


# DENNING ECOLOGY OF BROWN BEARS IN SOUTHCENTRAL ALASKA AND COMPARISONS WITH A SYMPATRIC BLACK BEAR POPULATION[1]

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*Abstract*: Brown bears (*Ursus arctos*) in southcentral Alaska spent an average of 201 days in winter dens. Males spent the least time in dens (mean = 189 days) and parturient females the most (mean = 217 days). Females with cubs of the year and females pregnant at den entry spent the least amount of time out of dens (158 and 164 days, respectively) and males the most (180 days). No difference in den entrance date based on sex or reproductive status was observed. Mean den entrance date was 14 October. Entrance date differed between years, early entrance appeared associated with berry crop failures and colder weather. Mean date of exit from dens was earliest for males (23 April) and latest for females with newborn cubs (15 May). Exit dates also varied between years with late exits correlated with colder weather and persistent snow cover.

Dens used by brown bears in this area were excavated, no unmodified natural cavities were used. These dens collapsed during spring and summer precluding reuse. Some individuals dug dens in the same general area from year to year; mean distance between den sites used in successive years by all bears was 6.1 km. Characteristics of den sites and sizes of dens are described. Typically dens were dug at higher elevations and on the periphery of home ranges used during summer and fall. Upon exit, most bears moved to lower elevations but females with newborn cubs tended to remain in the vicinity of den sites. Available data suggest this behavior reduces loss of newborn cubs to predation by other bears.

Compared to a sympatric population of black bears (*Ursus americanus*), brown bears denned at higher elevations, spent less time in dens, and entered dens earlier. Den exit dates were similar. Dimensions of brown bear dens were not significantly larger than excavated black bear dens and mean date of emergence from dens was about the same. A proposed hydroelectric project in this study area would likely have reduced black bear populations through impacts on black bear denning habitat. The project would have had only indirect impacts on brown bear denning habitats.

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Throughout much of its range in North America the brown bear species spends over half of its life hibernating in winter dens. During this period, bears do not eat and they minimize energy expenditures on physiologic functions (Nelson et al. 1983). Inadequate dens could result in increased drain of physiologic reserves leading to reduced fitness of individuals. Studies of denning ecology are potentially valuable as such data may help bear managers assure that den habitat does not become limiting to bear populations. Managers of exploited bear populations may use den entrance and emergence data to concentrate hunting effort on desired segments of the population (O'Pezio et al. 1983). Information on denning habits in different areas is also useful in understanding the environmental cues bears use to initiate and terminate denning.

Denning ecology of Alaskan brown bears has been studied for high-density populations on the Alaska Peninsula (Lentfer et al. 1972), Kodiak Island (Van Daele et al. 1990), southeastern Alaska (Schoen et al. 1987), and a low density population in the Brooks Range of northeastern Alaska (Reynolds et al. 1976). The results of this study are the first reported for a moderate-density population in central Alaska. To my knowledge, the results reported here also represent the first study of denning ecology in a region where both black bears and brown bears are sympatric and common. Elsewhere where both species exist, denning studies have concentrated on one or the other (Jonkel and Cowan 1971, Servheen and Klaver 1983, Vroom et al. 1980).

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## STUDY AREA AND METHODS

This study was conducted in the Talkeetna Mountains of southcentral Alaska along the Susitna River between the railroad station at Curry and the Denali Highway (Fig. 1). Vegetation at lower elevations is dominated by spruce (*Picea glauca* and *P. mariana*), birch (*Betula papyrifera*) and alder (*Alnus* sp.). At moderate elevations vegetation is dominated by shrubs including dwarf birch (*B. glandulosa*), and willow (*Salix* spp.). Above 800 m elevation tundra predominates. Densities of black and brown bear in this area were described by Miller et al. (1987).

Bears were captured using helicopter darting techniques from 1980 to 1988. Radio-marked bears were relocated from fixed-wing aircraft every 7-14 days during the years 1980 through 1985. Few den observations were made during 1986, 1987, and 1988 when bears were located only 4-5 times/year. Den locations were plotted

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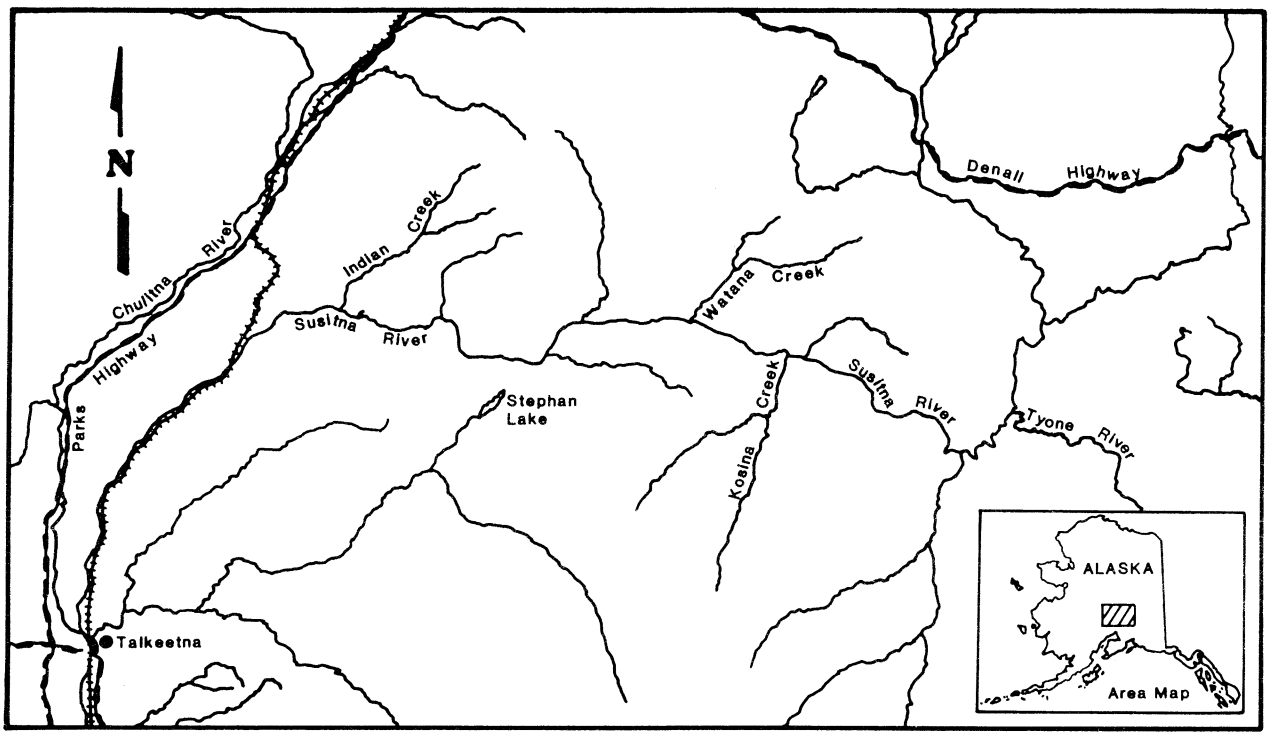


Fig. 1. Area in southcentral Alaska where black bear and brown bear denning ecology studies were conducted.

on 1:63,360-scale topographic maps. During late May through mid-June, den sites were visited and measurements and other observations were made; measurements followed those diagramed by Schwartz et al. (1987). Chamber volume was calculated as (height) (width) (length); entrance area as (height)(width). Incomplete data were caused by observations made from a helicopter at den sites too difficult to access or by collapsed dens.

Because bears were not located daily, den entrance dates were defined as the midpoint between the last date that a bear had been observed out of its den and the first confirmation date that it was in its den for the rest of the winter. Den emergence dates were similarly defined during spring. In 2 instances, bears dug new dens and redenned during spring. In these cases only the second, final emergence date was used. Entrance dates were not calculated in cases where the period between last observation out of den and first observation in den was >20 days; the same 20-day criterion was used for emergence dates included in calculations. Because bears frequently would remain in the immediate vicinity of their dens for some days following initial emergence, the first day out of den was defined as the earliest date a bear had been located >0.4 km from its den site. Time spent in den was defined as the period between these calculated entrance and emergence dates. Time spent out of den was defined as the period between emergence and entrance in the same calendar year.

Bears were classified into categories based on their sex or reproductive status. These categories were: (1) females with cubs-of-year (COY), (2) females with yearling offspring, (3) females either alone or with age-2 or older offspring (typical age of weaning in this area is 2.3 years [Miller 1987]), and (4) males. Reproductive status during the denning period was defined as the status extant at the time of emergence from den. Reproductive status for the period out of den was defined as the status extant at time of entry into the den, except that "pregnant" status was based on the presence of newborn cubs at time of emergence. For these categories, differences between entrance and emergence dates, time spent in dens, time spent out of dens, and differences between years in these dates or periods were examined using an analysis of variance and Duncan's multiple-range test in SPSS (Nie et al. 1975).

Weather data were available from automated weather stations at several points in the study area. Data were collected and compiled by R&M Consultants in unpublished reports to the Alaska Power Authority. Weather data presented here are for the "Watana" station in the center of the study area. If this station malfunctioned, data from this station were supplemented by data from the

"Devil's Canyon" station. Temperature data in these reports were compiled as the average for each day and the 2 preceding days of minimum daily temperatures for den entry and as the corresponding 3-day average of maximum daily temperatures for den exit (Kolenosky and Strathearn 1987). No systematic records on snow cover were available during the period of entrance into and emergence from dens. Den aspects were grouped into the 4 cardinal directions (based on True North)± 45 degrees.

## RESULTS AND DISCUSSION

### Denning Chronology

All radio-marked bears denned in all years. Denning chronology for 45 individual bears was obtained for 1-6 years.

Date of den entrance varied from 27 September to 10 November; the mean was 14 October. Date of den entrance did not vary significantly between bears of different sex or among status categories ($P > 0.10$) (Table 1). Elsewhere in Alaska, pregnant females entered dens earlier than other bears (Schoen et al. 1987, Van Daele et al. 1990). Because there were no differences in sex and status in this study, all data were combined to examine for differences in the entrance date between years. Mean date of den entrance was earliest in the fall of 1981 (7 October), followed by the fall of 1982 (11 October) (Table 2). These mean entrance dates were significantly earlier than those occurring in other years (Table 2); the early entrance in the fall of 1981 coincided with an apparent failure of the berry crops (especially blueberries [*Vaccinium* spp.]) as well as with abnormally extensive fall movements of black bears (Miller unpubl. data). Black bears in this study area also entered dens earlier in the fall of 1981 (Schwartz et al. 1987). In late September 1981, there was a cold snap during the period of den entry and temperatures were generally lower in this fall than during fall 1984 (the year of latest mean entry date) (Fig. 2). The relatively early den entrance in the fall of 1982 was not correlated with either a similar cold snap or a berry crop failure, but the 3-day average minimum temperature was generally 2 degrees(F) to 3 degrees(F) cooler than during 1984. Therefore, cooler-than-normal temperatures, reduced availability of food, and possibly other factors, appeared to contribute to earlier-than-normal den entrance dates.

More emergence dates ($n = 89$) were recorded than entrance dates ($n = 58$) because monitoring was more intensive in spring than fall so that reproductive status could be determined before post-exit mortality of offspring occurred. Exit dates occurred between 5 April and 2 June; the mean exit date was 5 May (Table 3). Females with newborn cubs had a mean exit date of 15 May, significantly later than other categories of bears ($P < 0.01$) (Table 3). Females accompanied by yearling offspring were the second-latest group to emerge ($\bar{x}$ = 4 May); this was significantly later than for males, the earliest category to emerge ($P < 0.01$, Table 3). Males also emerged from dens earlier ($\bar{x}$ = 23 April) than all female categories (Table 3).

Mean den exit dates differed between years when all categories of bears were combined. The latest mean exit date, 8 May, was observed in 1985 ($n = 20$). The late emergence in 1985 may be explained by deep snow, which was exceptionally persistent during that spring; similar results were reported in southeastern Alaska

**Table 1. Den entrance dates (month/day) for Alaskan brown bears based on reproductive status at exit from den. No significant differences were found between these entrance dates ($P > 0.10$).**

| Status | Mean entrance day[a] (mo./day) | Range (S.D.) |
|---|---|---|
| 1. Female with COY | 10/13(16)[b] | 10/1-10/18(5.6) |
| 2. Female with yearlings | 10/15(10) | 10/4-11/4(9.0) |
| 3. Female alone or with offspring aged 2.0+ | 10/14(18) | 9/28-11/10(10.9) |
| 4. Males | 10/16(14) | 9/27-11/10(9.0) |
| All bears | 10/14(58) | 9/27-11/10(8.7) |

[a] Defined as midpoint between last day found out of den and first day found in den.
[b] Sample size indicated in parentheses.

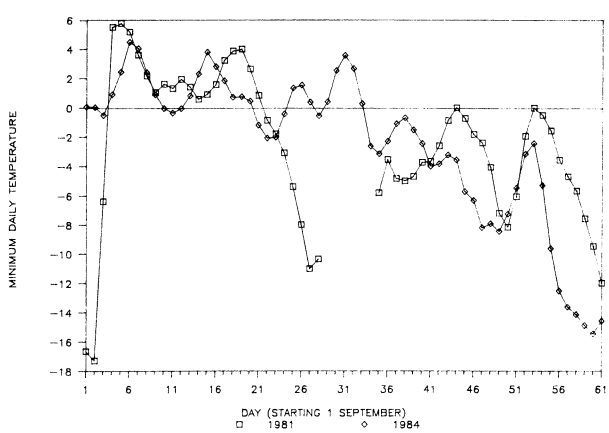


**Fig. 2. Comparison of minimum daily temperature (C) (averaged over 3 days) during the period of entrance into dens in 1981 (year of early mean entrance date on 7 October) and 1984 (year of late mean den entrance date on 18 October). Gaps reflect missing data.**

**Table 2. Den entrance dates (month/day) for all sex and age categories of Alaskan brown bears in different years (1980/81-1985/86).**

| Den year | Mean entrance day[a] mo./day | Range (S.D.) | Significant differences[b] with bears in den year | | | | |
|---|---|---|---|---|---|---|---|
| | | | 80/81 | 81/82 | 82/83 | 83/84 | 84/85 |
| 1980/81 | 10/20(5)[c] | 10/18-10/20(0.9) | — | *** | * | | |
| 1981/82 | 10/7(12) | 9/27-10/12(4.8) | *** | — | | *** | *** |
| 1982/83 | 10/11(8) | 9/28-10/18(5.7) | * | | — | * | ** |
| 1983/84 | 10/17(14) | 10/1-11/10(8.5) | | *** | * | — | |
| 1984/85 | 10/18(21) | 10/1-11/10(9.0) | | *** | ** | | — |
| All years | 10/15(60) | 9/27-11/10(8.7) | | | | | |

[a] Defined as midpoint between last day found out of den and first day found in den.
[b] Significant difference from other years indicated with *($P < 0.10$), **($P < 0.05$), or ***($P < 0.01$).
[c] Sample size indicated in parentheses.

**Table 3. Den exit dates (month/day) for Alaskan brown bears based on reproductive status at exit from den.**

| Status | Mean exit day[a] (Mo./day) | Range (S.D.) | Significant differences[b] with bears of status no. | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| 1. Female with COY | 5/15(32)[c] | 4/23-6/2(10.5) | — | *** | *** | *** |
| 2. Female with yearlings | 5/4(13) | 4/11-5/22(13.1) | *** | — | | *** |
| 3. Female alone or with offspring aged 2.0+ | 4/30(26) | 4/11-5/24(10.4) | *** | | — | ** |
| 4. Males | 4/23(18) | 4/5-5/5(8.4) | *** | *** | ** | — |
| All bears | 5/5(89) | 4/5-6/2(10.5) | | | | |

[a] Defined as midpoint between last day found in den and first day found out of den.
[b] Significant difference from other years indicated with *($P < 0.10$), **($P < 0.05$), or ***($P < 0.01$).
[c] Sample size indicated in parentheses.

(Schoen et al. 1987). Temperatures during the spring of 1985 were also cooler than during the spring of 1981 when emergence was earliest (Fig. 3). Since the cool temperatures and the persistence of snow are clearly related, it is difficult to attribute the late emergence in 1985 to just one of these factors. The earliest mean exit date was 24 April in 1981 ($n = 8$).

No significant differences between years in exit dates were observed for males or females that were either alone or accompanied by offspring older than yearlings. Differences were observed for females with newborn cubs and with yearling offspring (Table 4). Females with newborn cubs emerged earlier in 1981 ($\bar{x}$ = 30 April, $n = 3$) than in other years (Table 4). Similarly, the late spring of 1985 was correlated with the latest date of emergence for females with newborn cubs (25 May) (Table 4). The earliest mean emergence date for females with yearlings was 20 April (spring 1984); this was

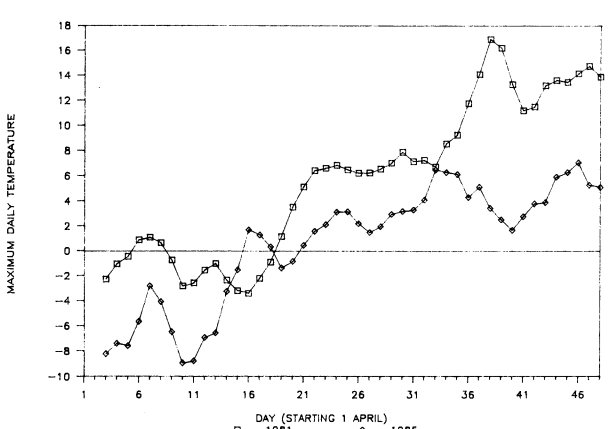


**Fig. 3. Comparison of maximum daily temperature (C) (averaged over 3 days) during the period of exit from dens in 1981 (year of early mean exit date on 24 April) and 1985 (year of late mean den exit date on 8 May).**

**Table 4. Den exit dates (month/day) for Alaskan brown bear females with offspring in different years (1980/81-1985/86).**

| Den year | Mean exit date[a] (Mo./day) | Range (S.D.) | Significant differences[b] with bears in den year | | | | |
|---|---|---|---|---|---|---|---|
| | | | 80/81 | 81/82 | 82/83 | 83/84 | 84/85 |
| Females with newborn cubs at exit: | | | | | | | |
| 1980/81 | 4/30(3)[c] | 4/14-5/3(5.8) | — | | * | ** | *** |
| 1981/82 | 5/12(3) | 4/28-5/22(12.3) | * | — | | | ** |
| 1982/83 | 5/22(2) | 5/15-5/28(9.2) | ** | | — | ** | |
| 1983/84 | 5/8(8) | 4/24-5/19(8.2) | | | ** | — | *** |
| 1984/85 | 5/25(6) | 5/20-5/28(4.1) | *** | ** | | *** | — |
| All years | 5/13(22) | 4/23-5/28(11.6) | | | | | |
| Females with yearlings at exit: | | | | | | | |
| 1981/82 | 5/13(4) | 4/28-5/22(10.2) | | — | | ** | |
| 1982/83 | 5/8(2) | 4/30-5/15(10.6) | | | — | | |
| 1983/84 | 4/20(3) | 4/11-5/5(13.3) | | ** | | — | * |
| 1984/85 | 5/6(4) | 4/24-5/20(10.7) | | | | * | — |
| All years | 5/5(13) | 4/11-5/22(13.1) | | | | | |

[a] Defined as midpoint between last day found in den and first day found out of den.
[b] Significant difference from other years indicated with *($P < 0.10$), **($P < 0.05$), or ***($P < 0.01$).
[c] Sample size indicated in parentheses.

significantly earlier than the latest mean date for this category of bears (13 May 1982) (Table 4).

Overall, brown bears spent an average of 201 days in winter dens during this study (Table 5); to my knowledge, this is the longest mean denning period recorded for brown bears and is about 6 weeks longer than those recorded in Yellowstone National Park (Judd et al. 1987) and 2-4 weeks longer than those in southeastern Alaska (Schoen et al. 1987) or Kodiak Island (Van Daele et al. 1990). This variation is directly correlated with the period of cold winter weather in these different areas. Time spent in dens was not reported for the northeastern Alaska area studied by Reynolds et al. (1976). Bears in northern Alaska probably spend more time in dens than in southcentral Alaska.

In southcentral Alaska, female brown bears accompanied by newborn cubs spent more time in their dens ($\bar{x}$ = 217 days) than other categories of bears (Table 5). Females accompanied by yearling offspring at den exit spent the second-longest period in winter dens, significantly longer than males who spent the least time in dens (189 days) (Table 5). Similar results were reported by Craighead and Craighead (1972), Pearson (1975), Schoen et al. (1987), Judd et al. (1987), and Van Daele et al. (1990).

The nutritional demands on females nursing newborn cubs are higher than for other categories of bears, however, they spend the least amount of time out of dens (Table 5). Males probably expend the least amount of their physiologic reserves on reproduction and males spend significantly more time out of dens than females with newborn cubs (Table 5).

## Den Characteristics

All but one of the dens examined in this study were excavated in hillsides; the exception was a den that was in a natural cavity under a large rock and the bear using this den had enlarged the cavity. In 2 cases, natural rock caves that had been used as day beds for >1 year were found near dens. Following emergence a radio-marked bear with newborn cubs was observed using one of these natural caves. Dens in natural caves were more common in southeastern Alaska (Schoen et al. 1987).

Of the 96 dens where measurements were made, 86% had collapsed, making some or all measurements of den dimensions impossible. No evidence of previous use was found for any of the excavated dens examined. Reuse was probably precluded by collapse of the den chamber during the spring and summer.

Mean elevation of 102 dens was 1,207 m (range 320-

**Table 5. Mean number of days spent in and out of dens by Alaskan brown bears based on reproductive status at exit from den.**

| Status | Mean no. days | Range (S.D.) | Significant differences[a] with bears of status no. 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| Days spent in dens: | | | | | | |
| 1. Female with COY | 217(14)[b] | 197-231(10.0) | — | ** | *** | *** |
| 2. Female with yearlings | 204(10) | 158-230(20.6) | ** | — | | ** |
| 3. Female alone or with offspring aged 2.0+ | 195(17) | 158-217(14.5) | *** | | — | |
| 4. Males | 189(12) | 155-231(15.0) | *** | ** | | — |
| All bears | 201(53) | 156-231(18.1) | | | | |
| Days spent out of dens: | | | | | | |
| 1. Female with COY | 158(7) | 149-166(6.2) | — | * | | ** |
| 2. Female with yearlings | 176(5) | 151-214(26.0) | * | — | | |
| 3. Female alone or with offspring aged 2.0+ | 172(5) | 154-179(10.3) | | | — | |
| 4. Males | 180(6) | 166-219(19.8) | ** | | — | * |
| 5. Pregnant females | 164(11) | 149-177(8.4) | | | * | — |
| All bears | 169(34) | 149-219(15.8) | | | | |

[a] Significant difference from other years indicated with *($P$<0.10), **($P$<0.05), or ***($P$<0.01).
[b] Sample size indicated in parentheses.

1,626 m, S.D. = 286.6 m); most dens (79%) were located at 1,000-1,600 m (Fig. 4). Mean slope of hillside at 76 dens was 32 degrees (range = 11-60 degrees, S.D. = 8.1 degrees). Most dens (94.7%) were on slopes of 20-50 degrees. Of 95 dens, more were on south aspects (44.2%) than on west (24%), east (20%), or north (12%) aspects. Under the null hypothesis that all aspects were equally available, aspect of dens was not random ($X^2 = 21.8$, $P < 0.01$).

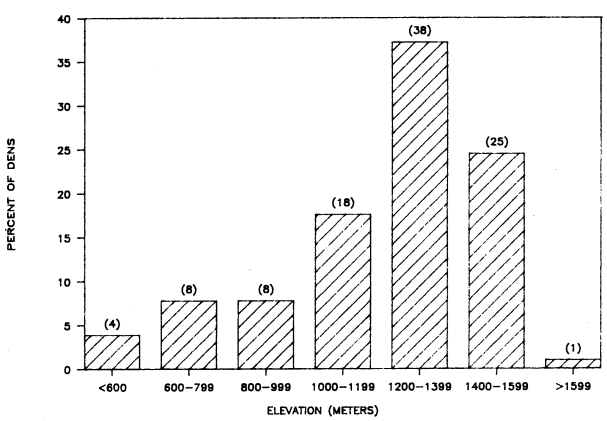


Fig. 4. Elevation of brown bear dens in southcentral Alaska.

Den measurements are provided in Table 6. Typically dens were characterized by an entrance, a short tunnel, and a bedding chamber. Most often the entrance went straight into the hillside (without bends) to the bedding chamber. In 24% of the dens, the bedding chamber did not have bedding material. In the remaining dens, a nest of local vegetation (grass, twigs, or moss) was present but was seldom of appreciable volume.

During the winter the entrance to most dens was sealed by snow, although during winters of light snowfall, some den entrances remained unsealed by snow until January. The first bears to emerge in the spring typically dug out through the snow sealing their den entrance. Frequently, all snow had melted from around the den entrances of the last bears to emerge from winter dens.

Vegetation at 52% of the dens was alpine tundra; at 35%, it was shrubs including *Alnus* spp., *Salix* spp., or *Betula glandulosa*; and at 13%, it was tussock grass and rocks. Most brown bear dens in this study area were above timberline where root systems from trees or shrubs were not available to provide structural support to den roofs. Some of the few dens found at lower elevations in timbered or shrubby habitats were dug under shrubs (mostly *Alnus* spp.) where root systems provided such support.

**Table 6. Dimensions of brown bear dens in southcentral Alaska.**

| | Mean | Range | S.D. | *N* |
|---|---|---|---|---|
| Entrance height(cm) | 61.2 | 38.0-102.0 | 12.5 | 25 |
| Entrance width(cm) | 73.8 | 39.0-133.0 | 17.3 | 31 |
| Entrance area ($m^2$) | 0.45 | 0.18-0.88 | 0.14 | 24 |
| Chamber length(cm) | 131.8 | 81.0-39.0 | 42.1 | 15 |
| Chamber width(cm) | 138.8 | 84.0-231.0 | 40.3 | 22 |
| Chamber vol.($m^3$) | 1.85 | 0.65-4.46 | 0.99 | 12 |
| Chamber height(cm) | 101.2 | 68.0-207.0 | 29.8 | 17 |
| Total lenght (cm) | 246.1 | 119.0-552.0 | 95.8 | 25 |

Although the same den was not reused in different years, individual bears would commonly den in the same general area in different years. Mean distance between dens used in successive years was 6.1 km (range 0.1-29.1 km). There was no difference in distance between dens used in successive years between males (6.3 km) and females (6.1 km). These distances are small compared to the mean annual home ranges for males (1,272 $km^2$) or females (282 $km^2$) of these same bears (Miller 1987). This suggests bears tend to den in the same general area in different years.

## Bear Movements

Characteristically, bears denned near the periphery of the ranges they occupied during the rest of the year and at higher elevations then they occupied during non denning periods. In some instances bears would move long distances (up to 75 km) outside of their summer and fall home ranges to den on the same hillside used previously. The longest such movements were made by males. These males may have been returning to the area of their natal dens. There could be strong selective pressures on bears to return to good denning areas, rather than risk denning in an area with equivalent characteristics but where an individual had no previous experience. Good sites are those where wind currents assure that the den entrance will be well-sealed with snow and where soil and frost characteristics are such that dug dens are unlikely to collapse during winter.

Females accompanied by newborn cubs would commonly remain at high den-level elevations for 2-5 weeks following emergence. In nearby Denali Park similar patterns were observed (Darling 1987). Other bears and these same females during years when they were unaccompanied by newborn cubs would move to lower, snow-free elevations following emergence. At these lower elevations the phenology of edible plants was more advanced and animal foods were more abundant. The longer period spent in dens by parturient females correlates with this movement pattern. If a female with newborn cubs did not move down to lower elevations in the spring, then she probably maintained a better energy balance by remaining in hibernation than she would have wandering around in the cold with nothing to eat.

I believe the delay in moving to lower elevations increases survivorship of newborn litters by decreasing predation on cubs by other bears. Females accompanied by newborn cubs who moved to lower elevations soon after emergence appeared to lose their cubs more often than females that remained at higher elevation (Miller 1987), although the amount of data is inadequate to verify this hypothesis. These data were obtained through use of radio-transmitters with expandable collars (Strathearn et al. 1984) placed on 13 newborn cubs. In 4 instances, documented cause of mortality was brown bear predation. Cause of mortality was undetermined in 2 cases; seven of the radio-marked cubs survived (Miller 1987). All but one of the 6 cub mortalities were in litters of females who moved down from higher-elevation den sites early in the spring. The single exception was also lost when its mother moved down to lower elevations later in the year (mid-July). Six of the surviving radio-marked cubs and 1 cub mortality occurred with females who remained at high elevations early in the spring.

## Comparisons with Black Bears

This study area is in the Susitna River Basin where black bear denning ecology was described and contrasted with 2 other areas in southcentral Alaska by Schwartz et al. (1987). Because studies of sympatric populations of black and brown bears are uncommon, some comparisons of the denning ecology of these 2 species are offered here. Studies of both species in this area were conducted simultaneously during 1980-1985 (Miller 1987).

The 2 species of bears denned in different portions of the study area; typically, black bears denned at lower elevations in spruce-forested habitats along the Susitna River and its major tributaries, while brown bears denned at higher elevations above timberline. The mean elevation for 96 black bear dens was lower (624.1 m, range = 267-1,324 m, S.D. = 171.8 m) than that for brown bear dens (1,207 m) (*t* test, $P < 0.05$). In the center of the study area only 2 of 74 black bears denned in locations considered typical of brown bear denning habitat, and only 1 brown bear denned in a location considered typical denning habitat for black bears. In the lower portion of the study area, brown bear habitat, including typical denning

habitat, was uncommon and brown bears were less abundant. In this lower area, there was less difference between elevations and habitats used by the 2 species.

All of the brown bear dens were excavated, compared with only 56% of the black bear dens. None of the excavated brown bear dens had been previously used, but 29% of the excavated black bear dens had been used in previous years. Roofs of dens excavated by black bears were frequently supported by root systems or boulders and these dens had more structural integrity than those of brown bears. There was no apparent selection for aspect in black bear dens; brown bears preferred south aspects. The slopes used by both species were similar ($\bar{x}$ = 35 degrees for black bears; $\bar{x}$ = 32 degrees for brown bears). Mean volume of the sleeping chamber in excavated black bear dens was 1.11 $m^3$ and for brown bears it was 1.85 $m^3$. Because of high variability these chamber volumes were not significantly different ($t$ test, $P > 0.1$). In general there was more bedding material in black bear dens than in brown bear dens. This may reflect the greater prevalence of vegetable matter useful for making nests at lower elevations where the black bears denned. Mean entrance area of black bear dens (0.22 $m^2$) was smaller than those for brown bears (0.45 $m^2$) ($t$ test, $P < 0.1$). Servheen and Klaver (1983) found that the height of entrance was smaller for black bear dens than for brown bear dens in Montana. In this study neither entrance height or width were significantly smaller for excavated black bear dens than for those of brown bears ($t$ test, $P > 0.1$).

Overall, black bears entered dens earlier ($\bar{x}$ = 9 October) than brown bears ($\bar{x}$ = 14 October) but emerged at about the same time ($\bar{x}$ = 6 May for black bears; $\bar{x}$ = 5 May for brown bears). The mean number of days spent in dens for black bears was 218 (S.D. = 15), compared with 201 for brown bears (S.D. = 18); days spent out of dens averaged 152 days for black bears (S.D. = 16), compared with 169 days for brown bears (S.D. = 15.8). When berry crops failed, both species entered dens earlier than during other years.

## General Observations and Management Implications

No evidence was collected supporting a conclusion that denning habitat available to the brown bear population or denning behavior was limiting bear population numbers in this area. Only 1 natural mortality of a radio-marked brown bear in a den site was documented; this may have been caused by den collapse. On Kodiak Island where population density is higher, mortalities in dens were more common (Van Daele et al. 1990). Although 20 known or assumed mortalities were observed where cubs disappeared from litters during the period between exiting from their natal dens and exiting from their dens as yearlings (Miller 1987), only 1 of these deaths occurred in the den during the denning period. One cub died during the winter of 1981/82 following a poor berry crop, 2 siblings of this cub survived. Similarly, 8 apparent mortalities were observed for bears between their exit from dens as yearlings and their exits the following year; none of these mortalities occurred during the denning period.

The brown bear hunting season in this area (Game Management Unit 13) is currently open from 1 September to 31 May. Hunting is open throughout the entire denning period, and some radio-marked bears have been shot at their den sites by hunters during the spring season. In this area spring bear hunters frequently search from aircraft for occupied den sites. Commonly, these dens are easily observed as dark holes in the snow surrounded by tracks and dirt expelled from the den by bears. When tracks around the den indicate the bear is still at the den, hunters frequently watch the den site and shoot the bear the next time it emerges. It is not legal for hunters to take brown bears accompanied by cubs (COY or yearlings) or to shoot bears the same day the hunters were airborne.

Available evidence indicates that brown bear populations in this area have declined as a result of harvests in excess of sustainable levels (Miller 1990). In order to maintain population numbers, managers in this area need to reduce harvests, particularly of adult females. Information on den entrance dates suggests that little can be done during fall seasons to concentrate hunting effort away from females, because different sexes and reproductive status categories of bears enter dens at about the same time. In spring seasons, however, male bears are the first to leave dens and females with cub or yearling offspring are the last to leave dens. The harvest data support this observation as there is a larger proportion of females in hunter kills during late May than for earlier in the season (Fig. 5). However, the percentage of females in the kill is highest during early September, and 2-4 times as many females are killed during each week of September than during each week of the spring season (Fig. 5). In this area, the most effective way to decrease hunter kill of adult females would be to close the bear hunting season during early September.

Studies of both species of bears were designed to estimate impacts on bear populations of a proposed 2-dam hydroelectric project in the study area. This project is no longer under consideration. Relative to impacts on denning ecology, these studies concluded that the project

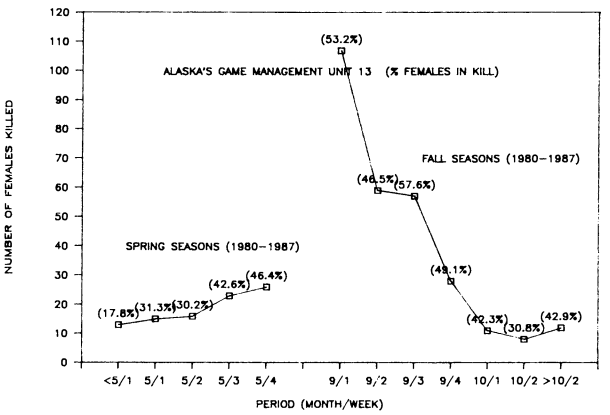


**Fig. 5. Number of female brown bear killed during each week of the open season. Percentage of kill that is female during week is indicated in parentheses. Data are from Alaska's Game Management Unit 13 during the period 1980-1987.**

would have had a significant negative impact on black bears (Miller 1987). Since most black bear denning occurred in a narrow elevation range near the river, I concluded that the proposed impoundments would have eliminated, through inundation and disturbance, a significant proportion of black bear denning habitat (Miller 1987). I also concluded that the proposed project would have had a negligible impact on denning ecology of brown bears in this area, except, perhaps, from noise associated with construction-related activities (Miller 1987, Schoen et al. 1987).

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