

GRIZZLY BEAR ACTIVITY BUDGET AND PATTERN IN THE FIRTH RIVER VALLEY, YUKON

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Abstract: I determined the activity of 5 radiocollared grizzly bears (*Ursus arctos*) in the Firth River Valley, Ivvavik National Park, Yukon, Canada, based on 574 hours of direct observation during 1994 and 1995. Radiocollared grizzly bears that were feeding primarily on caribou (*Rangifer tarandus*) tended to spend less time feeding and more time traveling or resting than bears that were feeding primarily on plants. During most observations bears fed primarily on plants. All bears spent a similar amount of time active (mean 66%, range 59–81%), during which they were primarily feeding or foraging (mean 56%, range 48–62%). For most behaviors, there was no difference among seasons; however, there was a difference for intraspecific behavior. Grizzly bear feeding bouts were longer in summer than fall or spring. In summer with 24 hours of daylight, grizzly bears tended to be most active in the evening and least active when the sun was lowest on the horizon. During fall, with increasing hours of darkness, grizzly bears were least active at night and had peaks of activity in the morning and evening. Grizzly bears in the Firth River Valley were not active more, relative to southern areas, to compensate for their short growing season, despite having more hours of daylight and not being constrained by human disturbance. Bears appeared to meet their energy requirements by acquiring protein and fat from caribou, Arctic ground squirrels (*Spermophilus parryii*), and other small mammals. Grizzly bears in the Firth River Valley currently appear to be able to effectively exploit available resources; however, repeated disruptions from human activity have the potential to adversely affect the time available for the acquisition of necessary energy.

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Key words: activity budget, activity pattern, grizzly bear, *Ursus arctos*, Yukon

Grizzly bears living in northern parts of Canada and Alaska must contend with a short season of food availability, lack of protective cover, and extremes in weather unlike bears living in southern Canada or the contiguous United States. Limited foraging time due to the short summer growing season may place constraints on growth, maturation, and reproductive rates of these bears. Conversely, longer hours of daylight during the growing season may enable more hours of foraging each day, as grizzly bears undisturbed by humans typically forage more in daylight hours (Aune and Kasworm 1989, MacHutchon et al. 1998, Olson et al. 1998), and thus may compensate in part for the shorter growing season. Understanding the seasonal activities of grizzly bears in the far north may provide insight into how they adapt to this environment and may be helpful for assessing the potential effects of human activities on bears in these areas.

Previous studies have documented grizzly bear activity in both northern and southern populations of grizzly bears. Activity pattern, defined as an animal's diel rhythms of activity and inactivity, has been documented through direct observation (Gebhard 1982, Hechtel 1985), observation from fixed points (Stemlock and Dean 1986), direct and indirect observation (Pearson 1975), interpretation of fluctuations in radio signals (Roth 1983, Roth and Huber 1986, Bjarvall and Sandegren 1987), and interpretation of signals from motion-sensitive radiocollars (Schleyer 1983, Harting 1985, Aune and Kasworm 1989, McCann 1991, Wenum 1997). Activity budget, defined as an animal's allocation of time among different behaviors, has most often been documented as percent time active or inactive through interpretation of fluctuations in radio signals or interpretation of signals from motion-sensitive radiocollars. Determining the breakdown of time allocated to different active and inactive behaviors is more

difficult to do because it typically requires continuous observation of animals. Three previous studies (Gebhard 1982, Stemlock and Dean 1986, Phillips 1987) documented grizzly bear activity budgets in this way. These studies were conducted in northern areas, where bears could be observed because of lack of tree cover. In 2 studies (Stemlock and Dean 1986, Phillips 1987), all observations were made from fixed observation points, thus observations may have been biased against activities that occurred when bears were elsewhere, out of view. Also, in both cases most bears observed were unmarked, thus sex and age were usually unknown. In the third study, Gebhard (1982) followed an adult female and her 2 yearlings for one spring to fall cycle.

The Firth River Valley, northern Yukon, represents the northern latitudinal limit of grizzly bears in Canada. As part of a larger research project investigating grizzly bear food habits, seasonal habitat use, and activity and movements for Ivvavik National Park, I determined activity pattern and activity budgets of radiocollared grizzly bears. The intent was to provide baseline documentation of bear activity for the park's use in planning for anticipated increases in human visitors to the park in the future, and to better understand the constraints on foraging imposed by the northern environment. This is one of the first studies documenting activities of several bears of known identity where observations were not limited to particular sites.

STUDY AREA

The Firth River (69°10'N 140°05'W) flows northward for 160 km from its headwaters in Alaska through the British Mountains and coastal plain of Ivvavik National Park (INP), northern Yukon, Canada, to the Beaufort Sea. INP encompasses 10,170 km² at the northwestern tip of

Yukon Territory, bordering the Arctic National Wildlife Refuge (ANWR), Alaska, USA, to the west. The British Mountains occupy the central and southern two-thirds of INP and rise to elevations of 1675 m. A band of flat to rolling topography 10–30 km wide forms the coastal plain between the British Mountains and the Beaufort Sea. This study was conducted along the British Mountains portion of the Firth River Valley. The area is characterized by short, cool summers and long, cold winters. Mean annual temperature is -10°C (6.5°C in summer, -25°C in winter) and mean annual precipitation is 300 mm. INP contains an extensive area that escaped Quaternary glaciation, thus landforms evolved under semi-arid conditions.

Vegetation of the Firth River Valley includes open-forest subarctic taiga, treeless arctic tundra, and the broad transition zone between the 2 referred to as treeline. Trees become smaller and more scattered with increasing latitude, and white spruce (*Picea glauca*) and balsam poplar (*Populus balsamifera*) reach their northern limit within the British Mountains along the lower Firth River Valley. Forests are most common on valley bottoms and southerly-facing slopes and are replaced by shrub communities with increasing latitude. There is an elevation transition from well vegetated valley bottoms through low shrub-dominated communities to alpine tundra. Slopes above 500 m are sparsely vegetated. Cotton-grass (*Eriophorum* spp.) and sedge (*Carex* spp.) tussocks typically dominate low-angle slopes or pediments.

Mammals of INP include caribou of the Porcupine caribou herd, moose (*Alces alces*), Arctic ground squirrels, and small mammals of the families Muridae and Soricidae. Anadromous and non-anadromous Dolly Varden char (*Salvelinus malma*) occur in the Firth River.

The sun reaches its highest point in the sky between approximately 1220–1230 Alaska Standard Time from 26 May to 4 September (D. Dodge, Pacific Space Centre, Vancouver, British Columbia, Canada, unpublished data). During this study, the sun remained above the horizon from 26 May to 23 July. First sunset and sunrise, defined as when the center of the sun was at the horizon line at sea level, occurred on 24 July; however, there were no true hours of darkness until 13 August. Daylight hours diminished from approximately 23.5 hours to 17 hours between 13 August and 4 September.

METHODS

During June 1993, I darted grizzly bears from a helicopter and immobilized them with Telazol® (tiletamine hydrochloride and zolazepam hydrochloride; Ayerst Laboratories, Montreal, Quebec, Canada) at approximate dosages of 7–10 mg/kg body weight. I tattooed and ear-tagged

all captured bears and recorded morphological characteristics. I fitted adult bears of both sexes with radiocollars (Telonics Ltd., Mesa, Arizona, USA); in late August 1995, I recaptured all radiocollared bears and removed collars.

I located radiocollared bears from aircraft; then 1–2 backpacking crews of 2–3 people each were flown by helicopter to locations where they could watch individual bears. I chose bears for observation based on the number of previous observation sessions for each bear each season, its location inside or outside the study area, and the feasibility of maintaining a good vantage without disturbing the bear. Bears were observed from an adjacent ridge top or side slope using a spotting scope at a distance of <2 km. The time of any change in a bear's behavior was recorded to the nearest second. Bears were followed if they moved and we continued to make observations for up to 36.9 hours if possible. Frequently, however, a bear moved temporarily out of sight, moved too extensively to follow, detected observers and ran off, or the weather deteriorated. If a bear disappeared from view during an observation but was re-sighted within 12 hours, I considered the total time it was observed to be a single observation session.

I used Alaska Standard Time to examine grizzly bear activity pattern because it most closely matched solar time for the Firth River Valley. Most observations were made between 0800 and 2400 hrs because helicopters were only available during the day and because bears typically moved out of sight within 8 hours of the start of an observation. Early morning observation time also was lost because of fog moving into the mountains from the coast, observer fatigue, and increasing darkness in fall.

Observers recorded 16 bear behaviors, which I later grouped into the following 6 categories. (1) *Feeding* referred to the handling and ingestion of food (e.g., digging or consuming the roots of alpine hedysarum [*Hedysarum alpinum*]). (2) *Foraging* referred to the search for food, including food plants (e.g., searching for alpine hedysarum), but also searching for, chasing or digging out ground squirrels or other small mammals. (3) *Traveling* included walking or running with no apparent search intent and with no resultant feeding activity. (4) *Intraspecific* behaviors included aggression, breeding, courting, nursing, playing, or other interactions between females and cubs or between 2 unrelated bears. (5) *Other* behavior included interspecific interactions between grizzly bears and other species, marking, drinking, grooming, digging a bed, defecating, standing and staring, or standing and looking around. (6) *Inactive/resting* included long-term rests when a bear lay down and slept as well as short-term rests when a bear sat briefly, sat down prior to bedding, sat up briefly during longer sleep bouts, or sat up after a long rest before moving off.

I delineated grizzly bear seasons of activity by general shifts in diet as determined from observations of bears, the phenological development of food plants, and scat analysis (MacHutchon 1996). Spring lasted from 26 May to 15 June, summer from 16 June to 31 July, and fall from 1 August to 4 September. The change from spring to summer corresponded with the widespread availability of common horsetail (*Equisetum arvense*) shoots and the change from summer to fall with the availability of blueberries (*Vaccinium uliginosum*). In spring grizzly bears fed primarily on alpine hedysarum roots and over-wintered berries such as crowberry (*Empetrum nigrum*) and bearberry (*Arctostaphylos rubra* or *A. alpina*). Bears shifted to green vegetation, particularly common horsetail and bearflower (*Boykinia richardsonii*), in summer. Bears fed primarily on berries, particularly blueberries and crowberries, in fall, but crowberries ripened later than blueberries and were less abundant. In addition to eating plants, bears killed or scavenged caribou in spring when the caribou moved to their calving grounds along the Yukon and Alaska coastal plain and again in summer when the caribou moved to their mid-summer range in the southeast corner of INP. They hunted ground squirrels and microtines throughout summer and fall and occasionally fed on moose and Dolly Varden char.

I divided each semi-continuous observation session into 2-hour observation blocks that I used as my sample unit for most analyses (0001–0200, 0201–0400, 0401–0600, etc.), and only blocks with ≥ 1 hour of observation time were used. Each time a bear was observed, the percent time it spent engaged in each behavior was recorded for each 2-hour observation block. To determine daily activity patterns, I calculated, by season, the mean percent time bears spent in active versus inactive behaviors during each 2-hour period in a day (averaged across individual bears and observation blocks). These 2-hour periods were the same time span as I used for observation blocks. I derived an activity budget for each season by summing the

mean percent time spent in each activity across all periods in the day and dividing by the number of periods sampled that season (e.g., 7 periods for spring, as all spring observations were made between 0600 and 2000 hrs; 12 periods for summer and fall, as observations were made around the clock).

To compare general activity among seasons, individuals, reproductive classes, and periods of the day, I used 2-way ANOVA (analysis of variance), using the percent time active in each individual 2-hour observation block as the sample unit for the dependent variable and using the following pairs of independent variables: period with individual, season, reproductive class, or year. Similarly, I used 2-way ANOVA to compare the prevalence of specific behaviors among individuals, season, and periods. Because sample variance was high among observation blocks, I also used Kruskal-Wallis non-parametric 1-way ANOVA to compare the following: (1) percent time active or in specific behaviors among seasons (using mean activity for each period each season as the sample unit); and (2) percent time active among periods within seasons (using all 2-hr observation blocks that season as the sample units). To compare behavior duration among seasons, I used the median test, as sample distributions of behavior duration were highly skewed.

RESULTS

Five grizzly bears, 4 adult females and 1 adult male, were captured and fitted with radiocollars. Females GF02 and GF07 were alone in 1994 and had cubs-of-the-year (COY) in 1995. Females GF03 and GF09 had COY in 1994 and yearlings in 1995. GM08 was an actively breeding male.

I recorded behaviors of radiocollared grizzly bears during 574 hours of observation between 26 May and 4 September during 1994 and 1995 (Table 1). Observation sessions ranged in length from 0.8 hrs to 36.9 hrs with an

Table 1. Average length and total number of observation sessions for individual radiocollared grizzly bears, Firth River Valley, Ivvavik National Park, Yukon, May to September 1994–95.

ID	1994									1995									Total		
	Spring			Summer			Fall			Spring			Summer			Fall					
	hr ^a	n ^b	\bar{x}	hr	n	\bar{x}	hr	n	\bar{x}	hr	n	\bar{x}	hr	n	\bar{x}	hr	n	\bar{x}	hr	n	\bar{x}
GF02	3.2	1	3.2	14.4	2	7.2	16.1	4	4.0	6.3	3	2.1	45.9	4	11.5	21.3	1	21.3	107.2	15	7.1
GF07	0			33.3	5	6.7	3.6	1	3.6	0			39.3	5	7.9	64.8	4	16.2	141.1	15	9.4
GF03	0			45.8	2	22.9	62.1	3	20.7	9.3	2	4.6	50.4	7	7.2	21.3	4	5.3	188.8	18	10.5
GF09	2.5	1	2.5	6.3	2	3.2	37.2	8	4.6	9.7	1	9.7	44.9	6	7.5	3.2	2	1.6	103.7	20	5.2
GM08	0			16.3	2	8.1	0			13.2	3	4.4	0.8	1	0.8	2.9	1	2.9	33.2	7	4.7
All	5.7	2	2.8	116.1	13	8.9	119.0	16	7.4	38.4	9	4.3	181.3	23	7.9	113.5	12	9.5	574.0	75	7.7

^a Total number of hours observed.

^b Number of observation sessions.

overall mean of 7.7 hrs. There were 9 observation sessions >20 hours, and total observation time for individual bears varied greatly. Since the following results are from 5 bears (and sometimes fewer), the results may not be representative of the population as a whole.

Bears fed mostly on caribou during 5 observation sessions (4 individuals; 38.5 hours of observation). One such observation occurred in spring 1994, when GF02 was observed resting for 3.2 hours near a caribou carcass she had been feeding on. All other observations of bears feeding primarily on caribou occurred in early July after the Porcupine caribou herd migrated southeast through INP and crossed the Firth River. Radiocollared grizzly bears that were feeding on, or foraging primarily for, caribou kills or carcasses tended to spend less time feeding and more time travelling or resting than when primarily feeding on or foraging for plants (Table 2). One bear (GF07) spent considerable time interacting with other bears around caribou carcasses, but most interactions were non-aggressive. She also spent considerable time travelling between 3 caribou carcasses that were close together in the same river valley. She was often out of sight in a thick shrub draw, where she likely was resting, so our documentation of the percent of time she was active is likely biased high. GF07 and 3 COY returned to the same area of caribou migration in 1995, but they stayed high on a mountain slope and were never observed feeding on a caribou carcass even though there were several in the area. GF03 and GF09 spent some time feeding and resting at caribou carcasses, but also spent considerable time foraging or travelling, apparently searching for other carcasses.

During most observations (70 of 75 sessions and 535.5 of 574.0 hrs), bears fed primarily on plants and occasionally pursued or dug for ground squirrels or microtines. I

detected no significant differences in overall activity level among individuals ($\bar{x} = 66.0\%$, range 58.7–81.0%; $F_{4,265} = 0.54$, $P = 0.707$), seasons (Fig. 1; $F_{2,267} = 0.59$, $P = 0.556$), reproductive classes (lone female: $\bar{x} = 52.8\%$; female with COY: $\bar{x} = 67.9\%$; female with yearling: $\bar{x} = 54.5\%$; male: $\bar{x} = 81.0\%$; $F_{3,266} = 1.95$, $P = 0.122$), or years (1994: $\bar{x} = 65.4\%$; 1995: $\bar{x} = 64.1\%$; $F_{1,268} = 0.08$, $P = 0.771$). However, in all analyses there was a significant effect of period (Fig. 2; individual: $F_{11,265} = 4.50$, $P < 0.001$, season; $F_{11,267} = 2.23$, $P = 0.013$; reproductive class: $F_{11,266} = 2.64$, $P = 0.003$; and year: $F_{11,268} = 5.77$, $P < 0.001$). Also, there was significant interaction between period and individual ($F_{40,265} = 1.62$, $P = 0.015$), which may have been because 2 bears (GM08 and GF09) were never observed during some periods, and period and reproductive class ($F_{29,266} = 1.69$, $P = 0.019$), which may have been because the male bear, GM08, was active throughout many of the periods in which he was observed.

Generally, grizzly bears of the Firth River Valley exhibited a diel activity pattern with bimodal activity peaks. This pattern was not evident in data from the spring months (Kruskal-Wallis, $\chi^2 = 2.67$, 6 df, $P = 0.849$); however, there were no complete observation blocks between 2000 and 0600 (Fig. 2). In summer, with 24 hours of daylight, grizzly bears tended to be most active in the evening and least active when the sun was lowest on the horizon (Kruskal-Wallis, $\chi^2 = 19.69$, 6 df, $P = 0.050$). During fall, with increasing hours of darkness, grizzly bears were least active at night and had peaks of activity in the morning and evening (Kruskal-Wallis, $\chi^2 = 51.24$, 6 df, $P < 0.001$). Two-way ANOVA also indicated a significant effect of period of the day between summer and fall (season: $F_{1,246} = 1.15$, $P = 0.286$; period: $F_{11,246} = 7.08$, $P < 0.001$; interaction: $F_{11,246} = 1.74$, $P = 0.067$). The bimodal

Table 2. Activity budgets (mean % of time) of individual radiocollared grizzly bears feeding primarily on plants versus caribou, Firth River Valley, Ivvavik National Park, Yukon, 1994–95.

Behavior	GF02—1994 ^a		GF07—1994 ^b		GF03—1995 ^c		GF09—1995 ^d	
	Plants	Caribou	Plants	Caribou	Plants	Caribou	Plants	Caribou
Active								
Feeding	34.6	0.0 ^e	36.8	1.9	50.0	13.2	34.6	11.0
Foraging	10.8	0.0	4.3	4.0	11.9	6.1	11.1	18.0
Travel	16.4	0.0	4.3	22.2	2.0	25.9	4.4	28.4
Intraspecific	0.0	0.0	3.4	49.8	2.5	4.0	1.8	1.4
Other	10.1	3.0	1.4	4.5	0.3	2.6	0.7	4.8
Total active	71.9	3.0	50.2	82.4	66.7	51.8	52.6	63.6
Inactive/resting	28.1	97.0	49.8	17.6	33.3	48.2	47.4	36.4
Observation blocks (n)	8	2	14	3	15	12	17	3
Observation sessions (n)	2	1	3	2	6	1	5	1

^a GF02 was alone in 1994. The caribou observation session was in spring and all plant observation sessions were in summer.

^b GF07 was alone in 1994, and all plants and caribou observation sessions were in summer.

^c GF03 had 3 yearlings in 1995, and all plants and caribou observation sessions were in summer.

^d GF09 had 1 yearling in 1995, and all plants and caribou observation sessions were in summer.

^e GF02 stayed near a caribou carcass for several days. She did not feed on the carcass during the observation session; however, she was observed feeding on it prior to the observation session.

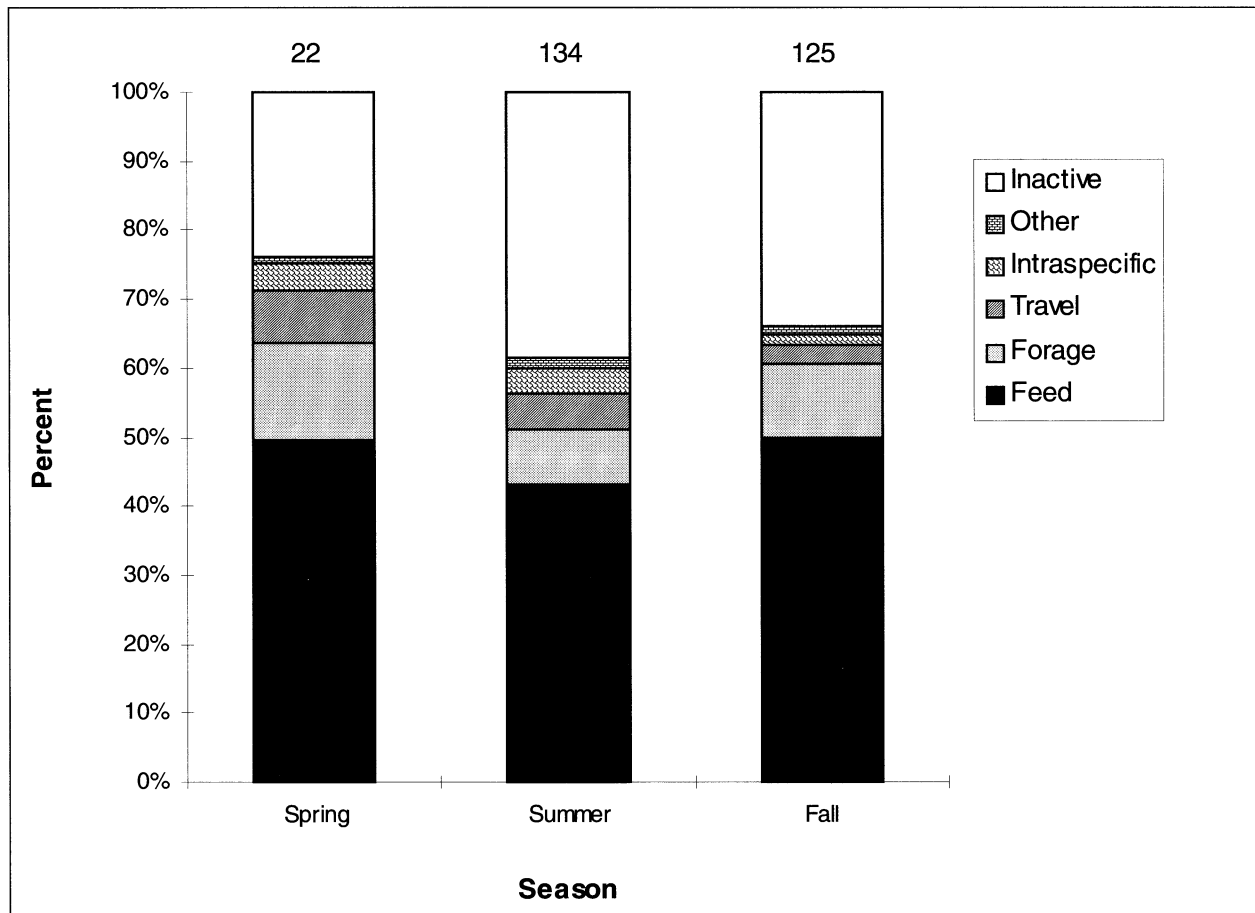


Fig. 1. The seasonal activity budgets of radiocollared grizzly bears when primarily feeding on plants, Firth River Valley, Ivvavik National Park, Yukon, 1994–95. The number of 2-hour observation blocks for each season is indicated above the bars.

activity peaks were more pronounced in fall than summer.

Consistent with the generally higher activity level during day versus night, bears fed more during 0400 to 1000 and 1600 to 2200 hours than during 2200 to 0400 and 1000 to 1600. Two-way ANOVA indicated a significant period effect on feeding ($F_{11,267} = 2.08, P = 0.022$), travel ($F_{11,267} = 2.50, P = 0.005$), and inactive/resting ($F_{11,267} = 2.23, P = 0.013$), but no significant period effect on foraging ($F_{11,267} = 1.31, P = 0.218$), intraspecific ($F_{11,267} = 1.26, P = 0.246$), or other behavior ($F_{11,267} = 0.42, P = 0.945$). There were no significant season effects or season and period interaction effects on any behavior. However, Kruskal-Wallis 1-way ANOVA indicated that seasonally, there was a difference in amount of time in intraspecific behavior ($\chi^2 = 6.99, 2 \text{ df}, P = 0.030$; Fig. 1), with more observed in spring or summer than fall. Courtship and breeding by GM08 was 69% of intraspecific activity in spring, but otherwise, interaction between females and their cubs (i.e., nursing and playing) was the main intraspecific activity in all seasons. Additional interspe-

cific activity in summer was the courtship and breeding of GF07 in 1994. Some additional intraspecific activity in fall was the aggressive action of 2 females (GF03, GF07) protecting their young from adult males.

I detected no significant differences among individuals in the amount of time feeding ($\bar{x} = 45.5\%$, range 37.0–50.6%; $F_{4,265} = 1.63, P = 0.169$), travelling ($\bar{x} = 5.0\%$, range 1.5–7.4%; $F_{4,265} = 2.36, P = 0.054$), intraspecific ($\bar{x} = 3.9\%$, range 1.7–11.0%; $F_{4,265} = 0.73, P = 0.572$), or inactive/resting ($\bar{x} = 34.1\%$, range 19.0–41.3%; $F_{4,265} = 0.54, P = 0.707$), but there was a significant difference among individuals in the amount of time foraging ($\bar{x} = 10.3\%$, range 6.7–12.7%; $F_{4,265} = 2.82, P = 0.026$) and in other behavior ($\bar{x} = 1.3\%$, range 0.3–2.5%; $F_{4,265} = 3.37, P = 0.011$). There was significant interaction between period and individual for travelling ($F_{40,265} = 1.89, P = 0.002$), intraspecific ($F_{40,265} = 4.28, P < 0.001$), and inactive/resting ($F_{40,265} = 1.62, P = 0.015$).

Grizzly bear feeding bouts were longer in summer than fall or spring for all individuals combined (median test, $\chi^2 = 48.24, 2 \text{ df}, P < 0.001$; Table 3). The duration of

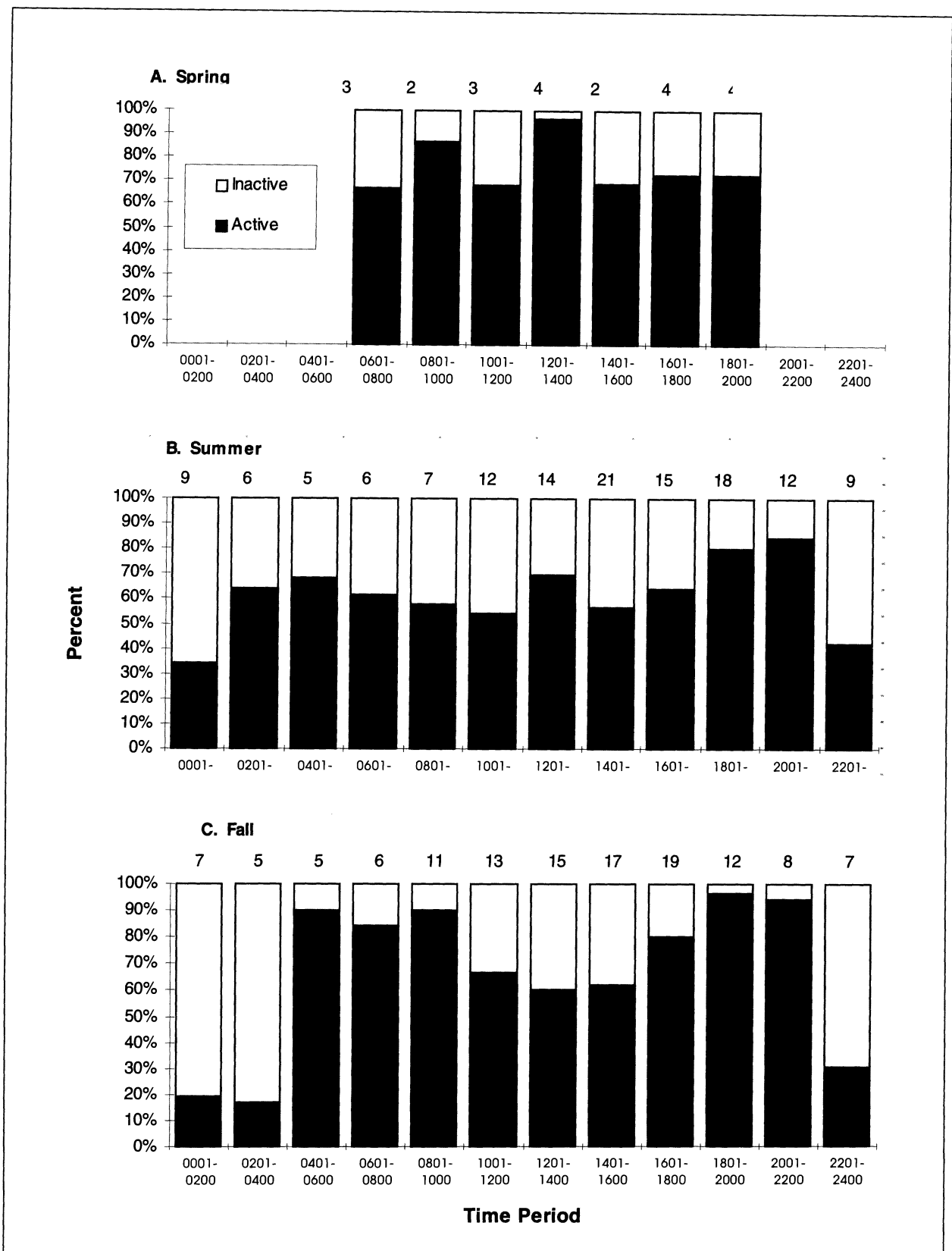


Fig. 2. The seasonal activity patterns of radiocollared grizzly bears when primarily feeding on plants, Firth River Valley, Ivvavik National Park, Yukon, 1994–95. The number of 2-hour observation blocks for each period is indicated above the bars.

bouts of all other behaviors did not vary among seasons. The median duration of intraspecific behaviors was also determined for all individuals combined (Table 4). Only females with young were observed nursing or playing, and these behaviors occurred in all seasons. Only lone females and the male were observed courting or breeding, and these behaviors only occurred in spring and summer, peaking between mid-May and early July. Lone female bears and the male bear also did most of the marking observed; marking was only seen in spring and summer. Females with COY and yearlings reacted aggressively to occasional attempts by male bears to attack their young.

DISCUSSION

Few studies have documented the behavior of grizzly bears from direct observations. Gebhard (1982) observed one female grizzly bear and yearlings; that female spent similar proportions of time active (64%) and feeding and foraging (59%) as grizzly bears in this study. The following year, Hechtel (1985) watched the same female and young; that year her percent time active was only 55%. Phillips (1987) watched a number of unmarked and marked grizzly bears when they moved onto his study area in northeast Alaska. Most bear activity he observed in mid-June was breeding and resting (41% and 26%, respectively). However the main activity throughout summer and fall was feeding and foraging, which bears did somewhat more frequently than I observed ($\bar{x} = 73\%$, range 60–82%). Similarly, Stemlock and Dean (1986) watched unmarked grizzly bears that moved into 2 observation areas in Denali National Park, Alaska; activity budgets varied between study areas but overall, bears were active 85% of the time (range 62–100%) and feeding averaged 70% (range 52–94%). These results may not be directly comparable to results of Gebhard (1982) or this study because they represented behavior of bears only

Table 4. Median duration (min) of intraspecific and marking behavior by radiocollared grizzly bears, Firth River Valley, Ivvavik National Park, Yukon, 1994–95.

Behavior	<i>n</i> ^a	Median	Range
Intraspecific			
Nursing	90	4.17	0.17–12.92
Play	63	0.65	0.02–11.42
Courtship	14	0.38	0.03–26.88
Breeding	3	12.07	6.75–57.33
Aggressive	6	1.74	0.17–21.43
Marking	14	0.45	0.12–3.92

^a The total number of times a behavior was recorded.

when present at particular observation areas and not over their entire home range.

Nevertheless, overall active time of grizzly bears in the Firth River Valley appeared to be similar to other observational studies in areas of the far north. It was also similar to bear activity reported in studies from parts of southern Canada and the contiguous USA (Aune and Kasworm 1989, McCann 1991, Wenum 1997) and Europe (Roth 1983, Roth and Huber 1986, Clevenger et al. 1990), in which motion-sensing radiocollars were used to document activity.

Median duration of resting–bedded behavior in Firth River Valley bears was generally less than the 38 to 73 minutes recorded by Gebhard (1982) or the 42 to 90 minutes recorded by Phillips (1987). This was likely due to the method of recording behavior. Whereas I recorded every break in a resting–bedded bout, Gebhard (1982) excluded breaks of less than 30 seconds and Phillips considered a bear to be resting anytime it was lying or sitting. Resting–bedded bouts in this study were periodically interrupted when a bear sat up temporarily or got up to defecate or change position. In addition, bears frequently lifted their head and looked around (Murie 1981, Gebhard 1982, Phillips 1987), possibly to be able to detect potential predators or prey.

Median duration of nursing of 4.2 min (mean 4.4 min)

Table 3. The median duration (min) of radiocollared grizzly bear behaviors in spring, summer and fall, Firth River Valley, Ivvavik National Park, Yukon, 1994–95.

Behavior	Spring			Summer			Fall		
	<i>n</i> ^a	Median	Range	<i>n</i>	Median	Range	<i>n</i>	Median	Range
Feeding ^b	523	1.03	0.05–29.42	1529	1.57	0.03–102.40	2481	1.03	0.02–111.67
Foraging	529	0.33	0.00–11.50	1424	0.36	0.02–20.00	2412	0.32	0.02–36.37
Forage–chase	8	2.04	0.3–73.95	104	1.33	0.07–53.12	27	0.67	0.08–33.77
Travel–walking	158	0.75	0.08–6.85	770	0.60	0.00–47.40	461	0.58	0.03–11.28
Travel–running	6	0.21	0.05–0.78	46	0.27	0.03–2.50	38	0.30	0.07–7.82
Resting–bedded	25	15.82	0.35–92.50	168	22.08	0.22–409.58	83	23.08	0.22–368.63
Resting–temporary	41	0.67	0.03–11.67	212	0.56	0.02–26.33	120	0.60	0.05–66.42

^a The total number of times a behavior was recorded in a season.

^b Significantly different duration among seasons using the median test, $P < 0.001$.

was similar to most previous reports of 4.2–4.8 min (Murie 1981, Stemlock 1981, Gebhard 1982), but greater than the 2–3 min reported by Phillips (1987). In contrast to Stemlock and Dean (1986), I found that females periodically played with their young, even though play sessions were relatively short. GF09 with one cub spent more time playing than females with 2 or 3 cubs. Cubs commonly played together; thus, mothers with >1 cub likely did not need to play with cubs as much. I observed 3 breeding attempts (i.e., mountings), with median duration of 12.1 min (mean 25.4 min); previously Stemlock and Dean (1986) reported mean duration of 7.0 min ($n = 15$). Marking behavior during this study appeared to be associated with breeding activities because it was only observed in spring and summer and usually done by lone females or the adult male.

Similar to this study, Stemlock and Dean (1986) found that grizzly bears in central Alaska were most active during daylight hours and least active at night and that bears were more active throughout the day as nighttime darkness increased in fall. In one of their study areas, grizzly bears had diurnal peaks of activity in morning and evening during summer, as in this study, but these peaks were not obvious in the second study area. Hechtel (1985) found considerable variation among individual bears in diel activity patterns. One bear had long periods of inactivity in the afternoon, while other bears were most active during mid-day and least active at night. In southern parts of grizzly bear range with more hours of darkness throughout the year, McCann (1991) and Wenum (1997) also found that grizzly bears were most active during daylight hours and least active at night. McCann (1991) suggested that there was a bimodal peak of activity in morning and evening, but Wenum (1997) found that adult female grizzly bears were nearly continuously active through the day.

Several authors have suggested that grizzly bears are less nocturnal and more crepuscular or diurnal in areas with low human density or activity (Roth 1983, Aune and Kasworm 1989, Clevenger et al. 1990). MacHutchon et al. (1998) found that in areas of high human use, subadult grizzly bears appeared to habituate to human use and remained day-active, whereas lone adults and family groups avoided the area or were more night-active. In an area of low human use, grizzly bears were generally diurnal. Similarly, in this study grizzly bears in a northerly area of low human use were primarily day active.

High variation in grizzly bear activity budgets and patterns has been reported across their range, among and within individuals (Roth 1983, Schleyer 1983, Hechtel 1985, Roth and Huber 1986, Stemlock and Dean 1986, Aune and Kasworm 1989, Clevenger et al. 1990, McCann 1991), and among seasons (Gebhard 1982, Stemlock and Dean 1986). Grizzly bear activity may be influenced by

individual traits such as age, sex, weight, reproductive status, and physiology and by environmental factors including weather, thermal stress, lunar phase, predation, seasonal food type and abundance, available daylight, and human disturbance (Schleyer 1983, Hechtel 1985, Bunnell and Harestad 1989, McCann 1991). The duration, frequency, and diel timing of observations may influence interpretation of activity.

I was unable to detect any differences in activity among individuals or reproductive classes. The percent of time active did not vary among seasons despite increasing darkness in fall. Moreover, the amount of time feeding and foraging also did not vary among seasons. I expected feeding times to be higher in fall because berries are more digestible than green vegetation or roots and they are higher in carbohydrate energy, which is important for fat deposition prior to denning (Bunnell and Hamilton 1983, Pritchard and Robbins 1990, McLellan and Hovey 1995). Possibly my sampling was inadequate to detect actual patterns, but in 2 years of observation I saw nothing to suggest major seasonal changes in activity. The only difference I observed was that duration of feeding bouts was higher in summer than spring or fall. Alpine hedysarum, though common in the Firth River Valley, had a patchy distribution and individual plants were well dispersed within patches. Feeding bouts were likely shorter in spring because grizzly bears frequently had to move short distances between alpine hedysarum plants when feeding in a patch. The short handling time required to dig alpine hedysarum roots prior to their ingestion was usually recorded as feeding; therefore, feeding times in the spring may have included some additional foraging time. When grizzly bears were feeding on horsetail and bearflower in summer or blueberries in fall, handling time was negligible; therefore, most feeding time represented actual ingestion of foods. Horsetail or bearflower usually occurred in dense patches in drainage depressions and along creeks, but patches were often far apart. In contrast, blueberry plants often occurred in large patches along southerly facing slopes and on river terraces, but individual shrubs within patches were spread out. Consequently, feeding bouts were longer in summer than in fall.

Several factors suggest that bears in the far north should increase their feeding and foraging time relative to bears further south: (1) the diversity of major bear foods is generally less in the north than in the south (McLellan and Hovey 1995); (2) suitable growing sites are not as abundant in the north; and (3) the growing season is short, so the period of food plant availability is generally shorter. Nevertheless, we did not find that grizzly bears in the Firth River Valley were more active than bears in southern Canada and the contiguous USA or Europe, despite having more hours of daylight and, apparently, not being con-

strained by human disturbance. The demands of supporting cubs did not increase activity either. This suggests either that bears can meet their energy requirements in a similar amount of time as bears in the south, or their activity is constrained by other factors. Handling time of the major food plants appeared to be negligible. There was little difference in the crude protein levels of 4 main grizzly bear foods from the Firth River Valley and the same or similar species from the Flathead River Valley of southeast B.C. (MacHutchon 1996). I suggest that grizzly bears in the Firth River Valley are meeting their energy requirements by acquiring protein and fat from caribou, ground squirrels, and other small mammals. Grizzly bears of the Firth River Valley had a large positive deviation from McLellan's (1994) relationship between adult female body weight and litter size, although sample size was small (MacHutchon 1996). This deviation was primarily because mean litter size (2.3 cubs/litter, $n = 6$) was large relative to other populations. Litter size alone is not necessarily an indicator of habitat quality (McLellan 1994), but the data suggest that female grizzly bears in the Firth River Valley are at least as well nourished as grizzly bears elsewhere.

Mammals are likely the highest quality food throughout the year (McLellan and Hovey 1995), but their ease of capture and relative availability varied among the seasons. Despite the mobility of ground squirrels in spring and summer, grizzly bears expended considerable energy hunting them. When caribou were available, radiocollared grizzly bears focused considerable effort on obtaining them. They traveled more, likely in search of carcasses. They wandered widely, perhaps trying to pick up scents, and did not feed in vegetation patches that they passed. Sometimes bears wandered hillsides above the Firth River and other times would search along the river channel. Northern grizzly bears that have access to caribou and feed on caribou on a regular basis have higher densities and productivity than populations that do not feed on caribou (Reynolds and Garner 1987). The availability of mammalian prey, particularly caribou, may compensate for the constraints of latitude.

Grizzly bears in the Firth River Valley have a short growing season available to acquire the energy necessary for growth, reproduction, and hibernation. Although they currently appear to be able to effectively exploit available resources, further constraints on their ability to forage could have long-term implications. This highlights the need to carefully manage human activities in the north to minimize their impacts on bears or their food resources. Grizzly bears in the Firth River Valley appear to fear humans and generally have not habituated to human activity; therefore, they can be easily displaced from important habitats or prey items (MacHutchon 1996). The avail-

ability of security cover, whether it is vegetation or darkness, can be important in reducing the displacement effects of human activity (McLellan 1990), but grizzly bears in the north have limited vegetative security cover and no darkness during most of their non-denning period. Repeated disruptions have the potential to adversely affect the time available for the acquisition of necessary energy.

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