DENNING ECOLOGY OF THREE BLACK BEAR POPULATIONS IN ALASKA

CHARLES C. SCHWARTZ, Alaska Department of Fish and Game, Box 3150, Soldotna, AK 99669
STERLING D. MILLER, Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99503
ALBERT W. FRANZMANN, Alaska Department of Fish and Game, Box 3150, Soldotna, AK 99669

Abstract: Between 1978 and 1985, denning ecology of the black bear (*Ursus americanus*) was studied in the Kenai Peninsula, the Susitna River basin, and Prince William Sound, Alaska. All these populations are near the northern extension of their range. In different years the mean number of days spent in dens varied from 189 to 233 days; the maximum time spent in a den by an individual bear was 247 days. Timing of emergence in the spring and entrance in the fall appeared most related to time of year and secondly to weather, snow accumulation and melt, and food availability. Bears in the more severe climate along the Susitna River entered dens almost 2 weeks earlier and emerged later than bears on the warmer Kenai Peninsula. Chronology of denning differed among pregnant females and other sex and age groups, but overlap occurred with all age and sex groups. Site selection, vegetation type, and den type (cave, tree, excavated) varied with area and was related to winter weather conditions (rain vs. snow), soil type (deep vs. shallow and rocky), and topography of the areas (mountains vs. flats). Den morphometry was compared among areas. Denning chronology was compared with that of other North American black bear populations and with current denning theory.

Int. Conf. Bear Res. and Manage. 7:281–291

In November 1963, the Craigheads (Craighead and Craighead 1965) tracked a grizzly bear (*U. arctos*) to its winter den using radiotelemetry. Subsequently, telemetry studies have provided a steady flow of information about denning ecology of bears. Beecham et al. (1983) indicated that a wide array of physical and environmental conditions prevail throughout the range of black bears in North America and that black bears are diverse and adaptable in selecting the site and period for denning. They stated that "this flexibility suggests a need to investigate the factors influencing denning chronology and den site selection throughout the bears' range."

From 1977 to 1985, biologists with the Alaska Dep. of Fish and Game (ADF&G) conducted radiotelemetry studies of black bears in 3 regions of Alaska: Prince William Sound, the Kenai Peninsula, and the Susitna River basin. Although objectives of each study varied, each provided the opportunity to investigate denning chronology and den site selection for 3 black bear populations occupying different habitats within the northern limits of black bear range in North America.

Numerous individuals assisted with various phases of data collection and analysis. They include D. McAllister, D. Johnson, W. Ballard, T. Spraker, R. Modafferi, B. Taylor, J. Whitman, C. Gardiner, R. Tobey, E. Goodwin, L. Lieb, N. Tankersley, D. Anctil, B. Cassell, and T. Cunning. We especially thank aircraft pilots V. and C. Lofsted, M. Hauk, and L. Rogers for their skill in flying the tagging and tracking aircraft. We thank D. McAllister and D. Johnson for much of the field assistance required to measure dens, G. Del Frate, D. Anctil, T. Otto, and N. Graves for data summarization, and S. M. Miller for statistical assistance; K. Schneider, S. Peterson, and B. Townsend provided critical manuscript review. R. Modafferi was cooperative in providing information needed to locate the dens in the Prince William Sound area. Kenai Peninsula and Prince William Sound studies were a contribution of Fed. Aid in Wildl. Restor. Proj. W-17, W-21, W-22, and W-17–10, W-17–11, W-21–1, W-21–2, respectively. Susitna studies were funded by the Alaska Power Authority.

STUDY AREA

Study areas are in northwest Prince William Sound (PWS), the north-central Kenai Peninsula (KP), and the Susitna River basin (SRB) (Fig. 1). The PWS study area is approximately 5 km south of the town of Whittier, and includes most of the area between Blackstone Bay and Kings Bay. Topography and climate of the region have been described by Cooper (1942), McIlroy (1972), and Modafferi (1982). In general, the area consists of a series of irregular bays with mountains that rise precipitously to peaks ranging from 700 to 1,700 m. The climate at low elevations is maritime; temperatures are fairly even and precipitation is high (150–370 cm/year), occurring mainly as snow. Vegetation of the area ranges from sedge (*Carex* spp.) and beach ryegrass (*Elymus arenarius*) flats and tide marshes to forested hillsides mainly of mountain (*Tsuga mertensiana*) and western (*T. heterophylla*) hemlock and Sitka spruce (*Picea sitchensis*), to subalpine habitats of Sitka alder (*Alnus crispa*), salmonberry (*Rubus spectabilis*), bluejoint reedgrass (*Calamagrostis canadensis*), and lady ferns (*Athyrium filix-femina*).

The KP study area is approximately 57 km south-

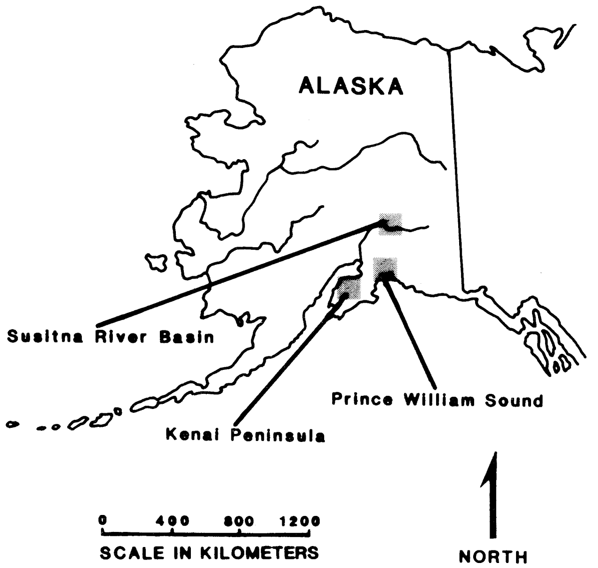

Fig. 1. Three black bear denning ecology study areas in south-central Alaska.

west of Anchorage on the north-central lowlands of the Kenai Peninsula (Fig. 1). Spencer and Hakala (1964), Sigman (1977), and Oldemeyer et al. (1977) have previously described the topography, climate, and vegetation of the area. The area consists of ground moraines with low ridges, rolling hills, and muskeg. Relief ranges from 35 to 90 m above sea level. Climate is classified as continental and maritime. Annual precipitation ranges from 40 to 50 cm, half of which falls as rain during the late summer. Annual snowfall ranges from 135 to 160 cm. The area's vegetation is typical of an interior boreal forest of Alaska. Major tree species include white spruce (*Picea glauca*), black spruce (*P. mariana*), paper birch (*Betula papyrifera*), aspen (*Populus tremuloides*), and willow (*Salix* spp.). The area is covered by podzol soils that were glacially scoured and dotted with numerous lakes and bogs.

The SRB study area was approximately 75 km northeast of Talkeetna, Alaska, in the Talkeetna Mountains (Fig. 1). The area consists of a finger of forested habitat along the Susitna River valley (Miller et al., this volume). Miller and Ballard (1982) have described topography, climate, and vegetation of the area. The area is mountainous, with elevations ranging from 300 to 2,300 m. Climate is continental, with relatively cold winters and warm summers. Precipitation averages 80 cm/year, mostly as snow during the winter. The area is boreal forest with black and white spruce dominant, and paper birch, willow, and aspen occurring on well-drained sites. The vegetation at higher elevations above the forest consists of a shrub zone dominated by alder (*Alnus* spp.), willow, and dwarf birch (*B. glandulosa*).

METHODS

We used 3 methods to capture bears during summer. In the PWS area, we used Aldrich foot snares set along trails (Modafferi 1982) and helicopter darting (Miller and Ballard 1982). In the SRB and KP areas, we used helicopter darting, and in the KP area we used barrel traps as well (Schwartz et al. 1983). During winter, we immobilized yearlings of radio-collared females in their dens in the SRB and KP areas. We fitted bears with radiotransmitters (Telonics, Inc., Mesa, Ariz.) and tracked them at approximately equal time intervals (7–10 days) from fixed-wing aircraft fitted with twin H-type antennas attached to a scanner-receiver (Telonics, Inc., Mesa, Ariz.). Bear locations were plotted on USGS maps (1:63,360). All bears 4 years old or older were classified as adults, those 2–3 years old were subadults, 1-year-olds were yearlings, and those less than 1 year were cubs.

Because radio-tracking flights were not made daily, the exact dates of den entrance and emergence were unknown. Consequently, we mathematically determined dates of den entrance and emergence and the total length of time spent in the den. The minimum number of days a bear could have been in its den was determined as follows: MINDAYS = (365 − FID) + LID, where FID (1st in den) was the Julian day a bear was 1st located at its den site in the fall, and LID (last in den) was the last Julian day a bear was located at its den site in the spring. Likewise, the maximum number of days a bear could have been in its den was determined as follows: MAXDAYS = (365 − PD) + OD, where PD (pre-den) was the Julian day of the last location of a bear away from its den site in the fall, and OD (out of den) was the 1st Julian day a bear was located away from its den in the spring. MINDAY and MAXDAY represented the minimum and maximum number of days, respectively, that a bear could have been in its den. The mean number of days a bear spent in a den was defined as MEANDAY = (MINDAY + MAXDAY)/2. Differences between time of den entrance (FID), time of emergence (LID), and the time in the den (MEANDAY) were compared among study areas, and among sex and reproductive classes of females (females with yearlings, females with cubs, solitary females) using an analysis of variance and Duncan's multiple range test. A significance level of 0.05 was used for all tests. Because we did not radio-track on a daily basis, standard deviations presented contain 2 sources of variation—that associated with differences between bears, and those associated with the flight schedule.

We compared the relationship between den entrance and emergence times with maximum and minimum temperatures for the SRB using data available from the Alaska Power Authority, Anchorage, Alaska. Snowfall data for SRB were obtained from monthly surveys of 2 snow courses established in the study area (Snow Surveys and Water Supply Outlook for Alaska, Soil Conserv. Serv., U.S. Dep. of Agric., various dates). Better weather data, including snowfall, from the KP study area were available through climatological data summaries from a weather station at Kenai, Alaska. We compared the data visually, using plots of weather data and histograms of entrance and emergence times.

We catalogued den morphometry for all dens visited and took measurements (Fig. 2) during the spring or summer after bears had left the dens. We collected only nonaffected statistics from excavated dens that had collapsed when visited. Natural cavities and tree dens with unusual shapes or nondefinable measurements were not included in the analysis. We compared differences among den types and morphometry with analysis of variance.

Examination of dens showed whether they had been reused. Excavated dens with vegetation growing on the tailing pile were classified as previously used and dens with fresh tailings were classified as new unless we discovered old tailings under the fresh ones. Cave and tree dens were more difficult to evaluate unless used by previously marked bears.

Study periods for PWS, KP, and SRB were for years 1981–82, 1978–85, and 1980–85, respectively.

RESULTS AND DISCUSSION

Denning Chronology

We tracked 357 radio-collared bears from 1978 to 1984; 300 of these animals provided data for denning chronology studies. A radio-collared bear was an individual bear or family group (i.e., female with cub or cubs) radio-tracked for 1 year. The same bear followed for subsequent years was counted more than once. This represented 186, 114, and 11 bear years from the KP, SRB, and PWS areas, respectively. Not all bears provided all types of data, so the number of observations depended on the statistic calculated; N values are presented. Data from the PWS area were minimal, thus major comparisons were made only between the KP and SRB areas.

All bears studied denned in all years. Entrance and emergence dates varied among study areas and years (Tables 1 and 2). In general, bears from the KP entered dens later in the fall than those in SRB ($\bar{x}$ = 18 Oct vs. 9 Oct) and emerged earlier in the spring ($\bar{x}$ = 19 Apr vs. 6 May). Differences in entrance and emergence dates resulted in a total time in the hibernaculum (MEANDAYS ± SD) for SRB bears of 218 ± 15 days that was significantly longer than the 196 ± 13 days for KP bears (a difference of 22 days. We only have data from PWS for the den year 1981–82, when bears in this area apparently entered their dens later than in SRB. On 29 September, no bears were denned in the PWS; this was the last flight of the year. PWS bears also emerged earlier than those of the SRB but later than KP bears. The average date of den emergence for PWS in 1981–82 was 30 April; the mean was 26 April and 9 May for the KP and SRB, respectively.

Comparisons of time spent in the den, entrance, and emergence dates for male and female bears in each study area were separate because the female reproductive class could confound a test for a year effect. Results indicated no significant difference be-

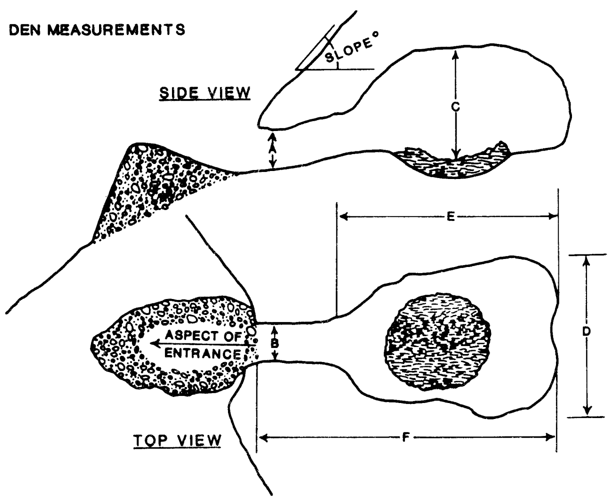

Fig. 2. Measurements taken of black bear dens: A = entrance height, B = entrance width, C = chamber height, D = chamber width, E = chamber length, and F = total length of den.

Table 1. Denning chronology for black bears on the Kenai Peninsula, Alaska from 1978–84.

Den Year	N	FID[a] $\bar{x}$	FID[a] (Range)	LID[b] $\bar{x}$	LID[b] (Range)	Mean days[c] ± SD In den	Mean days[c] ± SD Out of den
1978–79	9	22 Oct	(3 Oct–8 Nov)	21 Apr	(19 Apr–27 Apr)	194 ± 11	—
1979–80	14	18 Oct	(2 Oct–28 Oct)	27 Apr	(23 Apr–9 May)	204 ± 10	176 ± 9
1980–81	14	25 Oct	(10 Oct–7 Nov)	16 Apr	(3 Apr–27 Apr)	189 ± 10	166 ± 9
1981–82	17	21 Oct	(8 Oct–27 Oct)	26 Apr	(16 Apr–6 May)	198 ± 11	180 ± 10
1982–83	26	16 Oct	(6 Oct–3 Nov)	18 Apr	(29 Mar–6 May)	194 ± 11	161 ± 8
1983–84	44	17 Oct	(21 Sep–11 Nov)	13 Apr	(11 Apr–24 Apr)	192 ± 16	177 ± 16
1984–85	40	17 Oct	(3 Oct–31 Oct)	26 Apr	(22 Apr–9 May)	201 ± 10	173 ± 12
All years	164	18 Oct	(21 Sep–11 Nov)	19 Apr	(29 Mar–9 May)	196 ± 13	—

[a] FID = first date observed in den.
[b] LID = last date observed in den.
[c] Mean days = mean number of days in den or out of den during summer preceding entrance.

Table 2. Denning chronology for black bears on the Susitna River Basin, Alaska from 1980–84.

Den Year	N	FID[a] $\bar{x}$	FID[a] (Range)	LID[b] $\bar{x}$	LID[b] (Range)	Mean days[c] ± SD In den	Mean days[c] ± SD Out of den
1980–81	14	7 Oct	(30 Sep–14 Nov)	5 May	(30 Apr–21 May)	222 ± 13	—
1981–82	19	22 Sep	(9 Sep–7 Oct)	9 May	(4 May–18 May)	233 ± 9	134 ± 12
1982–83	30	11 Oct	(29 Sep–20 Oct)	3 May	(25 Apr–10 May)	212 ± 10	148 ± 8
1983–84	27	16 Oct	(26 Sep–25 Oct)	29 Apr	(8 Apr–11 May)	209 ± 15	158 ± 14
1984–85	26	15 Oct	(21 Sep–9 Nov)	14 May	(30 Apr–23 May)	221 ± 14	157 ± 15
All years	116	9 Oct	(9 Sep–8 Nov)	6 May	(8 Apr–23 May)	218 ± 15	—

[a] FID = first date observed in den.
[b] LID = last date observed in den.
[c] Mean days = mean number of days in den or out of den during summer preceding entrance.

tween the average time spent in the den, entrance, and emergence dates for bears in the KP area for den years 1978–79 through 1984–85 for males and females; so Table 1 shows combined data.

In the SRB during den year 1981–82 the time bears spent in the den and the emergence dates differed significantly from the time spent in dens during den years 1980–81, 1982–83, or 1984–85 (Table 2). This difference occurred because bears in the SRB area entered their dens significantly earlier in the fall of 1981–82 than in other years, apparently because of the relatively poor 1981 berry crop in the SRB. Berry crop failure was suspected at the time because of on-ground appraisals and much larger fall home ranges in 1981 than in previous years (Miller, unpubl. data). Weather conditions in the fall of 1981 were essentially equivalent to those in 1980. Den emergence in the SRB during the spring of 1983–84 was significantly earlier than in 1981–82 and 1984–85. No environmental reason was detected for the earlier emergence in 1984; available data indicate that snow accumulation and temperatures were typical during this spring. The temperature data indicated no early thaw that might have flooded dens.

Because females and males on the KP did not differ among years, we compared males and 3 reproductive classes of females (pregnant, with cubs, and nonpregnant) across all years. Pregnant females entered their dens significantly earlier (12 Oct) and remained in them longer (204 days, $N = 30$) than females with cubs (22 Oct, 192 days, $N = 25$), nonpregnant-females (22 Oct, 193 days, $N = 35$), and males (23 Oct, 193 days, $N = 25$). Emergence times were not different.

Observations in the spring in the KP area suggested that females with newborn cubs (pregnant females at entrance) remained at the den longer than other classes of bears. We tested this by comparing, among males and the 3 reproductive classes of females, the period during which a bear could be seen at the entrance to its den in the spring. The test was nonsignificant, indicating that all classes of bears, including females with newborn cubs, spent approximately the same amount of time at their dens in the spring.

We made similar comparisons with SRB bears but excluded the year 1981–82 from the analysis because it was different (bears entered dens earlier) from all other years. Pregnant females entered dens significantly earlier (10 Oct) and remained in the dens longer (222 days, $N = 29$) than males (15 Oct, 206 days, $N = 28$) and females with cubs (15 Oct, 213 days, $N = 14$) but not nonpregnant females (12 Oct, 216 days, $N = 17$). Males did not stay in their dens as long as nonpregnant females.

We tested for differences in length of stay in dens among study areas using a 2-way analysis of variance. We excluded years 1978 and 1979 from KP data because these years were not represented in the SRB; we also excluded 1981 because it was different from other years in the SRB. These results indicated that trends among reproductive classes were similar in the study areas, although time spent in the den during winter differed between the 2 areas.

Entrance, emergence, and total time in the den reported here were earlier, later, and longer, respectively, for bears in Alaska than for bears in Washington (Lindzey and Meslow 1976), Minnesota (Rogers 1977), Idaho (Beecham et al. 1983), Alberta (Tietje and Ruff 1980), New York (O'Pezio et al. 1983), and Arizona (LeCount 1983) and reflect the length of winter in Alaska. We believe the difference between SRB and KP was mainly related to the length of winter. Like Lindzey and Meslow (1976), Jonkel and Cowan (1971), and Beecham et al. (1983), we observed pregnant females entering the den significantly earlier than other classes of bears. We could not demonstrate statistically that females with newborn cubs remained at the den longer in the spring, although we believe this to be the case.

The maximum time (MEANDAYS) spent by an individual in its winter den was 247 days. An adult female in the SRB study area spent this period in its den during 2 den years (1980–81 and 1984–85); both times it was pregnant when it entered the den. To our knowledge this is the longest recorded period spent in a den by a black bear in North America. The 2nd and 3rd longest times spent in dens (246 and 245 days) were recorded for 2 adult females during den year 1981–82. Neither of these females had newborn cubs when 1st spotted after emergence from these dens, although both were due to have litters. As mentioned above, the preceding year (1981) was a berry crop failure, and these females may have lost their cubs in this den as a result.

Energetically, the length of time a bear can spend in its den is related to its stored fat reserve and the rate of catabolism of this fat. Conversely, the number of days a bear spends out of the den determines how long it has to replenish those fat deposits for the next denning period. We computed the length of time bears remained out of the den for the KP and SRB study areas. Bears on the KP remained out of their dens for an average of 173 ± 13 days ($\bar{x}$ ± SD) for the years 1979 through 1984 with a range of 161–180 days (Table 1). Bears in the SRB were out of their dens 152 ± 16 days for the years 1981–84 with a range of 134–158 days (Table 2). The difference between the time bears on the KP and SRB were out of the den was 21 days. This may partially explain differences in productivity of bears in these 2 areas (Miller and Schwartz, unpubl. data). Bears in SRB appear to inhabit a more marginal and variable habitat than KP bears. We observed no relationshilp between exit date in 1 den year and entrance or emergence dates during the adjacent year. This suggests that there is no biologically fixed period a bear must remain out of its den regardless of entrance or emergence dates.

Weather and Time of Denning

Environmental factors such as snowfall (Jonkel and Cowan 1971, Craighead and Craighead 1972), temperature (Folk 1967), and food availability (Jonkel and Cowan 1971) have been implicated as influencing the onset of denning. Visual inspection of these weather variables superimposed over denning chronology histograms revealed that no single variable alone was responsible for influencing the onset of denning. In general, bears entered their dens in the fall at approximately the same time each year; 1981 was an exception in the SRB.

Frost seemed to be a prerequisite for denning, and in no year did bears enter their dens before the onset of freezing weather. The relationship between den entrance and declining temperatures was inconsistent from year to year. In some years, bears were in their dens when maximum daytime temperatures remained below freezing, whereas in other years bears remained out even though temperatures were low. The relationship between denning and snowfall was also inconsistent. In some years, denning occurred just before a major snowstorm, whereas in other years all bears on the KP denned before any snow accumulation.

Although we did not measure food abundance, we observed that pregnant females denned when substantial amounts of food were available. Consistently freezing temperatures reduced the quality of some fall berries such as blueberry (*Vaccinium* spp.) and crowberry (*Empetrum nigrum*); however a major food of KP bears was lowbush cranberry (*V. vitas-idaea*), which did not deteriorate with freezing. In fact, lowbush cranberries remained on the plants throughout the winter and were an important food in spring (Smith 1984).

Den emergence in the spring was not related to any single environmental parameter. There was no apparent trend between increasing spring temperatures and emergence. In all years, in both study areas, bears began to emerge from the den before nighttime temperatures remained above freezing, and in most years emergence was complete by the time nighttime temperatures exceeded 0 C. Daytime temperatures exceeded 0 C when bears emerged, but the change from below to above zero daytime trends did not affect emergence. In some years daytime temperatures were above freezing for weeks before bears emerged. Snow on the ground delayed emergence in years when the snow remained for an extended period in the spring. However, in years when accumulated snow was gone early, bears did not emerge immediately after snow melt. In the KP during spring of 1981, there was no snow on the ground after late February, yet bears did not emerge until mid-April, as in most other years. Bears in SRB emerged significantly earlier during 1 spring with apparently typical snow and temperature patterns. Den entrance dates during this winter were the latest recorded; this combination resulted in the shortest total period spent in dens during the study period in SRB (Table 2).

Our data on denning agree with those of Lindzey and Meslow (1976), who believe that the cumulative effect of weather and physical condition determine the onset of denning. Nonlactating females (both pregnant and nonpregnant) had the greatest opportunity to fatten in the fall because they did not need additional energy to care for young or to maximize breeding opportunities, as did adult males. Therefore, most of a nonlactating female's time was devoted to searching for food, which could partially explain why pregnant, nonlactating females enter their dens 1st, long before weather is a factor or food shortage is apparent. It does not explain why nonpregnant, nonlactating females from the KP did not den early, although the fact that nonpregnant, nonlactating females from the SRB did enter dens at around the same time as pregnant females lends support to this thesis. For the other classes of bears, physical condition may have been of less consequence to denning, and they entered dens when it was profitable to do so from an energetics standpoint. Early den entrance in the SRB during the 1981–82 season was associated with a shortage of available food. This agrees with the statement of Nelson and Beck (1984:51), who stated that "thus, in the poorer food years, it is advantageous to achieve hibernation prior to the loss of high carbohydrate foods and the onset of colder weather. Conversely, there is little advantage to being able to make efficient use of food in good years for the extra 2–3 weeks that food may be available because bears will be in adequate condition for survival and reproduction anyway." It is interesting that the only bears seen out of their dens during winter on the Kenai Peninsula were in poor physical condition with no remaining fat.

Emergence in the spring seemed to be related to weather only when adverse conditions extended the denning period or when fat reserves were not sufficient to sustain a bear through the normal denning period. During an early spring, bears did not emerge from the den sooner in response to warmer environmental conditions. This is contrary to Rogers' (1974) observation for bears in Minnesota, where he believed emergence was associated with temperatures greater than 10 C.

Den Locations

Between 1979 and 1984, we located 96, 91, and 17 dens in the KP, SRB, and PWS areas, respectively. Bears selected different types of den sites in the 3 study areas. Bears on the KP used excavated dens almost exclusively (96%), whereas bears in the SRB used both natural (caves and rockpiles) (41%) and excavated dens (56%). Bears in PWS used natural dens (60%), excavated dens (20%), and tree dens (20%) (Table 3). Differences in site selection and den type were related to topography and climatic conditions in the 3 study areas. The KP area was relatively flat with primarily outwash soils deposited from past glaciation. There were few natural cavities as soils were deep and heavily forested. The 3 dens constructed in natural cavities were under glacial boulders. Rock or cave dens were more common on the SRB and PWS areas because of the shallow soils and the more rugged terrain with exposed rock.

Tree dens were more common in the PWS area than in either the KP or SRB areas. Use was again related to availability of suitable den sites. PWS, a coastal rain forest, had extensive stands of virgin timber. It contained many large-diameter trees that potentially contained hollow trunks or stumps. Dens were located in hemlock and spruce trees. In contrast,

Table 3. Type of den used by black bears from 3 study areas in Alaska, 1978–84.

	Study area								
	Susitna River Basin			Kenai Peninsula			Prince William Sound		
Den type	*N*	%	N:P:U (%)[a]	*N*	%	N:P:U (%)[a]	*N*	%	N:P:U (%)[a]
Excavated	51	56	51:29:20	92	96	50:42:8	3	20	100: 0:0
Natural	37	41	5:73:22	3	3	0:100:0	9	60	0:78:22
Tree	3	3	0:67:33	1	1	0: 0:100	3	20	40:20:40
Total	91	100		96	100		15	100	

[a] N:P:U = % newly constructed: % previously constructed: % year of construction unknown.

most mature trees in the boreal forests of the KP and SRB were rarely sufficiently large to accomodate a den. The only species to reach a diameter of > 1 m was black cottonwood (*Populus trichocarpa*); all tree dens in the KP and SRB were in cottonwood trees.

Weather may also influence den site selection. PWS, because of its coastal nature and relatively wet winters, was different from the KP and SRB areas. Dens excavated in shallow soils would be more prone to flooding during winter rainstorms or winter thaws, compared with tree dens or rock caves. Excavated dens are inherently more prone to flooding during winter thaws or rapid spring melt.

Of the 96 dens located and marked on the KP from 1978 to 1984, only 3 bears moved to a different den after den entrance and before den emergence. Two of these bears moved after we tagged their yearlings; the other moved without disturbance from us, but we can only speculate as to why she moved. The move occurred after a thaw, suggesting that the den flooded.

One interesting den we visited on the KP in midwinter was in a bog. When visited, the den was in poor condition and beginning to collapse; the grass nesting material was saturated with water from a recent winter thaw. This bear with 2 yearlings remained in that relatively poor denning location all winter. On emergence the next spring, both yearlings died of starvation. When captured, the female was in extremely poor physical condition. She survived but did not produce cubs the next winter.

Of the bears using the 91 dens located in the SRB from 1981 to 1984, 3 moved to different dens after den entrance and before den emergence. One bear abandoned a tree den after we disturbed it in early spring. The other 2 bears moved without disturbance from us. As with the KP, both moves occurred after spring thaws and probably were associated with water flooding the den. We also observed what appeared to be competition between bears for denning sites in the fall. On 3 occasions, we located more than 1 bear at a known den site (natural cave) at the same time. This usually occurred during the period of normal den entrance. In all cases, only 1 bear ultimately used the site for denning, with the 2nd, and in 1 case, 3rd bear leaving late in the den entrance period to den at a different site. It appeared that these cave dens were preferred denning sites and possibly indicated that early den entrance was advantageous when competition for sites existed.

Throughout their range, black bears den in a variety of locations. Jonkel and Cowan (1971) in Montana and Johnson (1978) in the Smoky Mountains reported denning occurred mainly in trees, whereas Erickson (1964) in Michigan, Lindzey and Meslow (1976) in Washington, and Beecham et al. (1983) in Idaho reported bears mostly used excavated dens. Those studies and our data indicate that bears tend to be somewhat opportunistic in their choice of denning sites.

Various authors have reported that black bears select specific aspects for den location (Johnson 1978, Beecham et al. 1983), whereas others report no selection (Lindzey and Meslow 1976). We tested this by combining all data on aspect of entrance from the 3 study areas into 8 groups from 0°-360° in 45° increments with north, south, and so forth at the center of the group. For example, east, or 90°, would include aspects from 67°-112°, and so forth. A chi-square test indicated there was no significant difference among aspect groups ($X^2 = 8.2$, $P > 0.05$). Similar tests for each study area were likewise nonsignificant, indicating that bears in the 3 study areas in Alaska did not appear to select for a specific aspect when choosing a den site.

The mean slope ($\bar{x} \pm$ SD) where bear dens were located was steeper in the SRB (35° ± 35) and PWS (35° ± 20) areas than in the KP (14° ± 12). That difference was expected because the SRB and PWS were in mountainous areas, whereas the KP was relatively flat. Slope of dens in the KP area and SRB did not differ significantly among age and sex of bears; however, a significant difference existed between the slope for excavated (25° ± 13) vs. natural (42° ± 31) dens in the SRB area. Rock piles and natural caves were more common in steeper areas compared to areas with deeper soils suitable for the construction of an excavated den. Beecham et al. (1983) found a similar difference between excavated and tree dens in their study area in Idaho.

Reuse of dens was common in all 3 study areas. Of the 92 excavated dens on the KP, 50%, 42%, and 8% were classified as new, used, or status unknown, respectively. Likewise, of the 51 excavated dens in the SRB, 51%, 29%, and 20% were classified as new, used, or status unknown, respectively. All 3 natural cavities from the KP were previously used; of the 37 natural cavities from the SRB 5%, 73%, and 22% were classified as new, used, or status unknown. Results were similar for the PWS area, where 75% of the dens had been used previously and the status of 25% was unknown. The high percentage of reuse of cave dens possibly suggests a preference for this type of den. Excavated dens on the KP and SRB areas were relatively stable, unlike dens of brown bears described by Reynolds et al. (1976) for the central Brooks Range. Soils in the KP and SRB areas are relatively cold; as a consequence, roots of the forest vegetation were lateral and on or near the soil surface. This concentration of tree roots at ground level created a naturally woven roof structure for excavated dens and allowed them to persist for many years. The few collapsed dens were in areas with sparse tree cover or where the trees were too small to form the complex matted root system necessary to provide good roof support. Cave dens were inherently stable.

The high reuse of natural cavity dens in SRB was unexpected considering the characteristics of these dens, many of which appeared drafty and cold and frequently incompletely sealed by the snowpack when we visited them in March and April. Similarly, 2 of the 3 tree dens in SRB were in snags that were open at the top, allowing precipitation to enter and body heat to escape. There was no snow in these dens when the bears were present, but during the following winter, when these dens were not occupied, they were full of snow in April. This suggests that, when these dens are occupied, the occupants melt the snow that falls on them with their body heat.

Reuse of dens reported here was high compared with other studies. Jonkel and Cowan (1971), Pearson (1975), Tietje and Ruff (1980), LeCount (1983), and Alt (1984) reported low instances of den reuse in Montana, Yukon Territory, Alberta, Arizona, and Pennsylvania, respectively.

Black bears in the KP study area denned in 2 major vegetation types: mature upland forest (31%) and regrowth upland forest (67%). One den was located in a black spruce bog (1%). We compared these percentages with those discussed by LeResche et al. (1973) for a typical 2.5-km^2 area within their study area, where mature forest, regrowth forest, spruce bog, and grass-sedge composed 46%, 46%, 1%, and 6% of the area respectively. A chi-square test for independence was significant ($X^2 = 20.1$, $P < 0.05$). These data indicated that black bears tended to select regrowth vegetation and denned less in mature forest. Bears did not den in grass-sedge openings and avoided bogs in most cases. These avoidances were explainable because those habitats were low, tended to be wet, and were subject to spring flooding. This finding was in agreement with Beecham et al. (1983), who found

Table 4. Mean dimensions ($\bar{x}$ ± SD in cm) of dens used by black bears in 3 areas of Alaska, 1978–84.

Area	Type	*N*	Entrance			Chamber				Den length
			Height	Width	Area (m^2)	Length	Width	Height	Vol. (m^3)	
Kenai Peninsula	Excavated	91	43 ± 10A[a]	54 ± 15A	0.23 ± 0.11A	104 ± 29A	106 ± 25A	69 ± 16A	0.81 ± 0.43A	175 ± 56A
	Natural	2	37 ± 6	41 ± 7	0.15 ± 0.05	133 ± 35	81.4 ±	53 ± 1	0.58 ± 0.13	234 ± 126
Susitna River Basin	Excavated	40	45 ± 22A	57 ± 20A	0.22 ± 0.13A	125 ± 43B	119 ± 33B	70 ± 25B	1.11 ± 0.77B	213 ± 119B
	Natural	27	54 ± 19	46 ± 17	0.24 ± 0.11	207 ± 239	83 ± 30	66 ± 16	0.92 ± 0.71	418 ± 260
Prince William Sound	Natural	9	60 ± 45	86 ± 81	0.47 ± 0.36	113 ± 51	126 ± 36	76 ± 21	1.20 ± 0.92	409 ± 286
	Tree	5	46 ± 11	48 ± 16	0.23 ± 0.10	72 ± 10	81 ± 15	75 ± 10	0.46 ± 0.04	132 ± 45

[a] Any 2 means not sharing a common letter are significantly different (P <0.05) according to Duncan's Multiple Range Test. Statistical comparison was made between excavated dens from the Kenai Peninsula and Susitna River Basin.

that bears in Idaho denned in thick brush, apparently to conceal their dens.

In the SRB, 56% of all dens were in vegetative types dominated by alder; 32% were in spruce, birch, or mixed hardwood stands; 9% were in shrub or alpine tundra types; and 3% were tree dens in riparian cottonwood stands. The preferred site appeared to be alder draws with an association of spruce or birch trees; no data were available on vegetative composition of the study area, so no chi-square tests were performed.

Den Morphology

For excavated dens, differences in dimensions were observed among study areas (Table 4) and among specific age-sex groups within study areas (Table 5). Sample sizes were too small to compare all den types among study areas. A comparison of excavated dens between SRB and KP indicated no significant differences among entrance height, width, or area, but chamber dimensions (height, width, length, and volume) were significantly larger for the SRB. We have no explanation why SRB bears would construct a larger den chamber, because they were similar in body size and weight to KP bears.

We also compared data from excavated dens in the SRB and KP areas to test for differences that could be attributed to different sex-age groups of bears. In general, males needed a significantly larger entrance height and area (Table 5). Males in the KP area had a larger chamber than females with cubs and nonpregnant females. Den chambers excavated by males in the SRB did not differ in size from other groups, but the overall den length was longer, indicating they had a longer tunnel.

Nesting material had been used by bears in all dens we visited except for 1 excavated den used by an adult male on the KP. Nesting material was vegetation that occurred in the immediate area of the den.

Unusual Observations

We observed 5 cases of co-occupancy of dens, excluding females with newborn cubs or yearlings. In 3 cases, females denned with their 2-year-olds (ages of all bears are at den emergence). In 1 case, a female denned with her single yearling and her 4-year-old daughter from a previous litter. The 4-year-old may have produced cubs in this co-occupied den, as we heard cubs squealing when we visited the den in late winter; however, the female did not emerge with cubs in the spring. The 5th instance of co-occupation was a 2-year-old female denning with another female and her yearling male. The 2-year-old was not an offspring of this female but was from a litter of 3 born to another female in the area. We could not determine if the 2 adult females were related and we could find no other reports in the literature regarding co-occupation of black bear dens.

We generally visited dens for marking or immobilizing females with yearlings in mid to late winter (Feb–Apr). On at least 6 occasions (1 SRB and 5 KP), we observed evidence of body wastes at the den

Table 5. Mean dimensions ($\bar{x} \pm$ SD in cm) of excavated dens used by black bears in 2 areas of Alaska, 1978–84.

Status	N	Entrance			Chamber				Den length
		Height	Width	Area (m²)	Length	Width	Height	Vol. (m³)	
Kenai Peninsula Area									
Female with cubs	24	45 ± 11A[a]	59 ± 15A	0.27 ± 0.11A	111 ± 34A	100 ± 18A	64 ± 11A	0.72 ± 0.32A	171 ± 53A
Female with yearlings	23	40 ± 9B	51 ± 14A	0.20 ± 0.06B	103 ± 29A	111 ± 19AB	70 ± 14AB	0.84 ± 0.43AB	172 ± 56A
Female, nonpregnant	20	38 ± 6B	49 ± 10A	0.18 ± 0.05B	91 ± 24A	97 ± 30A	64 ± 20A	0.61 ± 0.37A	177 ± 72A
Males	24	48 ± 11A	54 ± 20A	0.27 ± 0.16A	110 ± 24A	117 ± 29B	76 ± 18B	1.04 ± 0.49B	178 ± 47A
Susitna River Basin									
Female with cubs	15	37 ± 8A	58 ± 14A	0.21 ± 0.06A	131 ± 40A	120 ± 32A	62 ± 12A	0.99 ± 0.31A	193 ± 84A
Female with yearlings	7	30 ± 7A	49 ± 9A	0.15 ± 0.04A	127 ± 46A	128 ± 42A	80 ± 26A	1.49 ± 1.25A	177 ± 32A
Female, nonpregnant	10	33 ± 5A	50 ± 11A	0.17 ± 0.04A	113 ± 53A	101 ± 18A	63 ± 10A	0.75 ± 0.40A	169 ± 70A
Males	7	67 ± 44B	70 ± 37A	0.42 ± 0.18B	126 ± 48A	138 ± 39A	93 ± 55A	1.55 ± 1.20A	361 ± 195B

[a] Any 2 means not sharing a common letter within a column are significantly different ($P < 0.05$) according to Duncan's Multiple Range Test. Statistical comparisons are separate for each study area.

entrance. Feces on the snow indicated they were deposited sometime in mid to late winter. Five of the 6 dens that had feces at the entrance belonged to females with newborn cubs; the 6th was from a 3-year-old female that did not produce cubs. This information is contrary to that reported by Beecham et al. (1983) and that indicated by Folk et al. (1972), who stated that bears do not urinate or defecate during the period of dormancy. We observed no evidence that body waste was eliminated during the denning period near dens containing females with yearlings or males.

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