

DENNING OF GRIZZLY BEARS IN THE YELLOWSTONE NATIONAL PARK AREA

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Abstract: Radiotelemetry was used to locate 101 grizzly bear (*Ursus arctos*) dens from 1975 to 1980; 35 dens were examined on the ground. Pregnant females denned in late October, and most other bears denned by mid-November. Duration of denning averaged 113, 132, and 170 days for males, females, and females with new cubs, respectively. Males emerged from mid-February to late March, followed by single females and females with yearlings and 2-year-olds. Females with new cubs emerged from early to mid-April. Den sites were associated with moderate tree cover (26%–75% canopy cover) on 30°–60° slopes. Dens occurred on all aspects, although northerly exposures were most common. Grizzly bears usually dug new dens but occasionally used natural cavities or a den from a previous year. Males usually dug larger dens than females with young. Eight excavated and 2 natural dens of the 35 examined dens were used for more than 1 year.

Int. Conf. Bear Res. and Manage. 6:111–117

The Interagency Grizzly Bear Study Team has studied grizzly bears in and around Yellowstone National Park since 1973. One major objective was to identify grizzly bear habitat requirements. Grizzly bears occupy dens in the Yellowstone area for up to 6 months of each year and dens are therefore an important segment of the habitat. Intelligent management decisions depend on knowing dates of den entry and emergence, general areas of denning, and site selection. We gathered data pertaining to these factors from fall 1975 through 1980.

Craighead and Craighead (1972) did the original work on grizzly bear dens and denning habits in this area between 1963 and 1968. Since the completion of those studies, the Yellowstone grizzly bear population has dispersed considerably because garbage dumps within the park have closed (Judd and Knight 1980).

We acknowledge the assistance of many seasonal employees in investigating den sites, especially D. Burrup, L. Cayot, C. Hancock, C. Hunt, and H. Ihsle. M. Duffy piloted the helicopter when we marked den sites, and D. and R. Stradley piloted the planes used to gather data on den locations and denning and emergence dates. J. Beecham reviewed this manuscript.

STUDY AREA

The study area is centered in Yellowstone National Park and encompasses portions of 4 adjacent national forests in Montana, Wyoming, and Idaho (Fig. 1). The area consists of a large, high-elevation plateau and the mountain ranges encircling it. The majority

of the 20,000-km² area lies between 2,000 and 2,500 m in elevation, with extremes of 4,200 m in Grand Teton National Park and 1,560 m near Emigrant, Mont. Cooper (1975) discussed the physiography of regions within the study area.

The coldest month is January and the warmest is July; respective average temperatures are –8 C and 17 C. Annual precipitation ranges from 35 cm in the northeast to 97 cm in the southwest. A rain shadow effect causes xeric conditions in the Yellowstone Valley and the eastern edge of the study area. Approximately 60% of the precipitation falls as snow, with areas above 2,100 m receiving an average of over 380 cm. An average of 58 cm of snow remains of the ground on 1 May on Lupine Creek in the north compared to 210 cm on Togwotee Pass in the southeast (Farnes and Shafer 1980).

The vegetation of the area varies with the diverse topography and climate. Seventy-five percent of Yellowstone National Park is timbered: 61% lodgepole pine (*Pinus contorta*), 4% spruce (*Picea engelmannii*), 3% Douglas-fir (*Pseudotsuga menziesii*), 3% subalpine fir (*Abies lasiocarpa*), 3% whitebark pine (*P. albicaulis*), and 1% other timber (Civilian Conserv. Corps, unpubl. data). Alpine and mountain meadows, marshes, thermal areas, and riparian communities of varying sizes are interspersed throughout the forested areas. Habitat and community types found on the study area are described by Knight et al. (1978).

METHODS

We trapped grizzly bears in culvert traps or Aldrich foot snares, placed radiocollars on them, and released them. We tracked instrumented bears from the air using a Piper Supercub (Judd and Knight 1977).

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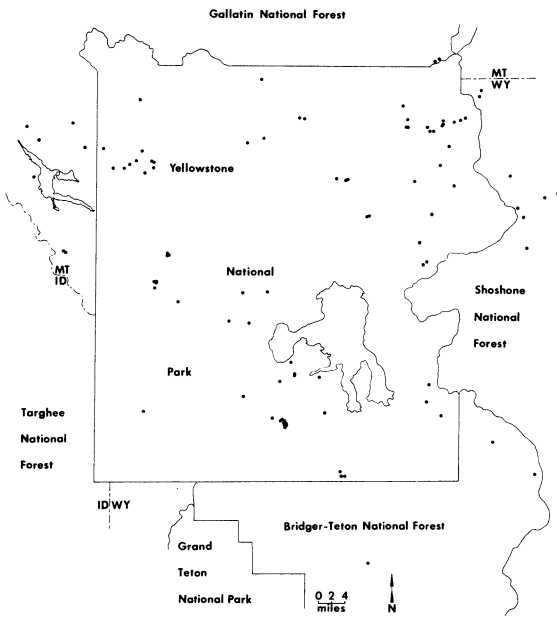


Fig. 1. Outline of the study area showing locations of known den sites during 1975–80, including dens used more than once.

Indicated dates of den entrance are not exact because bears may have been active when located during 1 flight and judged to be denned during a flight several days later. The median day between the 2 flights was used as the estimated entrance date. We judged bears equipped with motion-sensing transmitters to be denned when the signal rate indicated they were inactive. Otherwise, we judged bears to be denned when the quality of the signal tone and its intensity indicated they were underground. In many cases, signals from denned bears could only be received for a few seconds at a spot directly opposite the den entrance, and this signal also was used to judge whether the bear was denned.

Bears often spent several days near the den before entering for the winter. Occasionally, a bear entered the den and then emerged again. In these cases, we recorded the latest date that the bear entered the den as the denning date. When all instrumented bears had denned, we made helicopter flights to pinpoint locations and mark the sites. We used surveyor's tape to mark sites, which we then photographed and classified according to habitat features that could be identified from the air.

We determined emergence dates in the same manner as entrance dates except that motion-sensing transmitters on active mode, clear tones, and loud,

Table 1. Mean denning dates for grizzly bears in Yellowstone National Park, 1975–80.

	All years		1975		1976		1977		1978		1979		1980	
	Date	N	Date	N	Date	N	Date	N	Date	N	Date	N	Date	N
All bears	9 Nov	70	23 Nov	5	3 Nov	11	8 Nov	12	21 Nov	12	6 Nov	13	1 Nov	17
Males	13 Nov	34	29 Nov	2	1 Nov	4	13 Nov	6	27 Nov	6	11 Nov	8	4 Nov	8
Solitary females	7 Nov	11	26 Nov	2	16 Nov	1	15 Oct	1 ^a	7 Nov	2 ^a	30 Oct	1	3 Nov	4
Pregnant females	26 Oct	13			20 Oct	3	24 Oct	2	13 Nov	2	17 Oct	2	25 Oct	4
Females w/cubs	12 Nov	5			10 Nov	1	14 Nov	1	21 Nov	1	13 Nov	1	31 Oct	1
Females w/yearlings	15 Nov	7	8 Nov	1	15 Nov	2	14 Nov	2	4 Dec	1	6 Nov	1		

^a These females were probably pregnant but lost cubs before spring observations.

multidirectional signals indicated that the bear had moved from the den. In most cases, tracks could be observed from the air, and the bear had moved a detectable distance from the den site.

Weather permitting, we made tracking flights 3 times weekly before bears denned and once weekly from January until the 1st bear emerged. We then resumed a schedule of 3 flights a week.

After bears had left the vicinity, we measured dens (Fig. 2), classified them according to aspect, slope, elevation, soil type, topography, and vegetative characteristics of the site, and made photographs and schematic diagrams for each den. Ground crews also located and examined inactive dens. We defined an active den as one that was located during the year of use and an inactive den as one located at least 1 year after use. We identified inactive dens as grizzly bear dens by hair in the bedding.

One active den of an unmarked grizzly bear was sighted from the air in 1978. Fourteen active dens were examined only from the air due to the logistics of getting to the sites. Ground crews were sometimes unable to locate dens because of dense vegetation, deadfalls, and topography. Only den locations, time of denning, and emergence were recorded during 1979 and 1980. Some dens had collapsed by the time they were examined, so only partial measurements were made. Figure 1 shows the sites of all dens.

RESULTS AND DISCUSSION

One hundred one dens, including those used more than once, were located from 1975 to 1980. We examined 35 on the ground and measured them when possible. Twenty-one were active, and 14 were inactive. Crews located 2 active dens of unmarked grizzly bears while examining dens of radio-collared bears.

Denning

The mean entrance date for 70 bears tracked to dens over a 5-year period was 9 November (Table 1), with variation among individual bears and years. The earliest entrance date recorded was 28 September for a pregnant female; the latest was 21 December for a 3.5-year-old female. This female denned with another slightly larger bear, possibly her mother. We are not aware of any documented precedents where 2 bears of this age denned together or where a bear was 4 years old before estrangement.

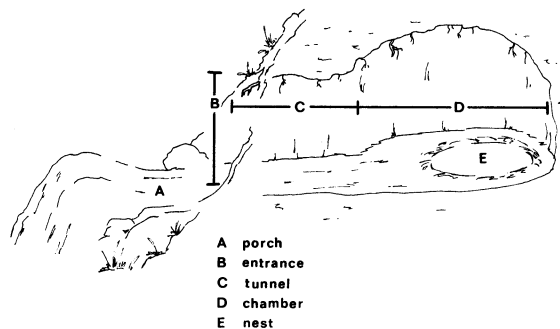


Fig. 2. Side view of a typical den showing measurements taken.

Pregnant females entered dens earliest ($t = 3.92$, $df = 68$, $P < 0.001$). These emerged with cubs-of-the-year the following spring. In 3 cases in 1977 and 1978 (Table 1), lone females that were not observed with cubs during the following year entered dens earlier than 4 females that were pregnant. These lone females were of breeding age (5, 9, and 14 years old), and the 9-year-old was observed copulating during the preceding summer. It is probable that at least the 2 older of the bears were pregnant and either aborted or lost their cubs before they were observed the following spring.

Differences in the mean denning dates of sex and age groups other than pregnant females were not significant ($P > 0.2$). Lentfer et al. (1972) and Pearson (1975) suggested that female grizzly bears with young entered dens earliest. Craighead and Craighead (1972) reported that most grizzly bears denned at the same time in response to snowstorms; we were not able to corroborate those results.

Most monitored bears spent 8–22 days in the immediate vicinity of the den before entering for the winter. This was probably a manifestation of prehibernation lethargy as documented by Craighead and Craighead (1972), but our method of radiotracking from the air was not designed to investigate this phenomenon.

Emergence

Instrumented grizzly bears stayed in their dens an average of 113 days for males and 170 days for females with new cubs. Duration of denning averaged 132 days for single females and those that entered the den with young.

Males were usually the 1st to emerge in the spring ($t = 2.08$, $df = 44$, $P < 0.05$), leaving their dens from mid-February to late March (Table 2). They were usually followed by single females and those

Table 2. Mean emergence dates for grizzly bears in Yellowstone National Park, 1976-80.

	All years		1976		1977		1978		1979		1980	
	Date	N	Date	N	Date	N	Date	N	Date	N	Date	N
All bears	28 Mar	55	31 Mar	3	30 Mar	7	3 Apr	15	20 Mar	15	29 Mar	15
Males	19 Mar	28	11 Mar	1	16 Feb	2	26 Mar	7	21 Mar	8	23 Mar	10
Solitary females	3 Apr	8	5 Apr	1	11 Apr	1	12 Apr	3	15 Mar	2	24 Apr ^a	1
Females w/ cubs	13 Apr	9			18 Apr	3	14 Apr	2	5 Apr	2	11 Apr	2
Females w/ yearlings	1 Apr	6	15 Apr	1	12 Apr	1	15 Apr	1	12 Mar	1	23 Mar	1
Females w/ 2-yr-olds	26 Mar	4					3 Apr	3	12 Mar	1	11 Apr	1

^a May have lost cubs before 1st visual observation; known to have copulated during previous spring.

with yearlings and 2-year-olds. Females with new cubs emerged last, from early to mid-April. An exception to this occurred in 1979, when females other than those with new cubs emerged earlier than males. Craighead and Craighead (1972) documented the same general emergence sequence in Yellowstone National Park, as have other investigators in other areas (Pearson 1975, Russell et al. 1978). Time spent at the den before moving from the vicinity was variable and not sex or age related. There were no significant correlations ($P < 0.001$) with snow depths and entrance or emergence dates by either sex.

Site Characteristics

Seventeen (13%) of 55 dens were under tree canopies of 0-25% cover, 8 (14%) were under 26%-50% cover, 17 (31%) were under 51%-75% cover, and 13 (24%) were under 76%-100% cover. Percentages of cover classes occurring within the area were not available, and preferences could not be calculated. Because over 70% of the area was forested, bears apparently did not actively seek den sites in open areas or show strong preferences for particular canopy classes.

Whitebark pine and subalpine fir appeared to be preferred overstory species at den sites. The most common tree species in the area in order of occurrence were lodgepole pine, Englemann spruce, subalpine fir, Douglas-fir, and whitebark pine. The most common overstory species at den sites in order of occurrence were subalpine fir, lodgepole pine, whitebark pine, Douglas-fir, and Englemann spruce. Using Johnson's (1980) methods, preferred overstory species for den sites, in decreasing order, were subalpine fir and whitebark pine, Douglas-fir, lodgepole pine, and Engelmann spruce.

Huckleberries (*Vaccinium* spp.) were a major understorey component on 74% of 27 sites where understorey cover was measured. Grouse whortleberry (*V. scoparium*) was most common, with globe huckleberry (*V. globulare*) occurring on only 4 sites. Grouse whortleberry was the most common understorey species on the study area.

Den elevation ranged from 2,000 to 3,050 m ($\bar{x} = 2,470$ m), with 68% at or above 2,450 m. However, there was an apparent clumping in the 2,450-2,750-m range, with 44% of the 55 dens occurring there.

Northerly aspects were used at 52% of 55 sites. There appeared to be some preference for northerly exposures, although dens occurred on all aspects.

Tree cover was generally more dense on northerly exposures.

Dens were usually located between the mid to upper one-third of moderately steep slopes (30°–60°). Sixty-nine percent of 55 dens occurred within this range. The remainder occurred on a variety of slopes; however, none were dug into completely flat ground, possibly because of lack of ground insulation and potential flooding. Slope at den sites ranged 20°–75° for 29 dens, with 86% of these on sites between 30° and 60°.

Den Construction

Grizzly bears in the Yellowstone system usually dug their dens but occasionally used natural cavities. Of the 21 active dens examined, 18 were excavated, 2 were in natural cavities, and 1 was in a hollow whitebark pine tree. Twelve of 14 inactive dens had been excavated and 2 were in natural caves. Thirteen (43%) of the 30 excavated dens were under trees, with roots acting as support for the roof. Three (10%) were dug under deadfalls, and the remaining 14 (47%) were dug into the hillside. The dens that were not dug under trees generally had good shrub cover, usually huckleberry, whose roots stabilized the roof somewhat.

Reynolds et al. (1976) found that grizzly bears in the Brooks Range of Alaska used both excavated and natural cave dens. Craighead and Craighead (1972) located only excavated dens in Yellowstone Park. Pearson (1975, 1976) found only dug dens for grizzly bears in the Yukon, as did Lentfer et al. (1972) for brown bears in Alaska. However, Curry-Lindahl (1972) in Europe and Kall (1976), Sharafutdinov and Korotkov (1976), and Ustinov (1976) in the U.S.S.R. found that the European brown bear (*U. arctos*) used a variety of dens. Most were dug, but natural caves, hollow trees, brush and log piles, and human-made structures were also used.

Most (47%) dug dens were located in sandy loam soils, with some in clay loams (13%) and rocky silt (13%) soils. The remaining (27%) were located in miscellaneous and unknown soil types.

Six of 18 active dug dens had partially or totally collapsed during the summer following use. Eleven of 12 inactive dens were partially or totally collapsed.

We were able to determine tunnel orientation in relation to the horizontal from the chamber for 28 dens (Fig. 2). Only 1 of the 30 constructed dens did not have a tunnel. Six were directed downward from

the chamber in what has been considered the classic heat trap configuration. Two were L-shaped, which would limit air flow; the remainder, including natural cavities, apparently relied on snow cover and bed material to limit air flow. There was apparently no attempt to dig a specific type of tunnel that would act as a heat trap.

We obtained measurements of den dimensions from 30 excavated dens (Table 3). Because 17 of 30 dug dens had partially collapsed before they were examined, not all measurements were obtained for all dens. The total length of dens of males was greater ($t = 2.3$, $df = 14$, $P < 0.05$) than those of females with young. Tunnel length ($P < 0.2$) and chamber length ($P < 0.2$) were greater in dens of male bears, probably to accommodate their larger body size. Other measurements were not significantly different.

Materials composing the bed (e.g., grasses, conifer needles, duff) appeared to be directly related to their availability at the site, not to the bear's selectivity. Depths of nest material and depressions in it varied and ranged 9–41 cm and 4–31 cm, respectively. We also examined 5 dens (1 subadult male and 4 unknown grizzly bears) with no bedding material.

Of dens in natural cavities, 4 were in caves and 1 was in a hollow tree. Considering heat conservation, these appeared to be inferior to excavated dens. Two natural caves were 10 m in total length with entrances, tunnels, and chambers larger than those of excavated dens. One small cave was within the size range of excavated dens, but the configuration of the entrance protected by a large overhang would necessitate a large amount of snowfall before closing in, and a relatively large chimney entering the chamber would have allowed warm air to escape. The other cave was similar to excavated dens in size and configuration but was in the bottom of an intermittent stream bed, which would necessitate an early emergence.

One den in a standing whitebark pine snag was within the range of excavated dens in all dimensions except the chamber height was over 3 m, which seemed inefficient in preservation of body heat.

Reuse of Dens

Ten of the dens examined had been used for more than 1 winter. Two, a large cave and the hollow whitebark pine, were judged by us to have poor insulating qualities. The cave was used for 2 consecutive years by the same bear and had been used before the

Table 3. Mean measurements (cm) for excavated dens, 1974-78.^a

	N	Entrance			Tunnel			Chamber			Nest ^b			Total den ln
		Ht	Wd		Ht	Wd	Ln	Ht	Wd	Ln	Wd	Ln	Ln	
Males	5	61 ± 34 ^c	68 ± 35	58 ± 12	94 ± 9	145 ± 47	94 ± 28	165 ± 60	186 ± 34	98 ± 16	112 ± 13	325 ± 44		
Females	11	63 ± 7	71 ± 6	56 ± 13	91 ± 22	111 ± 32	106 ± 18	184 ± 91	138 ± 51	104 ± 33	120 ± 38	248 ± 68		
Unknown	14	64 ± 11	67 ± 22	56 ± 12	81 ± 36	119 ± 47	76 ± 33	149 ± 81	144 ± 44	87 ± 44	135 ± 54	189 ± 90		
All	30	63 ± 18	69 ± 19	56 ± 12	87 ± 27	120 ± 41	93 ± 28	165 ± 81	149 ± 47	94 ± 31	112 ± 34	233 ± 89		

^a Condensed from data on 16 active and 14 inactive dens.

^b Includes measurements from dens of 2 males and 3 of unknown sex in natural cavities.

^c Mean ± standard deviation.

1st year we observed it. One excavated den was also used by the same bear for 2 consecutive years. Both bears that used the same den in 2 consecutive years moved to newly constructed den sites several kilometers away during the 3rd year that they were monitored. One excavated den was used by different bears in 2 consecutive years. We could not tell if the other 7 dens had been reused by the same or different bears.

CONCLUSIONS

Availability of denning sites did not appear to be a critical element of grizzly bear habitat in the Yellowstone area. Den sites were well distributed within Yellowstone National Park; a few sites were in surrounding national forests. Some bears were apparently selective in choosing a den site, as suggested by Ustinov (1976); others chose sites that seemed mediocre to poor. Our investigations indicate that a grizzly bear only needs a hole in the ground or a place to dig a den to survive the winter. Some bears selected large trees as roof supports for their dens, and it is therefore possible that logging programs could destroy some den sites. However, given the amount of protected habitat in Yellowstone National Park and surrounding wilderness areas and the large home range size of grizzly bears, it is unlikely that den sites will become scarce in the foreseeable future.

The importance of disturbance from human activity was not clear. Most of the study area was remote from human activity at all times of the year, and there were few opportunities to assess the effects of cross-country skiers, snowmobiles, or other disturbances on hibernating bears.

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