may be significantly biased and of questionable value.

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