

GRIZZLY BEAR – HABITAT RELATIONSHIPS IN THE YELLOWSTONE AREA

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Abstract: Habitat use by grizzly bears (*Ursus arctos*) was studied from 1977 through 1979 in a 20,000-km² area with Yellowstone National Park in the center. Of 1826 aerial radio locations of 46 instrumented grizzlies, 90% were in timber. Three-fourths of the locations were 100 m or less from an edge between timber and an opening. Timber over 3 m tall with a canopy cover of 26–75% accounted for 50% of all activity sites from March through November. The *Abies lasiocarpa/Vaccinium scoparium* community alone contained 23% of the total activity sites and 35% of the forested activity sites. Of 507 observations of feeding activity, 45% were recorded in timber over 3 m tall with a canopy cover of 26–100%, 34% in timber with a 0.1–25% canopy cover, 20% in open habitats, and 3% in timber less than 3 m tall. Ninety-nine percent of examined day beds were in forested communities.

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In 1975 the grizzly bear south of Canada was listed as a threatened species. To comply with the Endangered Species Act of 1973, Federal agencies must, therefore, avoid destruction or adverse modification of grizzly bear "critical habitat."

However, a lack of data has limited the ability of management agencies to define critical habitat and evaluate the effects of land use practices upon the grizzly. Research to determine the relationships between grizzly bears and habitat has been continuing and data are accumulating.

The use of timber as shelter by grizzlies has been documented (Jonkel and Cowan 1971; Craighead and Craighead 1972; J. Sumner and J.J. Craighead, unpubl. rep., Mont. Coop. Wildlife Res. Unit, Missoula, 1973; R. Knight et al., unpubl. annu. reps., Interagency Study Team, U.S. Dep. Inter., Park Ser., Bozeman, Mont., 1977, 1978; Roth and Osti 1979). Research has also determined that meadows are important foraging habitats for grizzlies (Graham 1978, Mealy et al. 1977). The extent to which grizzly bears used timbered areas for foraging was unknown and has been an important management-related question; therefore, since 1977 the Interagency Grizzly Bear Study (IGBS) has addressed this problem. This paper reports the findings of the IGBS on grizzly bear–habitat relationships.

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METHODS

Grizzly bear–habitat relationships were studied from 1977 through 1979 in a 20,000-km² study area with Yellowstone National Park (9000 km²) in its center. The study area is described in detail by Knight et al. (unpubl. annu. rep., Interagency Study Team, U.S. Dep. Inter., Park Ser., Bozeman, Mont., 1978).

Data were obtained by recording the activities of 46 transmitter-instrumented bears and observing unmarked bears. Instrumented bears were located from fixed-wing aircraft an average of 3 times a week during daylight hours between 0600 and 1300. Aerial telemetry equipment and techniques are described by Judd and Knight (1977). Distance from a located bear to the edge of the nearest timber opening measuring at least 100 m² was recorded.

Ground crews investigated a random sample of sites where bears had been located from aircraft and recorded the plant community present and any evidence of bear activity. Bear activity sites encountered by ground crews enroute to and from location sites were also recorded. This random sample of activity sites was combined with the sample of aerially located sites to increase the sample size. Identification of communities followed Pfister et al. (1977) for forested habitats and Mueggler and Handl (unpubl. rep., Inter-mountain For. and Range Exp. Stn., U.S. For.

Table 1. Grizzly bears radio-located and observed during aerial flights from 1977-1979.^a

Type of location	Spring (Mar-May)	Summer (Jun-Aug)	Fall (Sep-Nov)	Total
Total hours flown	234	577	417	1228
Radio locations ^b	321	857	648	1826
Marked sightings	52	79	71	202
Unmarked sightings	31	67	34	132

^a Does not include relocations of denned bears or relocations of cast collars.

^b Subject pools included 28, 20, and 22 bears in 1977-1979, respectively.

Serv., Missoula, Mont., 1974) for grass and shrublands. Detailed descriptions of recording techniques and community classification methods are provided by Knight and Blanchard (misc. rep., Interagency Study Team, U.S. Dep., Inter., Park Serv., Bozeman, Mont., in prep.).

RESULTS

Locations and Observations

A total of 1926 radio locations of 46 instrumented grizzly bears was made from aircraft between 1977 and 1979 (Table 1). Observations of unmarked grizzlies ranged from 12 during 1978 to 64 during 1977, while sightings of marked bears ranged from 7 during 1977 to 17 during 1978. This variation can be largely attributed to different flight methods and phenology (Knight et al., unpubl. annu. reps., Interagency Study Team, U.S. Dep. Inter., Park Serv., Bozeman, Mont., 1977, 1978).

Use of Timber vs. Open Area

Instrumented grizzly bears were located in the timber 90% of the time (1635 of 1826 radio locations, Table 2). The majority (76%) of the locations in timber were either in scattered timber (6%) or less than 100 m from an opening at least 100 m² in size (70%) (Table 2). Only 1% of the locations were in dense timber more than 1 km from an opening at least 100 m² in size.

Grizzly bears were observed in the open 191 times from 1977 through 1979 (Table 3). The majority (75%) of bears in the open were observed less than 100 m from timber cover; over half of these were less than 30m from timber.

Grizzly bears located in the timber tended to be far (more than 100m) from openings more often in spring (32%) and fall (30%) than in summer (18%) (Table 2). Bears observed in the open were more frequently near timber cover

Table 2. Distance to nearest opening (100 m² or greater) of grizzly bears located in the timber from 1977 through 1979.

Distance	Number of locations			Total
	Spring (Mar-May)	Summer (Jun-Aug)	Fall (Sep-Nov)	
At edge ^a	33	105	56	194
< 30 m	77	251	129	457
31-100 m	80	268	237	585
101-300 m	52	97	115	264
301-500 m	19	21	45	85
501-1000 m	8	10	13	31
1-2 km	9	5	4	18
> 2 km	1	0	0	1
Total	279	757	599	1635

^a Includes locations in scattered timber (canopy cover 10% or less).

during the spring than in summer or fall (Table 3).

Canopy Cover

On-the-ground examination of location sites and other activity sites encountered revealed that 79% of the 660 sites for which canopy cover was recorded were in timber over 3 m tall (Table 4), 4% were in timber less than 3 m tall, and 17% were in open habitats.

Canopy cover was 26-75% at over half the location sites in timber. Only 11% and 7% of the locations were under canopies with greater than 75% and less than 2% cover, respectively. Canopy cover was less than 25 at most (76%) location sites in timber reproduction. These sites can therefore be considered open habitats. Annual variation in canopy cover use was not apparent.

Habitat Use

A total of 85 different communities were recorded at the 686 location sites for which the community type could be determined. The *Abies lasiocarpa/Vaccinium scoparium* community alone contained 23% of the total activity sites and 35% of the forested activity sites. The *Abies*

Table 3. Distance to nearest timber cover of grizzly bears located in the open from 1977 through 1979.

Distance	Number of locations			Total
	Spring (Mar-May)	Summer (Jun-Aug)	Fall (Sep-Nov)	
At edge	11	9	6	26
< 30 m	15	27	13	55
31-100 m	9	37	17	63
101-300 m	4	13	8	25
301-500 m	3	7	3	13
501-1000 m	0	6	2	8
1-2 km	0	1	0	1
Total	42	100	49	191

Table 4. Forest canopy cover at grizzly bear activity sites from 1977 through 1979.

Canopy cover		No. of sites
Over 3 m tall:	0–1%	36
	2–5%	49
	6–25%	87
	26–50%	162
	51–75%	134
	76–95%	52
	96–100%	4
Subtotal over 3 m		524
Under 3 m tall:	0–1%	19
	2–5%	5
	6–25%	0
	26–50%	1
Subtotal under 3 m		25
No timber cover		111
Total		660

lasiocarpa/*Carex geyeri* (6%), *Abies lasiocarpa*/*Vaccinium globulare* (3%), and *Abies lasiocarpa*/*Calamagrostis rubescens* (3%) communities were also commonly used. Nearly 5% of the examined location sites were in ecotones. The most frequently used open habitats were *Artemisia tridentata*/*Festuca idahoensis* and *Festuca idahoensis*/*Agropyron caninum* communities.

Seasonal Use of Canopy Cover

Evidence of bear activity was recorded at 491 (72%) of 686 sites examined. Age of the activity was estimated at 477 of the 491 sites. Timber over 3 m tall with a canopy cover of 26–75% accounted for 50% of all activity from March through November (Table 5). Use in this cover class steadily increased from 38% in the March–May period to 60% in the September–November period. Timber over 3 m tall with an open canopy cover of 0.1–25% was most frequently used from March 1 through July 15. Timber over 3 m tall with a dense canopy cover of 76–100% was used most often from September through November. Activity in open communities was most frequently recorded from March through May, and least frequently from September through November. Timber less than 3 m tall never accounted for more than 6% of the recorded activity during any season.

Feeding Activities

Grizzly bears used timber cover for various feeding activities (Table 6) in addition to shelter

Table 5. Seasonal use of canopy cover classes by grizzly bears from 1977 through 1979.

Timber canopy cover	Season				Total
	Mar–May	Jun 1–Jul 15	Jul 16–Aug 30	Sep 1–Nov 30	
Over 3 m tall:					
0.1–5%	15 ^a	31	14	2	62
6–25%	18	26	10	8	62
26–50%	24	42	38	34	138
51–75%	18	54	30	23	125
76–95%	10	10	7	19	46
96–100%	2	0	0	2	4
Under 3 m tall:					
0.1–5%	2	5	4	3	14
No timber canopy	23	24	23	4	74
Total sites	112	192	126	95	525

^a Number of examined location and activity sites.

and resting areas. There were 507 instances of feeding activity and 419 observations of other activity recorded.

Forty-five percent of the recorded feeding activity was in timber over 3 m tall with a canopy cover of 26–100%, 34% in timber over 3 m tall with a canopy cover of 0.1–25%, 20% in open habitats, and 3% in timber less than 3 m tall. Non-feeding activities (Table 6) were also recorded most frequently (63%) in timber over 3 m tall with a canopy cover of 26–100%, followed by timber over 3 m tall with a canopy cover of 0.1–25% (23%), open habitats (11%), and timber less than 3 m tall. Little annual variation was noted.

Torn logs constituted 27% of the recorded feeding activities. Tearing logs apart for ants and other insects was the most frequently observed activity under timbered canopy cover of 6–75% in Douglas-fir (*Pseudotsuga menziesii*), Englemann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta*), and ecotone communities.

Eighty-eight percent of all digging in pine squirrel (*Tamiasciurus hudsonicus*) middens and caches for whitebark pine (*Pinus albicaulis*) cones and nuts occurred under timbered canopy cover of 26–95%. This was the most frequent feeding activity in whitebark pine communities and second only to torn logs in subalpine fir communities.

Grizzly bears stripped bark from trees for the underlying cambium most frequently (82%) under timbered canopy of 6–75%. The majority (68%) of stripped trees occurred in subalpine fir

Table 6. Grizzly bear feeding and other activities by canopy cover class from 1977 through 1979.

Timber canopy cover	Number of sites at which specified activity was recorded								
	Feeding activity							Nonfeeding activity ^a	
	Carcass	Grazing	Stripped bark	Root digs	Gopher digs	Pine nut digs	Torn logs		Torn anthills
Over 3 m tall:									
0.1-5%	9	9	3	23	20	2	18	17	36
6-25%	9	4	9	5	6	4	27	5	62
26-50%	10	3	13	9	2	19	49	5	120
51-75%	6	3	10	2	0	22	28	3	92
76-95%	3	1	4	2	0	17	5	1	47
96-100%	1	0	0	0	0	2	0	0	5
Under 3 m tall:									
0.1-5%	3	3	0	4	2	0	1	2	9
No timber canopy	2	11	0	40	28	0	6	15	48
Total activity occurrences	43	34	39	85	58	66	134	48	419

^a Nonfeeding activities include scats, tracks, claw marks, hair, and day beds.

communities. This activity was also recorded in Douglas-fir, Englemann spruce, lodgepole pine, and whitebark pine communities, involving every species of tree recorded.

Grizzlies usually fed upon ungulate carcasses under timbered canopy cover of 0.1-75%. One-fourth (25%) of the carcass feeding sites were located in subalpine fir communities. An additional 33% of the carcasses were located in Douglas-fir, lodgepole pine, and Englemann spruce communities. Carcasses were also recorded in ecotones, thermal areas, and riparian communities.

Non-forested communities contained 48% of all diggings for pocket gophers (*Thomomys talpoides*) and/or their food caches and 47% of all diggings for roots. Timbered canopy of 0.1-5% contained 38% and 32% of these activities, respectively. These digging activities were most common in grass-forb meadows (28%), big sagebrush (*Artemisia tridentata*) meadows (20%), and riparian communities (18%).

Evidence of grazing by grizzlies was identified at only 34 feeding sites (7%). Non-forested communities accounted for over half of the grazing, while 37% occurred in various forested communities.

Torn anthills were recorded in nearly equal numbers under timbered canopy of 0.1-5% and open communities. This activity was most frequently encountered in sagebrush meadows (29%), grass-forb meadows (24%), and subalpine fir (16%) communities.

Day Beds

Day beds were found most frequently (99%) in forested communities. Eighty-seven percent of the day beds examined were constructed less than 1 m from a tree, and 99% were less than 5 m. Various tree species provided immediate cover at the beds. Only 16 of 233 day beds located had no immediate cover, and 15 utilized snags or deadfall as cover. Thirty-four percent of the day beds were constructed in the *Abies lasiocarpal* *Vaccinium scoparium* community. Other commonly used communities were lodgepole pine (13%), subalpine fir-whitebark pine (9%), ecotones (8%), and *Pseudotsuga menziesii*/*Symphoricarpos oreophilus* (7%).

DISCUSSION

The data presented in this paper show that forested and open habitats are both important as foraging areas for Yellowstone grizzlies. There are some biases in the data because all aerial locations were made during daylight hours, certain feeding activities are more observable than others, and the possibility exists that some bears moved into the timber as the aircraft approached. Instrumented grizzly bears located in the open often become accustomed to low-flying aircraft and may not even look up. To date, any individual animal's reaction to the aircraft has been unpredictable. An experienced observer can determine whether an instrumented bear is moving.

The range of the grizzly bear in North America has been greatly reduced since the early 1800's when it may have included vast prairie regions from the Pacific Coast to the Mississippi River (Cowan 1972). Numerous historical observations of grizzlies along river bottoms and foothills of the plains probably account for the popular belief that grizzly bears prefer open habitats (Storer and Tevis 1955, Leopold 1970); however, bears in open habitats are more observable (Mundy and Flook 1973), so habitat preferences based on visual observations alone may be misleading.

The types of feeding activity most frequently recorded are the more observable and relatively long-lasting evidence such as torn logs and diggings for pocket gophers. Grazing is largely undetectable, yet grasses and sedges consistently make up the bulk of scat contents in this study area (Mealey 1975; Knight et al., unpubl. annu. reps., Interagency Study Team, U.S. Dep. Inter., Park Serv., Bozeman, Mont., 1977,1978). When used alone, examinations of radio-telemetry locations and feeding sites can also be misleading in determining food item preferences. Feeding site examinations provide the data to correlate bear activities with habitat types, while scat content analysis provides information about specific food items in the diet. This paper is intended to document grizzly bear habitat and timber cover use, and not food habits.

Grizzly bears in the Yellowstone system were located much more often in timber than in the open during the day. Examination of these locations has documented that substantial foraging by the bears occurred in the timber. Herrero (1978) has noted that "the brown bear has not lost its ability to forage on the forest floor, but it has gained the ability to exploit open habitat types at their peaks of productivity." Schallenberger and Jonkel (unpubl. rep., Border Grizzly Proj., School of For., Univ. Montana, Missoula, 1979) found that Rocky Mountain east front grizzly bears used timber more often than open areas (81% vs. 6% of total observations), while brown bears in Italy have also been found to use dense timber during the day (Roth and Osti 1979). Visual observation, in contrast to radio observations, suggests that "grizzlies appeared to occupy primarily fertile, open grasslands" (Mealey 1975) and that these bears appear to prefer open habitats as foraging grounds (Craighead 1979).

We do not know whether grizzly bears in the Yellowstone system presently use timber to the extent recorded because of an innate preference or to avoid contact with humans. Researchers in North America and Eurasia have documented negative correlations between the levels of human activity and grizzly/brown bear activity; Craighead and Craighead 1972; Zunino and Herrero 1972; Kaleckaja 1973; Pearson 1975; Martinka 1976; Chester 1976; Elgmork 1978; J.A. Nagy and R.H. Russell, annu. rep., Can. Wildl. Serv., Edmonton, Alta. 1978). Others suggest that bears can become accustomed to human activity associated with food sources (Cole 1972; Mundy and Flook 1973; Hamer 1974). Yellowstone grizzly bears have been subjected to several selection pressures that may have caused them to seek out and remain in the timber. Bears outside the National Park were hunted until 1974 in Wyoming and Montana and are presently subjected to substantial poaching. Problem bears inside and outside the park are also currently subject to control actions.

Despite the preponderance of observations in the timber, the importance of interspersion of timber and open habitats is apparent. Three-fourths of the total locations were less than 100 m from a timber opening edge. The importance of habitat interspersion to grizzlies has been documented by Craighead and Craighead (1972), Mealey (1975), Mealey and Jonkel (unpubl. rep., Border Grizzly Proj., School of For., Univ. Montana, Missoula, 1975), Schallenberger (unpubl. rep., U.S. For. Serv., Great Falls Mont., 1976), Graham (1978), and Knight et al. (unpubl. annu. rep., Interagency Study Team, U.S. Dep. Inter., Park Serv., Bozeman, Mont., 1978).

Since Yellowstone grizzly bears use forested areas to a large extent, any alterations in the quantity and/or quality of timber cover may affect the availability of utilized habitat. Radio locations and feeding sites indicate the majority of feeding activities and day beds occur in stands of moderate to dense (26–75%) canopy cover.

The impacts of human alteration of timber canopy cover on the grizzly bear may be lessened by: (1) creating open areas no greater than 300 m wide; (2) increasing the amount of timber-to-opening edges; (3) leaving a canopy over 3 m tall with cover greater than 5%; (4) leaving timbered strips at least 100 m wide between clearings.

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