

BROWN BEAR ACTIVITY AND HABITAT USE, DENALI NATIONAL PARK—1980

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Abstract: Brown bears (*Ursus arctos*) were observed in 2 alpine areas in Denali National Park, Alaska, in 1980. The dispersion and variety of habitat types and seasonal changes in food availability influenced use of the areas by brown bears. The presence of mated pairs apparently excluded family units. Habitat use and activities of bears were influenced by the phenological development of crowberry (*Empetrum nigrum*), peavine (*Hedysarum alpinum*), horsetail (*Equisetum arvense*), polar grass (*Arctagrostis latifolia*), soapberry (*Shepherdia canadensis*), and availability of animal food items.

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The purpose of this study was to determine the seasonal habitat use patterns and activities of brown bears in 2 alpine areas near the Park road in Denali National Park, Alaska. These areas included many of the habitat types important to bears that were used most by visitors. The information gathered should be helpful in locating trails, camping areas, and other visitor and maintenance facilities and in distributing visitor use among backcountry units. This study also contributes to our understanding of brown bears in habitat that probably resembles the periglacial environment in which they may have evolved (Herrero 1978).

Denali National Park has a recent history of accelerated but well-regulated human use. In 1972, a main highway linked the Park directly to Alaska's 2 major population centers, Anchorage and Fairbanks. The National Park Service has regulated traffic on the Park road since 1972, providing free shuttle bus service to visitors. A quota system for overnight foot travel in established backcountry units began in 1974. The brown bear population within the original Park was estimated at 300, a density of about 1 bear per 24-38 km² (Dean 1976). The Park has had a high but stable average rate of human injury (Herrero 1976), but there were no human fatalities from bear encounters in the Park from its establishment in 1922 through 1980.

STUDY AREA

In 1980, Denali National Park comprised an area 7,845 km² in the interior of Alaska. The original Park covered a strip 48-56 km wide, mostly on the north side of the central Alaska Range. The eastern two-thirds was accessible during summer by the Park road. Murie (1944, 1981) provided extensive and illustrated descriptions of the area. The climate is generally cool and wet during summer; snow begins to accumulate in October and remains into June at higher elevations (U.S. Dep. Comm. 1970).

Two study areas were chosen on the basis of prior knowledge of frequent brown bear use, general habitat characteristics, and the juxtaposition of suitable, elevated, observation points. The Toklat River and Sable Pass study areas were almost entirely above timberline and were transected by the Park road. The areas were about 15 km from each other, and no physical barriers precluded interarea travel by bears. Some bears may have used both areas within a single year or season.

The Toklat River study area (940 ha), at about km 80 along the road, was situated at a fork of that river and included the wide, braided, and changeable glacial river bed, about 950 m elevation, and the adjacent slopes to about 1,230 m. Vegetation of the area included a small patch of spruce (*Picea* spp.) woodland, shrubland, and dryas (*Dryas octapetala*) and shrub tundra types (Viereck and Dyrness 1980). All snow had melted by mid-May 1980, but aufeis accumulations remained into early summer. The Toklat River study area was traveled regularly during the summer by a few hikers and campers following the gravel riverbeds and adjacent vegetated gravel bars, but they probably had little influence on bear movements. A small area that produces considerable soapberry, and that has been used by bears for over 20 years, has usually been closed to hikers during late August and September and was closed during the fall of 1980.

The Sable Pass study area, at about km 64, covered about 905 ha between about 1,075-1,385 m elevation. Vegetation types were predominantly sedge tundra on north- and east-facing slopes, dryas tundra on south- and west-facing slopes, shrub tundra at lower elevations, and narrow zones of tall shrubland along streams. Higher, steeper slopes had rock outcrops and talus and sparse vegetation. In 1980 most snow had

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melted from south-facing slopes by late May and from north-facing slopes by 4–6 weeks later. A few perennial snow beds occur. Fresh snow fell on the area every month except July and occurs then in some years. The Sable Pass study area was completely contained within a summer-long closed area established in the 1950s.

MATERIALS AND METHODS

All data were collected by Stelmock between 8 May and 10 October 1980. Bear activity and habitat use data were collected by direct observation from elevated points. Binoculars were used to locate bears and variable-power spotting scopes to follow them. Observation distances ranged from 200 to 4,500 and 100 to 3,100 m on the Toklat River and Sable Pass areas, respectively. The areas were scanned every 10–20 min for additional bear-units even after 1 bear-unit had been located. (A bear-unit was defined as a single bear, a family unit, or a male bear with consort or consorts.) Generally, more than 1 bear-unit could be watched simultaneously. Detailed observations of the activities and habitat use patterns of all bear-units detected on the areas could be made concurrently except for about 1 hour on 1 day at Sable Pass when 6 bear-units could be seen at once. Sex determination of single bears on the basis of urination was seldom possible because of long observation distances. Behavior and relative size were used to infer sex of individual members of consorting bear groups. Family groups were identified as to number of young and year class of young (cubs, yearlings, and those 2 years old or older). The focal animals of family units and mated pairs were the mother and the presumed male, respectively.

Estimates of the numbers of bear-units observed on the study areas are based on the maximum number of each bear-unit type observed simultaneously. Repeated identifications of certain family units based on the age and number of young were reasonably accurate; however, long observation distances precluded repeated identification of many single bears.

The areas were observed for variable lengths of time during each day of observation. No specific time was set for the beginning of an observation period. An area was watched continuously from arrival at an observation point until at least 1800 hours, regardless of success, to reduce bias in estimates of the bears' relative use of the 2 areas. Observation periods were shorter on days that were partially devoted to vegetation mapping or other activities. All time spent

at the observation points was recorded. Periods of continuous observation of the study areas ranged from 2.5 to 36 hours. Observations could be extended over an entire diel period in May, June and July, but day length was considerably shortened by early August. Study areas were watched alternately for 1–3 days.

Activities

Bear activities were assigned to 1 of 9 categories: feeding, directional travel, sinuous travel, resting, nursing, mate-directed, play (other than mate-directed), other intraspecific interactions, and interspecific interactions. Feeding was subsequently divided into types of feeding activities and then subdivided, when possible, by food items as determined by direct observation of the feeding techniques of bears and subsequent checking at many feeding sites. Activity categories are presented below. *Feeding*.—Fifty percent or more (usually 75%) of the time collecting and ingesting a certain food type rather than searching for food or traveling. When the distinction between feeding and sinuous travel was not definite, the cumulative time spent feeding during a 5- or 10-min interval determined the activity. Feeding subdivisions were:

- 1) Feeding on berries of crowberry, soapberry, and bearberry (*Arctostaphylos rubra/alpina*)
- 2) Digging for roots of peavine
- 3) Grazing on horsetail or polar grass and/or other undetermined grasses, sedges, or forbs; Richardson's saxifrage (*Boykinia richardsonii*) stems and flowers; and oxytrope (*Oxytropis* spp.) flowers
- 4) Browsing on willow (*Salix* spp.) catkins
- 5) Feeding on arctic ground squirrels (*Spermophilus undulatus*) or voles (*Microtus miurus* and *M. oeconomus*), including either actual digging for or chasing rodents
- 6) Feeding on carrion.

Sinuous traveling.—Head lowered to the ground; frequent stops to inspect or ingest food items; less than 50% (usually 25%) of the time was spent ingesting; included travel while investigating rodent trails and burrows.

Directional traveling.—Head held high while walking or running; no frequent stops to inspect potential food items.

Resting.—(1) Nocturnal, including rest that continued for extended nighttime periods; (2) diurnal,

including periods of rest separated by bouts of other activities during the day.

Nursing.—The mother, being the focal animal of a family unit, provided milk.

Mate-directed.—Mounting and other mate-directed activity, including play, herding, and nuzzling.

Play.—Play among a mother and her young and among members of different bear-units. Mate-directed play was excluded.

Other intraspecific interactions.—Apparently the result of proximity to other bear-units, including moving toward or away from other bear-units.

Interspecific interactions.—Apparently non-predatory activities seemingly the direct result of proximity to animals of other species.

The percentages of time bear-units spent in each of the activity categories were calculated. Daily and seasonal patterns of activities were compared.

The season was divided into spring, summer, and fall based on the timing of major shifts in the observed feeding activities. The spring phase extended from early May to the end of May at the Toklat River and to mid-June at Sable Pass, summer lasted until the beginning of August at both areas; fall extended from 1 August until early October.

Vegetation Mapping and Habitat Use

Color enlargements were made at 1:5,000 from portions of aerial natural color positives (NASA/MS-C 209, Jul 1972, 30-0023 and 30-0017 for the Toklat River and Sable Pass, respectively). Vegetation types were described according to a 5-level, hierarchical classification system (Vioreck and Dyrness 1980). Vegetation types were mapped directly onto an acetate sheet taped over the photographs. Because vegetation types could be identified best at different phenological stages, mapping continued into late summer. Estimates of areal coverage of vegetation types were made using a polar compensating planimeter.

The criteria for classification at levels I, II, III, and IV are presented in Vioreck and Dyrness (1980) and Stelmock (1981). Stelmock (1981) describes level V type criteria and prevalent plant species.

The 1:5,000 color enlargements with acetate overlay maps of vegetation types provided the base for recording habitat use data. Once a bear-unit was located, its position was plotted using geologic formations and natural vegetation boundaries to relate map locations to the bear's position. Times when

bears crossed habitat type boundaries were noted to the nearest minute.

Independent frequency observations that would permit chi-squared comparisons of vegetation use among seasons could not be obtained from the continuous observation data by imposing an instantaneous scan because of the high degree of serial correlation between successive observations. A runs test indicated that to be independent, an interval of 1 hour would be required for serial observations of bears in level V vegetation types. Resultant sample sizes were too small to permit comparison based on tests using independent frequency observations, so observations were summarized as percentages of total bear-unit-hours occupying each vegetation type. The observation of 1 bear-unit for 1 hour was defined as 1 bear-unit-hour. The percentage values were divided by the areal coverage of each vegetation type to permit comparison of the intensity of use by bears among vegetation types.

RESULTS

Observation Success

One thousand eleven hours, distributed approximately equally between study areas, were spent watching from the observation points; 266 bear-unit-hours at Toklat River and 503 bear-unit-hours at Sable Pass resulted (Table 1). Averages of 43% and 68% of observation time were spent watching bears on the Toklat River and Sable Pass areas, respectively. The bear-unit-hours per hour spent observing between 0600 and 1800 hours (Alaska Daylight Savings Time) were calculated (Fig. 1); use was higher at Sable Pass than at Toklat River for all months except May. Increases in the June index value were mainly the result of increased use by bears normally present (regulars), but were partly due to use by more transient bears. Very low values of the index in early September were probably due to a temporary covering of the areas by snow and generally poor visibility due to adverse weather.

Each study area had regulars throughout the field season; other bears used the areas only at certain times. Bear-units observed at Toklat River included at least 3 single bears, a female with 2 2-year-old young, a female with 2 yearlings, and a female with 1 yearling. At least 1 female with 1 cub was seen on the area during May and June. This resulted in a minimum of 7 different bear-units (13 individual bears) at Toklat River. At least 2 single bears, a

Table 1. Total hours of observation, cumulative bear-unit-hours, and proportion of observation time observing at least 1 bear-unit for each 2-week interval at the Toklat River and Sable Pass study areas, Denali National Park, Alaska, 1980.

Period	Toklat River			Sable Pass		
	Hours observing	Bear-unit hours	Proportion of time observing bears	Hours observing	Bear-unit hours	Proportion of time observing bears
Early May	40.4	22.5	0.50	13.0	3.2	0.24
Late May	76.3	58.6	0.57	48.4	40.3	0.81
Early Jun	68.5	57.1	0.74	47.5	43.3	0.44
Late Jun	48.5	35.5	0.49	76.7	109.8	0.91
Early Jul	48.5	2.5	0.10	55.1	97.2	1.00
Late Jul	39.5	2.5	0.06	44.6	41.6	0.91
Early Aug	50.8	29.8	0.71	41.6	48.3	0.75
Late Aug	51.2	28.4	0.50	60.9	50.5	0.71
Early Sep	32.8	16.7	0.56	36.3	35.3	0.83
Late Sep	52.3	9.4	0.18	20.3	4.3	0.21
Early Oct	10.0	2.8	0.28	47.7	28.9	0.70
Total hours	518.8	265.8		492.1	502.7	

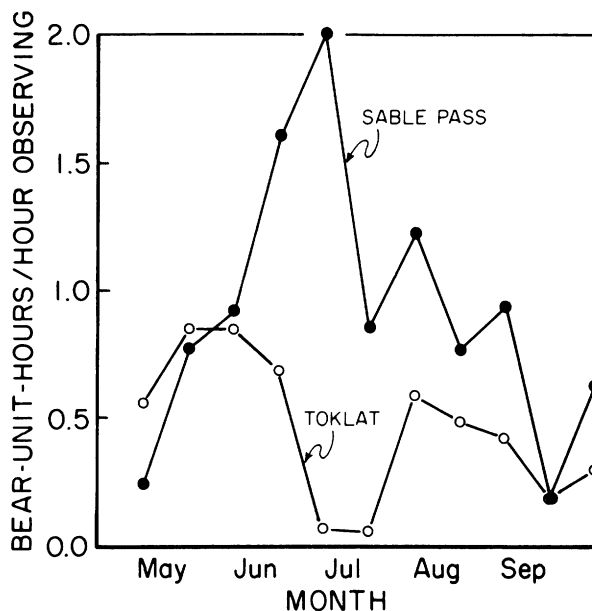


Fig. 1. Seasonal bear use within and between the Toklat River and Sable Pass study areas, Denali National Park, Alaska, 1980 (0600–1800 h only).

female with 3 cubs and a female with 2 2-year-olds, were regulars at Sable Pass. Two families, each with 1 cub; at least 2 larger bears; and a minimum of 1 other single bear were seen on the area during some part of the year (16 bears from 9 bear-units). Thirteen bears (from 6 bear-units) were seen at once on the Sable Pass area on 29 June.

During the spring, while mated pairs were seen on the study areas, few family units were observed, although family units had been seen in neighboring areas of the Park since 8 May; family units usually emerge from dens in late April (Fig. 2).

Differential sightability of bears in different vegetation types was tested. The level II vegetation types for initial sightings were compared to those recorded during instantaneous scans at 1-hour intervals. All information was combined for each area. At Toklat River, the test could not include the road or shrub tundra because we had no scan data for these types. The hypothesis of equal sightability in all vegetation types was not rejected ($X^2 = 5.38$, $df = 6$, $P = 0.30$ at Toklat River; $X^2 = 11.96$, $df = 7$, $P = 0.10$ at Sable Pass).

Although differential sightability among vegetation types did not appear to be a serious problem, initial observations of bears in certain vegetation types contributed most to the chi-square values. Initial observations were more frequent than expected in mat and cushion tundra at Toklat River and in herbaceous

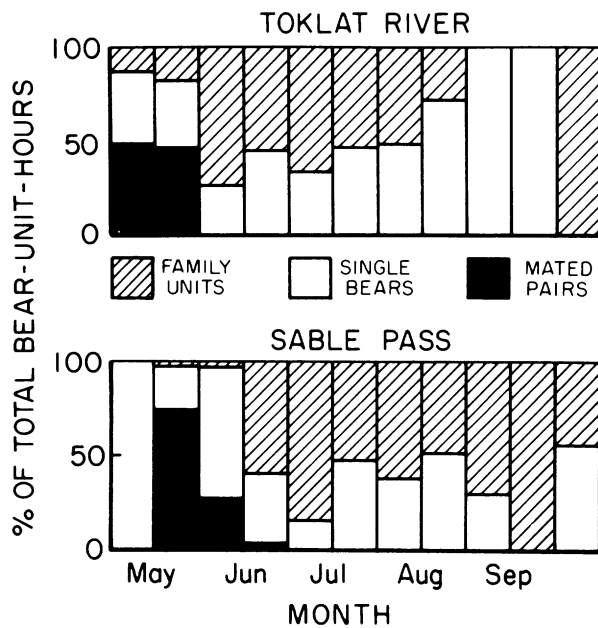


Fig. 2. Composition of bear-unit-hours by type of bear-unit for 2-week intervals, Denali National Park, Alaska, 1980.

vegetation and shrub tundra at Sable Pass; they were less frequent in tall shrubland and forest at Toklat River and in tall shrubland and sedge-grass tundra at Sable Pass. Sightability in forest and shrubland was probably reduced due to cover, especially after leaves came out. Better sightability in herbaceous vegetation may have resulted from the lack of cover, heavy use of the type, observer bias, or all of these.

Seasonal Activities

General activities.—Activity for each 2-week interval is shown in Table 2 for single bears and family units. Time spent nursing and nocturnal rest were excluded. Comparable information for mated pairs was combined due to small sample sizes. Proportional time spent feeding appeared to increase during September at both areas, and time spent resting diurnally decreased during late summer. Bears seen at Toklat River during July usually traversed the area with only short feeding bouts. The proportion of time spent in sinuous travel during fall was greater than spring or summer values at Sable Pass and greater than spring values at the Toklat River. Much of this increase at Sable Pass was attributed to hunting for ground squirrels.

Consorting bear-units were seen on or near the study areas from 12 May to 4 July; however, Stelmock observed no mountings later than 3 June, although

Table 2. Percent of total time spent in 8 general activity categories for bears observed at the Toklat River and Sable Pass study areas, Denali National Park, Alaska, 1980.

Activity	Toklat River								Sable Pass								Mated Pairs (both areas)
	Early May	Late May	Early Jun	Late Jun	Early Jul	Late Jul	Early Aug	Late Aug	Early Sep	Late Sep	Early Oct	Late Oct	Early Sep	Late Sep	Early Oct	Late Oct	
Feeding	51.2	54.1	54.8	51.8	40.4	2.8	81.2	93.7	90.8	61.6	65.4	67.8	81.0	82.8	81.0	67.5	74.1
Sinuous travel	4.9	13.8	8.0	7.9	44.3	90.4	8.5	4.9	6.6	31.6	32.9	1.9	16.4	14.4	16.4	32.5	24.9
Direct. travel	17.0	2.5	0.9	0.9	5.2	3.2	3.1	1.4	2.6	3.6	1.8	0.6	0	0.2	0	0	0
Resting	18.5	27.0	26.8	37.6	0	0	8.5	0	0	3.2	0	32.6	21.3	2.1	2.5	0	0.8
Mate-directed	0	0	0	0	0	0	0	0	0	0	0	12.1	0	0	0	0	0
Playing	4.0	0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intrasp. inter.	4.0	1.9	0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intersp. inter.	0.4	0.7	8.4	0.7	0	3.6	0.8	0	0	0	0	0	0	0	0	0	0
Total hours	11.2	29.5	57.1	35.5	2.5	2.5	29.8	28.4	16.7	9.4	2.8	86.5	48.3	50.5	35.3	4.3	28.9

others were reported later from other parts of the Park. In all but 1 instance, the mating activities of male bears were directed at a single female bear. In 2 cases, what appeared to be female bears directly approached lone male bears from some distance and remained with them until the end of the observation period or until they were out of sight. Herding of females by male bears, as described by Herrero and Hamer (1977) and Murie (1981), was seen only once. Mated pairs never spent more than 48 hours on the study areas at a time. During May and early June, mated pairs spent much time wrestling or caressing. Males often mounted or attempted to mount. The average duration of 15 completed mountings (excluding attempted mountings) was 7.0 min (range 2.4–27.0; variance = 48.7). Short-duration (2–5 sec) quivering thrusts by males were seen at about 1-min intervals during some mountings. Members of mated pairs generally fed synchronously within about 50 m of each other. Females would often be displaced from sites where they were digging roots by the approach of their mate. By late June few of the activities of either member appeared to be mate-directed, and within-pair distance increased.

All intraspecific interactions at Toklat River occurred when mated pairs were seen on the area. These usually involved a family unit that appeared to have been traveling to avoid a mated pair or a single bear.

Intraspecific interactions in late June at Sable Pass involved a small lone female bear that repeatedly approached and played with 2 2-year-old bears that accompanied their mother. This bear was also seen repeatedly approaching a cub with its mother on a snowbed. The mothers often pursued this lone bear. The mothers of 2 families that regularly used this area had at least 2 agonistic contacts while feeding on crowberry during September.

Interspecific interactions included the startling of a cub by an approaching red fox (*Vulpes vulpes*); single bears repeatedly running toward, and sometimes chasing small groups of caribou (*Rangifer tarandus*) for a short distance; a female chasing a golden eagle (*Aquila chrysaetos*) with a ground squirrel; and females with young moving away from moose (*Alces alces*) and caribou.

Play among siblings of all ages was common during the spring and summer, but play involving a female and her cubs was rare. There seemed to be a marked decrease in time spent in play among young of all ages in late summer and fall.

In spring, male members of mated pairs seemed to react most conspicuously to traffic disturbance. When members of a pair were resting together, it was always the male that sat or stood and sniffed or retreated for a short distance when a vehicle passed. In early spring when vehicles passed by, some single bears and family units ran or traveled continuously until out of sight of the road. The intensity of reactions to passing vehicles generally decreased during the summer, but some individual bears and families remained sensitive to traffic. These bears would approach the road cautiously and would run back or suddenly dash across the road if a vehicle approached. Other families and single bears would feed along the edge of the road during summer and fall with no strong reaction to traffic. All bears appeared to react at distances up to about 0.75 km to loud noises created by vehicles.

Stelmock's presence at the observation points had little noticeable effect on the habitat use and activity patterns of bears on the study areas.

Feeding activities.—Observed feeding activities in spring and early summer (Table 3) on the Toklat River area were generally consistent with the pattern seen in the Alaska Range (Murie 1944, 1981). Moose and caribou calves had been captured and consumed by bears during the spring in areas of the Park near but not on the study areas. Bears grazed in the area throughout June. During July little feeding was observed on the area; most bears traveled through while feeding very intermittently. Use of the area increased substantially in early August and continued through September. In late September root digging activity became predominant, and bears plowed their noses through up to 150 mm of fresh snow to find roots. Feeding on rodents became more common after snow had covered the area.

In contrast to bears at the Toklat River, during May and early June bears at Sable Pass fed on the over-wintered berries of crowberry almost exclusively, switching by late June almost completely to grazing. Bears fed on new berries beginning in late August. Active digging for rodents increased greatly during the fall.

Daily activities.—Figure 3 shows the observed diel distribution of broad activity categories. Details of total numbers of hours of observation and bear-unit-hours for the 24-hour period by each season are presented in Stelmock (1981).

Diurnal inactivity peaked around midday during the spring and summer phases at Toklat River and

did so less markedly at Sable Pass. Mated pairs appeared slightly less active during the day than other bear-units on the study areas during the spring (Table 4). Peaks in activity generally occurred at twilight. Because bears observed in the fall fed almost continuously, sometimes for more than 14 hours, lengths of intervals between rest periods in fall often could not be determined. The durations of fall rest periods shown in Table 4 were mainly of bears observed in early August. Stelmock rarely observed diurnal inactivity as day length decreased in the fall and bears switched to a diet consisting mainly of berries. A 2-way ANOVA indicated that the differences in duration of diurnal rest periods between areas and among the 3 seasons were not significant (F [area effect] = 0.35, df = 1, 146; F [season effect] = 1.42, df = 2, 146; F [interaction effect] = 2.23, df = 2, 146). The same analysis was used to test for differences in the mean intervals between rest periods in spring and summer. No significant differences were found due to area or season (F [area effect] = 3.95,

df = 1, 62; F [season effect] = 0.97, df = 1, 62; F [interaction effect] = 0.48, df = 1, 62).

During spring and summer, bears were observed bedding down before they were lost from sight due to darkness. These bears generally remained inactive from about 2400–0400 hours. Activity during darkness was probably underestimated because only those bears followed to their nocturnal resting sites could be watched. There appeared to be no consistent timing pattern for diurnal travel. Travel by mated pairs throughout the 24-hour period was much less than that of other bear-units during the spring.

Most of the activity included in "other activities" was related to mating. There appeared to be no definite daily timing of mate-directed events.

Seasonal habitat use.—Thirty-six level V vegetation types were recognized (Table 5) and assigned an acronym consisting of the 1st 2 letters of the generic name and specific epithet of 2 key plant species (see Appendix for a list of full names). Criteria for classification, a description of the types, percent-

Table 3. Percent of total feeding time spent feeding on 10 types of food items or in sinuous travel for bears observed at the Toklat River and Sable Pass study areas, Denali National Park, Alaska, 1980.

Food items or activity	Toklat River										
	Early May	Late May	Early Jun	Late Jun	Early Jul	Late Jul	Early Aug	Late Aug	Early Sep	Late Sep	Early Oct
Crowberry	0	2.6	0	0	0	0	0	0	0	1.0	0
Soapberry	0	0	0	0	0	0	23.6	86.1	73.5	38.7	0
Bearberry	0	0.3	0	0	0	0	0	0.9	1.0	1.8	0
Peavine	94.8	82.1	35.0	0	0	0	65.0	7.6	18.7	23.6	57.6
Horsetail/grass/sedge	0	0	49.4	72.5	48.9	3.0	1.2	0.1	0	0	0
Richardson's saxifrage	0	0	0	0	0	0	0	0	0	0	0
Oxytrope flowers	0	0	0	14.3	0	0	0	0	0	0	0
Willow spp. catkins	0	0	0	0	0	0	0	0	0	0	0
Rodents	0	0	2.8	0	4.3	0	6.9	0.4	0	2.3	8.9
Carrion	0	0	0.2	0	0	0	0	0	0	0	0
Sinuous travel	5.2	14.9	12.7	13.2	46.8	97.0	9.5	5.0	6.8	33.9	33.5
Total hours	12.6	39.8	35.9	21.2	2.1	2.3	26.7	28.0	16.3	8.7	2.7
Food items or activity	Sable Pass										
	Early May	Late May	Early Jun	Late Jun	Early Jul	Late Jul	Early Aug	Late Aug	Early Sep	Late Sep	Early Oct
Crowberry	98.7	91.8	80.8	19.4	1.1	0	39.7	81.1	79.8	43.8	63.3
Soapberry	0	0	0	0	0	0	0	0	0	0	0
Bearberry	0	0	0	0	0	0	0	0	0	0	0
Peavine	0	0	0	0	0	0	0	0	0	1.6	0
Horsetail/grass/sedge	0	0.4	2.3	67.8	85.9	83.2	18.6	3.4	0	0	0
Richardson's saxifrage	0	0	0	0	0	3.5	0.2	0.3	0	0	0
Oxytrope flowers	0	0	0	0	0	0	0	0	0	0	0
Willow catkins	0	0.5	0	0	0	0	0	0	0	0	0
Rodents	0	0	2.3	1.6	0.5	0	1.6	0.2	3.4	22.1	11.5
Carrion	0	0	0	0	0	0	12.3	0	0	0	0
Sinuous travel	1.3	7.3	14.6	11.1	12.5	13.3	27.5	14.9	16.8	32.5	25.1
Total hours	2.4	37.2	34.8	76.4	73.0	29.2	37.3	49.1	34.4	4.0	28.6

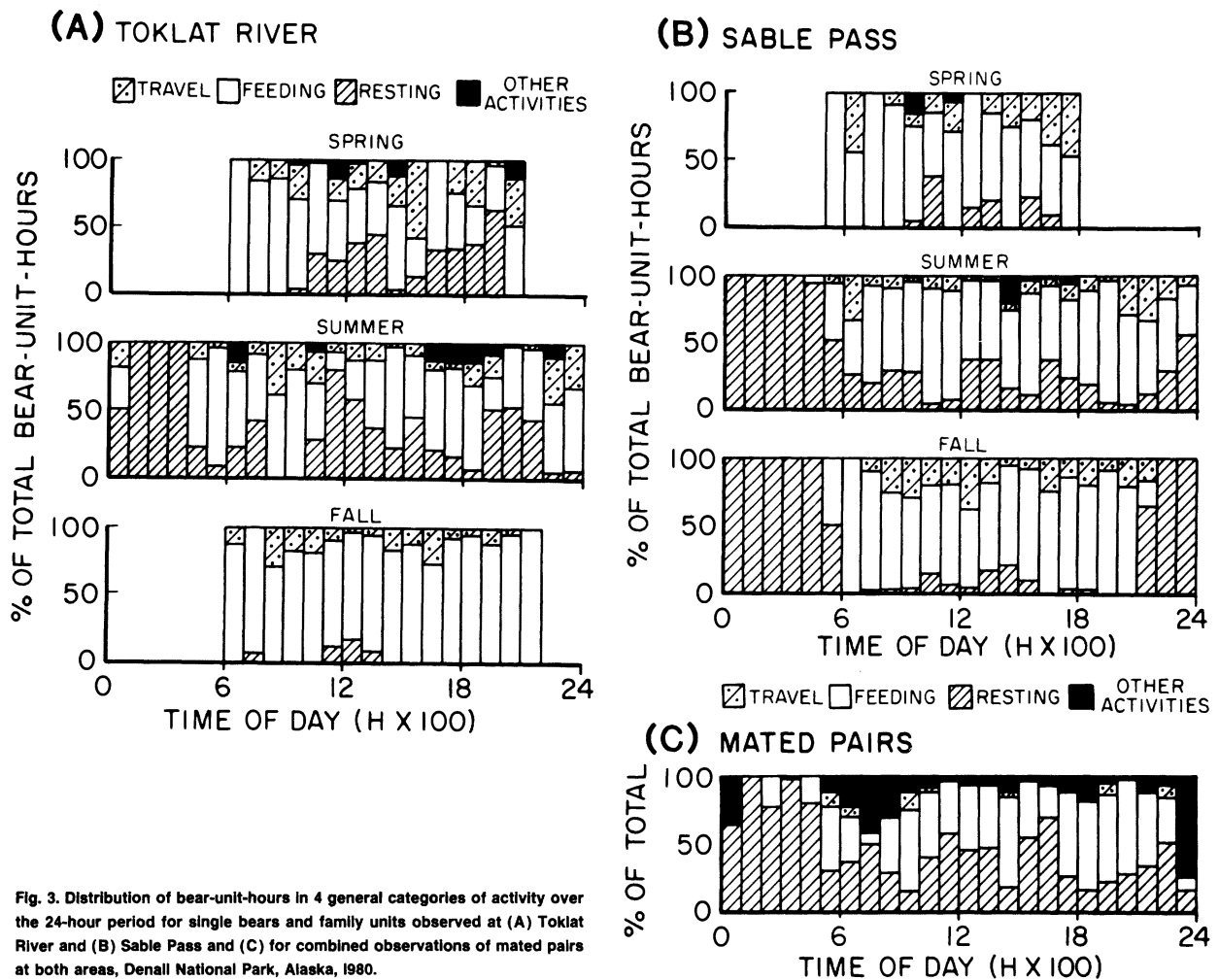


Fig. 3. Distribution of bear-unit-hours in 4 general categories of activity over the 24-hour period for single bears and family units observed at (A) Toklat River and (B) Sable Pass and (C) for combined observations of mated pairs at both areas, Denali National Park, Alaska, 1980.

ages of bear-unit-hours associated with level V types, and the relationship of use to type area are available in Stelmock (1981).

1. Toklat River. Coniferous and deciduous forest types were combined in Figure 4. Observed seasonal patterns of bear use within level II vegetation types were largely determined by high use of a few level V vegetation types. DROC-HEAL and DROC-SAGL mat and cushion tundra, along with SAAL-HEAL tall shrubland and BENA-SHCA low shrubland, were used extensively by bears for digging peavine roots in the spring. SAAL-HEAL received the most intensive use. Bears dug for roots on high dryas slopes (DROC-CATE mat and cushion) to some extent on the study area and were seen digging in this vegetation type in other areas of the Park. DROC-EMNI mat and cushion and BENA-VAUL shrub tundra vegetation types were located within 1 km northeast of

the Toklat River study area, and bears were observed feeding on crowberries on these areas to a limited extent in the spring and regularly during the fall.

Mating activities took place in the same types in which the bears fed; mated pairs and other bear-units generally rested in the same type of vegetation where they had fed except that they sometimes rested on aufeis or bare gravel on the nearby river bed. Small depressions or knolls were often used for resting. Family units climbed to SATR-DROC herbaceous tundra or DROC-CATE mat and cushion tundra at higher elevations for nocturnal rest and often escaped up to these areas when frightened or approached by other bears.

In June, bears grazed most intensively in several areas of SAAL-EQAR tall shrubland but also in CAPO-ARLA sedge-grass tundra and ARLA-EQAR herbaceous vegetation. Bears grazing in these

Table 4. Average durations of and intervals between diurnal rest periods for all bear-units observed during each season at the Toklat River and Sable Pass study areas, Denali National Park, Alaska, 1980.

Season	Duration (h)			Interval (h)		
	<i>N</i>	\bar{x}	(SD)	<i>N</i>	\bar{x}	(SD)
Toklat River						
Spring						
All bear-units	28	0.8	(0.6)	10	1.2	(0.6)
Mated pairs	16	0.7	(0.5)	8	1.0	(0.6)
Other units	12	0.8	(0.6)	2	1.8	(0.1)
Summer	22	1.1	(0.7)	16	1.2	(1.2)
Fall	4	0.7	(0.6)	—	—	—
Sable Pass						
Spring						
All bear-units	14	1.0	(1.1)	9	2.0	(1.1)
Mated pairs	8	1.2	(1.4)	7	1.9	(0.7)
Other units	6	0.8	(0.2)	2	2.5	(2.2)
Summer	63	0.8	(0.5)	31	2.1	(1.2)
Fall	19	0.5	(0.4)	2	2.4	(0.6)

types moved very little. The intensity of bear use of these 3 vegetation types was generally greater than that by bears in the same types at Sable Pass in spite of greater areal coverage for the same types at Sable Pass. The total period during which SASP-EQAR tall shrubland was used most intensively by bears lasted about 6 weeks at both study areas, even though grazing in this type began 2 weeks earlier and peaked sooner at Toklat River. Some grazing occurred along the road near the spruce woodland forest during the summer. Bears consumed oxytropes flowers in DROC-SAGL mat and cushion and BENA-SHCA low shrubland flats along river bars.

No distinct patterns of vegetation use were detected at Toklat River during July, probably because there were few observations. Bears quickly passed through the area along the river bed or moved sinuously among the taller dense shrubland areas or herbaceous types, presumably grazing on more shaded or succulent vegetation.

The 2 main fall food items, peavine roots and soapberries, were generally found in the same vegetation types, though in different proportions, and were often consumed alternately. DROC-SAGL and DROC-HEAL mat and cushion tundra, SAAL-HEAL tall shrubland and BENA-SHCA low shrubland were again used by bears for root digging. These areas and SHCA-DROC low shrubland were used for berry feeding. The SHCA-DROC areas, 1 of which is located adjacent to the Park road, were most frequently used by bears. Bears often restricted their movements within these small units and remained there for up to 9 hours.

2. Sable Pass. General seasonal shifts in vegetation use patterns at Sable Pass (Fig. 5) were also attributed to changes in intensity of use by bears of more specific vegetation types. In May and early June, bears fed on crowberries extensively in DROC-EMNI mat and cushion and BENA-VAUL shrub tundra types. Vegetation types similar to those at Toklat River that contained peavine were located within 1 km of the study area. Bears observed on the Sable Pass study area during the spring have been seen feeding on roots

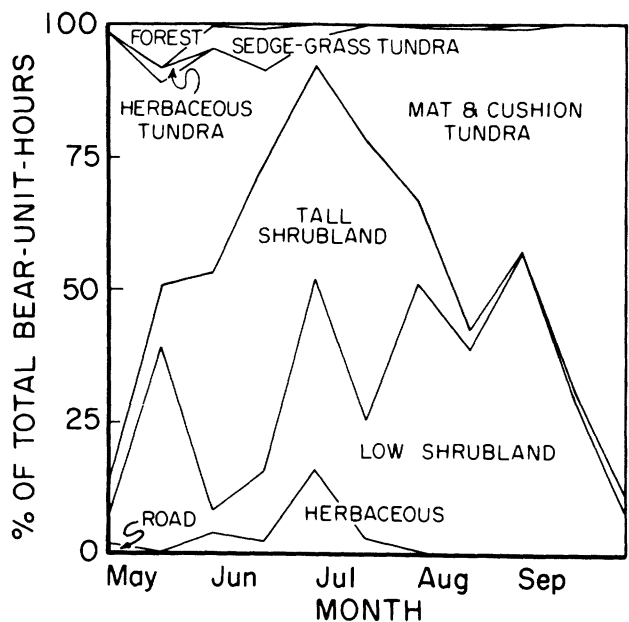


Fig. 4. Use of level II vegetation types by bears observed at Toklat River, Denali National Park, Alaska, for 2-week intervals during 1980.

Table 5. Outline of classification scheme for vegetation and areal coverage (%) of vegetation types at the Toklat River and Sable Pass study areas, Denali National Park, Alaska, 1980.

Classification level					Cover (%)	
I	II	III	IV	V	Toklat R.	Sable Pass
FOREST					3.6	—
	Conifer	Woodland	White spruce	(PIGL-SASP)	3.3	—
	Deciduous	Open	Balsam poplar	(POBA-SASP)	0.4	—
TUNDRA					63.5	74.4
	Sedge-grass				4.9	23.1
		Wet sedge-grass	Wet sedge meadow	(CAAQ-ERAN)	0.4	0.1
		Mesic sedge-grass	Mesic sedge-grass meadow	(CAPO-ARLA)	1.2	5.2
		Sedge-shrub	Sedge-birch	(CABI-BENA)	0.6	—
		Sedge mat & cushion	Sedge- <i>Dryas</i>	(CABI-DROC)	2.7	17.8
	Herbaceous	Alpine herbaceous	Alpine herbs	(SATR-DROC)	1.1	3.5
					0.8	16.2
	Shrub	Willow	Willow-grass	(SAPL-CACA)	—	0.6
		Birch & ericaceous	Birch & ericaceous-grass	(BENA-VAUL)	—	7.2
		Mixed shrub	Undiff. understory	(BENA-SAGL)	0.8	8.4
	Mat & cushion				56.7	31.6
		Open			41.2	4.3
			Snowbed	(SARO-DROC)	—	2.6
			<i>Dryas</i> -herb		40.2	1.8
				(DROC-EPLA)	29.9	1.8
				(DROC-HEAL)	11.2	—
		Closed			15.5	27.2
			Prostrate shrubs	(DROC-SAGL)	11.9	—
			Mat & cushion-sedge	(DROC-CABI)	0.9	2.7
			<i>Dryas</i>	(DROC-SAAR)	—	9.4
			<i>Cassiope</i>		2.7	15.1
				(DROC-CATE)	2.7	4.4
				(DROC-EMNI)	—	10.7
SHRUBLAND					32.2	20.3
	Tall				13.0	8.5
		Closed	Willow	(SAAL-SAAR)	0.1	—
		Open			12.9	8.5
			Willow		11.3	8.5
				(SASP-EQAR)	2.3	5.9
				(SAAL-HEAL)	0.4	—
				(SAAL-SHCA)	1.6	—
				(SAAL-DROC)	—	2.0
				(SAAL-SAGL)	7.0	—
				(SAAL-SAPL)	—	0.6
			Shrub birch-willow	(BEG-L-SASP)	1.5	—
	Low				19.2	11.8
		Closed	Dwarf birch-willow	(BENA-SABA)	0.8	—
		Open			18.4	11.8
			Willow		3.2	3.0
				(SAPL-EQAR)	0.8	3.0
				(SAGL-ELIN)	1.1	—
				(SAGL-SHCA)	1.4	—
			Dwarf birch-willow		13.9	8.8
				(BENA-SAPL)	3.3	8.8
				(BENA-SABA) open	3.5	—
				(BENA-SHCA)	7.2	—
			<i>Shepherdia-Dryas</i>	(SHCA-DROC)	1.3	—
HERBACEOUS					0.3	4.9
	Midgrass	Mesic	Midgrass-herb		0.3	4.9
				(ARLA-EQAR)	0.3	3.8
				(ARLA-BORI)	—	1.2
ROAD BED AND ADJACENT DISTURBED AREAS					0.4	0.5

in these neighboring areas. Peavine roots were also available on road banks on Sable Pass. Bears searched along grassy stream banks and in shrub tundra on the study area for rodents during the spring. Travel was often along packed snow ridges.

Grazing by Sable Pass bears started along the roadside, which is freed of snow early by plowing, and exposed stream banks (ARLA-EQAR herbaceous vegetation) in June; there the animals fed on the 1st green shoots of bluejoint grass (*Calamagrostis canadensis*). In late June, the animals grazed extensively in CAPO-ARLA sedge-grass tundra, SAAL-EQAR tall shrubland and SAPL-EQAR low shrubland. Late in the summer phase and during August and September, grasses, sedges, and Richardson's saxifrage were grazed along the periphery of areas with perennial snow accumulation (ARLA-BORI herbaceous vegetation).

In August, bears turned to feeding on new crowberries in the same habitat types as in the spring and also fed on berries in BENA-SAGL shrub tundra. Persisting snow cover appeared to prevent the spring-time use of overwintered berries in the latter type in the spring. Soapberry was rare on the delimited study area but occurred in several nearby locations, including extensive patches of SHCA-DROC low shrubland. Bears searched for ground squirrels as they traversed SATR-DROC herbaceous tundra on scree slopes and pursued them intensively in areas where snow had persisted much of the year (ARLA-BORI herbaceous vegetation). The high use of herbaceous types during the fall was mainly due to hunting for ground squirrels. Many ground squirrels emerged from under deep snow in these areas in the spring.

At Sable Pass, bears did not appear to choose specific vegetation types for resting during the day or for nursing. They usually rested near areas of feeding. Some bears rested on snowbeds during the day. On separate occasions during the summer, a single bear and a family unit spent a night resting on a small ledge on a scree slope. Another family remained on a caribou carcass for a night in mid-August. Bears approaching the Park road commonly appeared to be using strings of tall willow for cover.

DISCUSSION

The habitat use and activity patterns observed in 1980 were well with the range of variation observed in Denali National Park by Murie (1944, 1981), Valkenburg (1976), and Dean in other years, and by

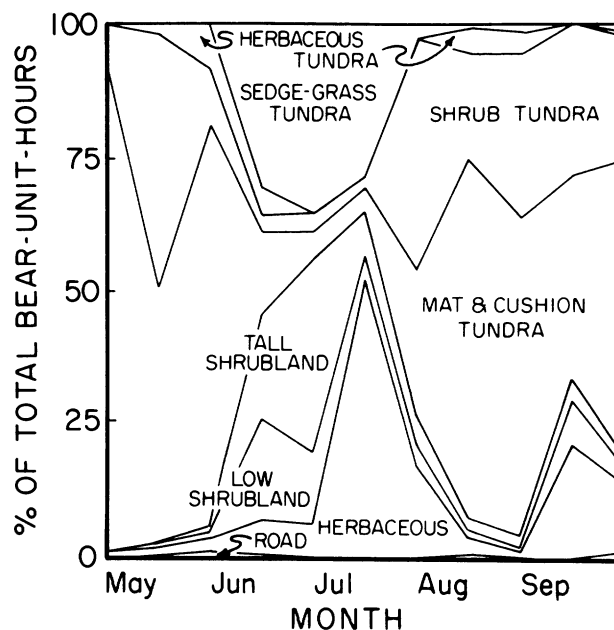


Fig. 5. Use of level II vegetation types by bears observed at Sable Pass, Denali National Park, Alaska, for 2-week intervals during 1980.

others in similar northern regions (Kistchinski 1972, Pearson 1975). However, Stelmock's data illustrate the importance of multi-year studies, especially when dealing with long-lived animals in changeable environments. The concentration on crowberry observed in 1980 is not typical of all years; frequently the late summer berry used most heavily is bog blueberry (*Vaccinium uliginosum*), which had a poor crop that year. The effects of regional climate and microclimate are important in determining the relative abundance of the several species of berries and, consequently, habitat use. Plant succession may alter the dispersion of certain vegetation types and food items. Long-term changes in the distribution of peavine and soapberry result from erosion, flooding, or succession on gravel bars not invaded by water channels (Viereck 1966). Ground squirrel populations appear to be quite reliable from year to year (Carl 1971, Murie 1981); microtines and meat from large mammals are less predictable. These changes in the seasonal and annual availability and distribution of certain resources may result in shifts in the pattern and timing of the feeding activities and habitat use of brown bears in Denali National Park.

Early spring habitat selection clearly reflects the occurrence of peavine and ericaceous berry producers. Areas where spring food items were more abundant appeared to be used by mated pairs.

The relative proportion of family units to single bears increased after mating activities had declined; this and the use of high cliffs and slopes by family units for nocturnal rest during the spring also suggested some avoidance by families of mated pairs, as has been reported by Murie (1981) and Pearson (1975). The increased use of Sable Pass later in the spring must have been partly in response to green-up.

Summer use was mainly confined to narrowly-defined vegetation types, often restricted to small stands but providing favored plant foods. The shifts in grazing activity from southerly exposed herbaceous streambanks and roadsides to north- and west-facing wet sedge slopes and tall willow swales closely matched the temporal sequence of snow melt and vegetation emergence.

Topographic diversity at Sable Pass provided a large assortment of vegetation communities and much variation in temporal availability of early phenological stages; the Toklat River area lacked this.

Brown bears observed on the study areas were generally diurnal in the early spring with a crepuscular pattern of activity. During the fall phase bears were active throughout the daylight and twilight hours and possibly during darkness. Diel activity patterns appear to vary considerably from region to region and perhaps with relationship to hunting. Bromlei (1965), Pearson (1975), and Sizemore (1980) reported extended activity in the fall.

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APPENDIX

Acronyms and Names for Level V Vegetation Types

ARLA-BORI	— <i>Arctagrostis latifolia-Boykinia richardsonii</i>
ARLA-EQAR	— <i>Arctagrostis latifolia-Equisetum arvense</i>
B EGL-SASP	— <i>Betula glandulosa-Salix</i> spp.
BENA-SABA (open)	— <i>Betula nana-Salix barrattiana</i>
BENA-SABA	— <i>Betula nana-Salix barrattiana</i>
BENA-SAGL	— <i>Betula nana-Salix glauca</i>
BENA-SAPL	— <i>Betula nana-Salix planifolia</i>
BENA-SHCA	— <i>Betula nana-Shepherdia canadensis</i>
BENA-VAUL	— <i>Betula nana-Vaccinium uliginosum</i>
CAAQ-ERAN	— <i>Carex aquatilis-Eriophorum angustifolium</i>
CABI-BENA	— <i>Carex bigelowii-Betula nana</i>
CABI-DROC	— <i>Carex bigelowii-Dryas octopetala</i>
CAPO-ARLA	— <i>Carex podocarpa-Arctagrostis latifolia</i>

DROC-CABI	—	<i>Dryas octopetala-Carex bigelowii</i>
DROC-CATE	—	<i>Dryas octopetala-Cassiope tetragona</i>
DROC-EMNI	—	<i>Dryas octopetala-Empetrum nigrum</i>
DROC-EPLA	—	<i>Dryas octopetala-Epilobium latifolium</i>
DROC-HEAL	—	<i>Dryas octopetala-Hedysarum alpinum</i>
DROC-SAAR	—	<i>Dryas octopetala-Salix arctica</i>
DROC-SAGL	—	<i>Dryas octopetala-Salix glauca</i>
PIGL-SASP	—	<i>Picea glauca-Salix spp.</i>
POBA-SASP	—	<i>Populus balsamifera-Salix spp.</i>
SAAL-DROC	—	<i>Salix alaxensis-Dryas octopetala</i>
SAAL-HEAL	—	<i>Salix alaxensis-Hedysarum alpinum</i>
SAAL-SAAR	—	<i>Salix alaxensis-Salix arbusculoides</i>
SAAL-SAGL	—	<i>Salix alaxensis-Salix glauca</i>
SAAL-SAPL	—	<i>Salix alaxensis-Salix planifolia</i>
SAAL-SHCA	—	<i>Salix alaxensis-Shepherdia canadensis</i>
SAGL-ELIN	—	<i>Salix glauca-Elymus innovatus</i>
SAGL-SHCA	—	<i>Salix glauca-Shepherdia canadensis</i>
SAPL-CACA	—	<i>Salix planifolia-Calamagrostis canadensis</i>
SAPL-EQAR	—	<i>Salix planifolia-Equisetum arvense</i>
SARO-DROC	—	<i>Salix rotundifolia-Dryas octopetala</i>
SASP-EQAR	—	<i>Salix spp.-Equisetum arvense</i>
SATR-DROC	—	<i>Saxifraga tricuspidata-Dryas octopetala</i>
SHCA-DROC	—	<i>Shepherdia canadensis-Dryas octopetala</i>
