

DENNING ECOLOGY OF BLACK BEARS IN CENTRAL ARIZONA

ALBERT L. LeCOUNT, Arizona Game and Fish Department, Phoenix, AZ 85023

Abstract: A total of 68 black bear (*Ursus americanus*) dens were located by radio-tracking 27 radio-instrumented animals from October 1974 through May 1979. Regardless of mild weather conditions and year-around availability of food, all bears denned. Duration of denning varied with sex and age class but averaged 4 to 5 months. Ninety-one percent of the dens studied were located in the Interior Chaparral vegetation type. Site selection appeared to be based on a combination of dense vegetative cover at bear height (0.3–1.8 m) and early development of spring forage. All dens were located under large rocks. Den sites appeared to be abundant, with most bears preparing numerous dens. Only 6% of our bears reused dens. Den sites of adult animals appeared to be within normal home range areas. Because of the ready availability of den sites, plans for conversion of chaparral areas to grassland should limit neither bear den sites nor bear populations.

Int. Conf. Bear Res. and Manage. 5:71–78

In Michigan, Erickson et al. (1964) determined the dates of entrance and emergence of black bears from dens, as did Denny and Gilbert (unpubl. rep., Colorado Fed. Aid Proj. W-61-R, 1952) in Colorado, Jonkel and Cowan (1971) in Montana, and Erickson (unpubl. rep., Alaska Fed. Aid Proj. W-6-R-5, 1965) in Alaska. Denning dates in these areas coincided with winter snowfall periods, and these investigators believed that denning was a mechanism enabling bears to avoid severe weather conditions and restricted food supplies. Casual observations in regions of less severe climates which indicated that bears in these areas did not den appeared to substantiate this belief (Cahalane 1943, Mathies 1972). However, recent work in areas such as Tennessee (Johnson 1978, Johnson and Pelton 1979), North Carolina (Hamilton and Marchinton 1980), Washington (Poelker and Hartwell 1973, Lindzey and Meslow 1976a, b), and California (Novick et al. 1981) has shown that bears do den in milder climates.

It is known that bears in the northern portion of Arizona, which has a climate similar to that of the northern Rocky Mountains or northeastern United States, do den (Bailey 1971). In 1973, a long-range ecological study of the black bear was begun in a central Arizona chaparral area which provided the opportunity to determine if bears den there as well (LeCount 1980). By aerial tracking of radio-instrumented bears, it was determined that bears in this area did build and occupy dens. This paper reports on denning dates, site selection, den construction, and den-related activities of bears in this central Arizona study area. In addition, the possible effects of pro-

posed conversion of chaparral to grassland on den site availability and bear populations are discussed.

I am grateful for the assistance given by J. Wegge of the Arizona Game and Fish Department on all phases of field work; W. Carrel, laboratory assistant, for electronic and aerial radio-tracking assistance; and R. Smith, Game Research Supervisor, and D. Roe, Research Branch Supervisor, for their counsel, supervision, and editorial assistance.

STUDY AREA

This study was conducted on an area of 100 km² in the vicinity of Four Peaks in the southern portion of the Mazatzal Mountains in central Arizona. Elevations within the area range from 575 to 2,300 m and topography is rocky and steep with many slopes exceeding 25°.

Annual precipitation averages about 63 cm. Summer rains (July–September) are usually in the form of thunderstorms. Winter precipitation (December–March) normally is associated with major storms of 1–3 days duration, and occasional snows seldom remain on the ground for more than a week. Average daily temperatures range from –5 C during mid-winter to over 38 C in summer. Daytime temperatures of 10–15 C are not uncommon during the winter months.

Because of elevational variation and broken topography, vegetation is diverse and interspersed. Major vegetation types include cactus (*Opuntia* spp.) areas of the Arizona Upland Desert Scrub (Brown and Lowe 1974) at the lower elevations, and the thick shrub and low tree associations of the Interior Chaparral at mid-elevational levels.

The latter type intergrades with the pine-oak woodland type of the Rocky Mountain Conifer Woodland at higher elevations, and the ponderosa pine (*Pinus ponderosa*) type of the Montane Coniferous Forest on the highest portions of the study area. Riparian areas bisect all types, with species composition varying with elevation. The primary economic land uses of the area are cattle grazing and mining, both of which are administered by the U.S. Forest Service.

METHODS

Between June 1973 and September 1978, 63 bears were captured with foot snares and immobilized with phencyclidine hydrochloride. Radio-transmitter collars were attached to 38 of these animals; 27 were subsequently radio-tracked at weekly intervals from ground and air until denning took place. Denning was recorded as the first date when weekly locations failed to change.

In January and February, den sites were located by ground radio-tracking. The exposure, elevation, slope, and vegetation type of each den site were recorded. Dens occupied by bears that did not have to be handled during the winter were measured after the bear departed. Dens occupied by bears that I handled were measured while the bear was immobilized. The height and width of the den entrance; the height, width, and length of the tunnel and cavity; and the length, width, depth, and composition of nests were recorded.

During summer 1978 and January 1979, percent vegetative cover was estimated in each of the 5 major vegetation types found on the study area at 6 different heights (0–15.2 cm, 15.2 cm–0.3 m, 0.3–0.9 m, 0.9–1.8 m, 1.8–4.5 m, more than 4.5 m). I sampled along 1,219 m of line intercept transect (Stoddart and Smith 1955) in each vegetation type. Weather records were obtained from Payson, Arizona.

RESULTS AND DISCUSSION

All radio-instrumented bears I monitored denned each fall. Between October 1974 and May 1979, 68 active dens were located; 44 were subsequently examined and measured. Twenty were used by adult males, 18 by adult females, and 6 by subadult bears.

Denning Periods

Denning by black bears has been hypothesized to be a mechanism which allows this species to survive in regions with severe winters (Denny and Gilbert, unpubl. rep., Colorado Fed. Aid Proj. W-61-R, 1952) and associated food shortages (Spencer 1955; Erickson, unpubl. rep., Alaska Fed. Aid Proj. W-6-R-5, 1965; Jonkel and Cowan 1971; Amstrup and Beecham 1976; Rogers 1976). However, this behavior also occurs in areas with mild winters and food which is available year round (Lindzey and Meslow 1976a, Johnson 1978, Johnson and Pelton 1979, Hamilton and Marchinton 1980, Novick et al. 1981). Central Arizona, where fall weather conditions are normally quite mild, is of the latter type. One or 2 major storms of 1–3 days duration moved through the study area each year between 1 October and 31 December, but all den sites were normally snow-free at the time of denning. Dens at lower elevations did not receive snow throughout the entire winter; dens at higher elevations received several light snowfalls (12–15 cm) during the winter, but snow usually melted within 2 weeks. Because of the mild weather conditions, various mast and berry crops were available through December, and green grass was available throughout the winter at lower elevations (desert scrub).

Even though weather conditions were mild, and food available each year, the onset of denning did not vary significantly between years. There was no apparent correlation between denning date and the approach of winter storms (Craighead and Craighead 1972, Novick et al. 1981), or with cooling temperatures (Lindzey and Meslow 1976a, Taylor 1971). Instead, it appeared that some other factor, such as photoperiod, endocrine function, or fat buildup (Jonkel and Cowan 1971), was responsible for this behavior.

I observed significant differences in denning dates between various sex and age groups within the population, however. Considerable overlap occurred among individuals but, as observed by other investigators, females denned slightly earlier than males ($P \leq 0.001$) (Erickson et al. 1964, Jonkel and Cowan 1971, Johnson 1978, Johnson and Pelton 1979). The average date of den entrance for all females was 10 November, and for

Table 1. Dates of den entrance and emergence of 51 black bears in the Four Peaks study area, Arizona, 1974–1979.

Age and sex (<i>N</i>)	Mean date (range)		Mean No. days denned
	Entrance	Emergence	
Adult males (17)	24 Nov (16 Oct–13 Dec)	20 Mar (20 Feb–1 Apr)	116
Subadult males (5)	24 Nov (9 Nov–8 Dec)	4 Apr (25 Mar–20 Apr)	131
Adult females (nonpregnant) (14)	11 Nov (18 Oct–13 Dec)	8 Apr (23 Mar–28 Apr)	148
Adult females (pregnant) (14)	10 Nov (22 Oct–29 Nov)	26 Apr (14 Apr–7 May)	167
Subadult female (1)	9 Nov	28 Mar	139

all males 24 November (Table 1). Pregnant females did not den earlier than nonpregnant females as reported by Craighead and Craighead (1972) for grizzly bears (*Ursus arctos*) and Novick et al. (1981) for black bears.

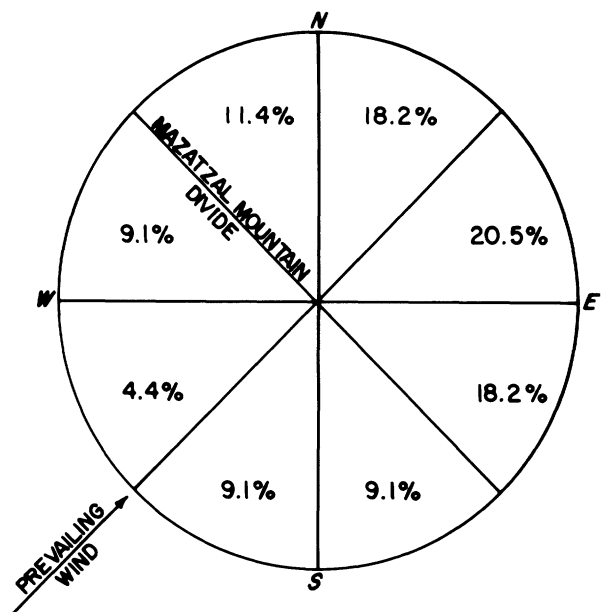
Emergence from dens, like entrance, did not vary significantly between years, but did vary between sex and age classes as observed by other investigators (Amstrup and Beecham 1976, Johnson and Pelton 1979, Novick et al. 1981, Reynolds and Beecham 1980). The average date of emergence for adult males was 20 March. Next came subadult bears (under 3 years of age) and females without cubs on 4 April. Females with cubs were the last to leave dens, not departing until 26 April (Table 1). The late emergence by females with cubs is probably related to the inability of the newborn to effectively travel with their mothers.

Adult males denned for the shortest period (116 days average) and pregnant females the longest (167 days). Nonpregnant females and subadults denned for an average of 139 days (Table 1). This 4- to 5-month period of dormancy is shorter than the 6-month duration found in Alaska (Erickson, unpubl. rep., Alaska Fed. Aid Proj. W-6-R-5, 1965), but is similar to that found in Colorado (Denny and Gilbert, unpubl. rep. Colorado Fed. Aid Proj. W-61-R, 1952), Idaho (Amstrup and Beecham 1976), Montana (Jonkel and Cowan 1971), and Washington (Lindzey and Meslow 1976a). It is, however, longer than the 3-month period found in North Carolina (Hamilton and Marchinton 1980), California (Novick et al. 1981), and Tennessee (Johnson 1978, Johnson and Pelton 1979).

Site Selection

Den site selection appears to vary considerably between geographical areas. In Washington, Lindzey and Meslow (1976b) observed black

bear dens on westerly slopes near sea level, while in California, Novick et al. (1981) found most dens on southern exposures from 1,920 to 2,469 m. Sixty-eight percent of all dens in this study were on northeast-facing slopes (Fig. 1). Elevation varied from 670 to 2,050 m, but 71% of all dens occurred between 1,200 and 1,678 m (Fig. 2). Slopes varied from 7° to 48°, with 68% of all dens located on slopes ranging from 20° to 40°. Beecham (1980) Found 52% of black bear dens in Idaho on slopes between 20° and 40°, and



NUMBER OF BEARS

Fig. 1. Percent distribution of 68 black bear dens by aspect (compass direction of slope) in the Four Peaks study area, Arizona.

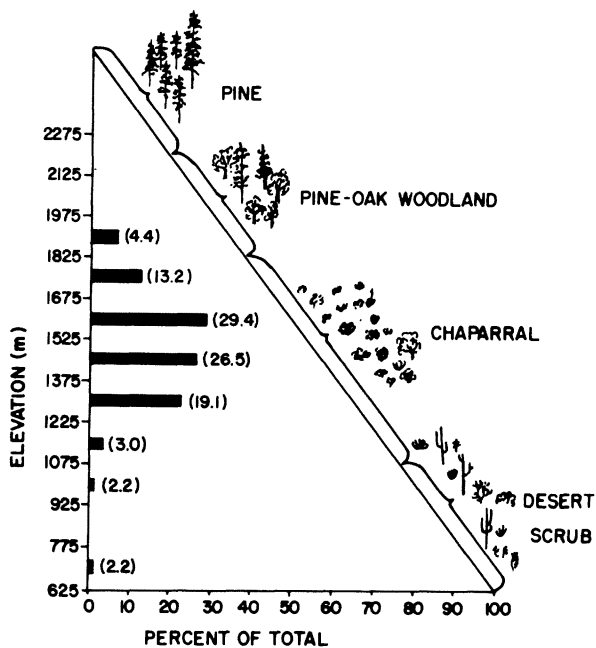


Fig. 2. Elevations of 68 black bear dens in the Four Peaks study area, Arizona.

most grizzlies denned on similar slopes (Lentfer et al. 1972, Pearson 1975,).

Bears were found denned in 3 major vegetation types: desert scrub (4.4%), Chaparral (91.2%), and the pine-oak woodland (4.4%). No dens were found in the ponderosa pine or riparian types. Lindzey and Meslow (1976b) found that various sex and age classes of bears in Washington tended to select specific vegetation types for construction of dens, with adult females selecting the most secure habitat. A similar situation appears to exist in central Arizona. Exposure, slope, and elevation of den sites varied considerably among individuals, but a definite selection was shown for the thick chaparral vegetation. Only 9% of all dens were found outside this vegetation type, and these were used by adult males.

Apparently, bears select chaparral because it has both adequate cover and reliable forage in spring. Although total canopy coverage in chaparral, pine-oak woodland, pine, and riparian areas varied little, chaparral and pine-oak woodland types had the greatest total cover at bear heights (0.3–1.8 m) (Table 2). Layering of cover in these 2 types of vegetation produced an overstory which tended to moderate the effects of wind, rain, and snow, and provided dense cover for

Table 2. Vegetative cover afforded by 5 vegetation types in the Four Peaks study area, Arizona.

Vegetation type	Percent canopy cover	
	Total	At 0.3–1.8m
Desert scrub	44.9	8.7
Chaparral	68.5	46.8
Pine-oak woodland	80.3	40.4
Ponderosa pine	76.9	8.5
Riparian	80.4	26.0

concealment of the den and protection for the bear. In pine forests or riparian areas understory cover was considerably less dense, and in desert scrub areas, all cover was appreciably lower.

The pine-oak woodland type was the only area similar to the chaparral in amount of cover (Table 2). The limited use of this type for denning may have resulted from its less abundant spring food supplies. Wegge and LeCount (unpubl. ms.) found that in the warm desert Southwest, green grass growth began on the desert during January. By March and April, grass began to become green in the Chaparral areas and spread to the pine-oak woodland and pine areas by May. A bear denned in the chaparral had abundant green grass available upon emergence from the den in late March or early April, but a bear denned in the pine-oak woodland had to travel from the den site immediately upon emergence to obtain spring forage. Longer movements would tend to increase chances for contact with other bears during the critical physiological transition period following hibernation (Nelson et al. 1973, Rogers 1974, Folk et al. 1976, Johnson and Pelton 1979).

The fact that only large adult males were found denning outside the chaparral appears to support this hypothesis. Of 26 dens, 3 were found in pine-oak woodland and 3 in desert scrub areas. According to Herrero (1978), only exceptionally large adult males are able to exploit the food resources of open habitats because their larger body size reduces the risk of predation by other species or other bears. Therefore, adult males appear to be the only animals which can den in the open desert scrub regions, or can move safely out of the pine-oak woodland areas upon emergence from the den. All other individuals appear to require the dense cover and adequate spring forage supplies near their den sites which are found in the chaparral vegetation type.

Table 3. Mean dimensions (in cm) of 44 black bear dens in the Four Peaks study area, Arizona.

Age and sex (N)	Entrance		Tunnel			Cavity			Nest			Depth of bedding ^a
	Height	Width	Height	Width	Length	Height	Width	Length	Length	Width	Depth	
Adult males (20)	56	97	46	76	234	61	104	211	99	86	28	13
Subadult males (5)	46	48	41	51	97	94	99	122	71	76	15	
Adult females (nonpregnant) (10)	41	58	41	58	86	64	89	119	76	76	20	10
Adult females (pregnant) (8)	33	66	43	48	76	56	112	149	74	66	20	13
Subadult female (1)	36	30	51	30	81	106	61	116	102	61	20	

^a Not measured for subadults.

Den Structure

Black bears den in a variety of natural sites such as hollow logs, tree cavities, holes dug into hillsides or under rocks, or under the base of stumps, trees, or logs (Erickson et al. 1964, Jonkel and Cowan 1971, Poelker and Hartwell 1973, Lindzey and Meslow 1976b, Johnson 1978, Johnson and Pelton 1979, Hamilton and Marchinton 1980, Novick et al. 1981). In addition, man-made structures such as drainage culverts, and basements or foundations of buildings have also been reported as den sites (Skinner 1925, Barnes and Bray 1966, Jonkel and Cowan 1971). Some denning bears even have reportedly been found in unsheltered depressions or brushy areas (Erickson et al. 1964, Hamilton and Marchinton 1980).

In the Four Peaks study area, all dens were found under rocks, probably because of the lack of large trees for bears to den in or under. Seventy-six percent of the dens examined were dug, with the remainder being natural cavities altered only slightly. Rocks selected for den sites varied considerably in size, but were usually large, solitary boulders. Only 7% were contained within a rockslide area. All dens, except those in rockslides, were surrounded by dense vegetation which concealed the entrance.

Den dimensions vary with the sex and age class using them, with adult males normally requiring slightly larger cavities than females and subadults (Lindzey and Meslow 1976b, Novick et al. 1981). Adult males in this study built or selected dens which had larger entrances and tunnels, and were significantly deeper, than those

used by other bears (Table 3). The deepest den found was 7 m long. Larger entrances undoubtedly allowed more heat loss than smaller, more compact dens, and it appeared that adult males constructed deeper dens to compensate for the heat lost through larger openings.

Ninety-one percent of the bears studied constructed nests within their dens (Table 3), compared with 100% in Tennessee (Johnson and Pelton 1979), 80% in Washington (Lindzey and Meslow 1976b), 39% in Michigan (Erickson et al. 1964), and 30% in Montana (Jonkel and Cowan 1971). All adult males studied constructed nests in their primary winter den, as did all females. Only 75% of subadult males constructed nest. Nests were also found in all but 2 2nd or 3rd dens used by an individual bear during a single winter. The 2 without nests were 2nd dens which nonpregnant females moved into after human disturbance. In each case, nesting material was available around the den site but was not utilized. All nests were composed of vegetative material (leaves, sticks, and grass) likely found near the den. The amount of nest material varied from a few leaves and sticks to nests with bedding 23 cm deep. Because of their larger body size, adult males constructed nests which were slightly larger than those constructed by other bears. However, no significant differences were found between the amount of nest material collected by pregnant females (Table 3) and nonpregnant females or other bears as described by Johnson and Pelton (1979) in Tennessee or Lindzey and Meslow (1976b) in Washington.

In addition to differences in den construction between various sex and age groups, there also

Table 4. Dimensions (in cm) of 5 dens prepared by 1 adult male black bear in the Four Peaks study area, Arizona, 1974–78.

Den year	Entrance		Tunnel			Cavity			Nest		
	Height	Width	Height	Width	Length	Height	Width	Length	Length	Width	Depth
1974–75	48	58	36	48	218	84	137	180	65	64	15
1975–76	84	74	41	84	610	43	155	320	106	81	10
1976–77	30	60				38	145	373	64	66	38
1977–78	46	66	31	36	215	53	104	187	71	30	86
1978–79	51	147	48	66	243	56	142	454	69	97	43

appeared to be differences between years by individual animals. Examination of multiple dens prepared by a given individual showed that construction was not consistent from 1 den to the next (Table 4). Lack of consistency suggests that den sites are perhaps selected primarily for cover and food requirements, while the extent of construction and amount of bedding are governed by such properties as rockiness or hardness of soil and availability of bedding material, as well as by the sex and age of the animal.

Movement

Bears on the Four Peaks study area have relatively small home ranges (LeCount 1980). Seasonal ranges, as described by some other investigators (Jonkel and Cowan 1971, Amstrup and Beecham 1976, Rogers 1977, Johnson and Pelton 1979, Reynolds and Beecham 1980), did not appear to exist in this area. Consequently, the only movements associated with denning were of 1 km or less into thick chaparral areas within the home ranges.

In some years, however, adult animals left the study area and traveled considerable distances (18–59 km); Rogers (1977) described similar movements in Minnesota. The reasons for these movements are unknown, but they may be related to factors other than scarcity of food in a bear's normal home range (LeCount, unpubl. rep., Arizona Fed. Aid Proj. W-78-R-23, 1979). Movement back to the normal home range, however, coincided with denning. During late summer and fall 1977, 2 adult males and 2 adult females moved from their normal home ranges. On 26 October they were located 18.0, 29.1, 44.6, and 58.7 km away from their normal home ranges in areas they had occupied throughout the fall. The next location of these animals was made on 1 November. During the elapsed 6-day interval, all 4 animals had returned to their normal home ranges and 1 male had denned. The remaining

male and 2 females were denned when next located 8 days later. In 1978, an adult male left the study area during the fall and remained away until 8 November, when he returned 32.0 km to his normal home range. Thirteen days after his return he denned. All 5 of these animals left areas where adequate den sites apparently existed, moved long distances rapidly during late October and early November, and denned quickly after their return. Such movements suggest that den sites of adult bears are usually within their normal home range.

In mild climatic regions, some bears have been observed to extend activity into February (Johnson 1978, Hamilton and Marchinton 1980) or not to den at all (Novick et al. 1981). All bears I studied denned, but some were not dormant throughout the winter. In February and early March, mid-day temperatures were often quite warm (12–15 C) and bears were frequently observed lying outside their dens. Some feeding activity was also observed and fresh scats were collected from around 2 den sites visited in February. Feeding, however, appeared to be confined to within 100 m of the den, and all bears appeared to return to their dens as daytime temperatures began to decline.

Den-Related Activities

Black bears in the Four Peaks study area apparently maintained more than 1 den. Four bears used 2 different dens, each in a single winter, without being disturbed by human activity, and 1 adult female used 6 different den over a 2-year period without using the same den twice. Reuse of dens was observed, but only 6% of all bears used an individual den more than once. Two adult females and 1 adult male each used the same den for 2 consecutive years, and another adult female returned to a previous den 2 years after first using it. All other bears used different dens each year, with some using as many as 6

different dens over a 6-year period. Only 1 bear was observed using a den previously used by another radio-instrumented bear. Low reuse of dens might reflect the high availability of desirable den sites in central Arizona. In Washington, Lindzey and Meslow (1976*b*) found that 90% of all bears studied reused dens in an area where den site availability was reduced by logging. In southern California, Novick et al. (1981) found only 13% reuse of dens in a chaparral and pine-oak woodland area where den sites were not limited. Thus, when abundant den sites are available, it appears that a bear will construct a large number of dens during its lifetime. Familiarity with several den sites has survival implications, because it allows an animal to go quickly to a former den when disturbed during the winter, thus reducing exposure time to winter weather conditions.

Bears denning in northern regions are easily aroused (Jonkel and Cowan 1971), but seem hesitant to leave their dens (Erickson et al. 1964, Beecham 1980). In less severe climatic regions, however, bears frequently abandon dens when disturbed (Poelker and Hartwell 1973, Hardy 1974, Lindzey and Meslow 1976*a*, Johnson 1978, Johnson and Pelton 1979). Thirty-six percent of all bears I disturbed in dens moved to a new den after disturbance. Females (40%) tended to abandon dens more readily than males (29%).

Lundberg et al. (1976) reported that frequent disturbances, which interrupted the transition into hibernation, caused bears to die of starvation and urea poisoning. All of the bears I disturbed during early hibernation emerged from their 2nd den at the appropriate time in the spring. However, no dens were visited, or animals disturbed, until the bear had denned for 30 days or more. Therefore, hibernation transition might have already taken place.

Bears in dens are vulnerable to attack by predators or other bears (Lindzey and Meslow 1976*a*, Rogers 1977). Hunters in some areas also take a significant number of bears in dens. Erickson et al. (1964) found that 37% of the November bear harvest in Michigan consisted of bears taken in winter dens. Only 2 instances of den-related mortality were recorded during my study. One subadult male, which had a head injury inflicted by another bear during the summer, was found dead in his den the following spring.

Cause of death appeared to be a severe infection of the sinus cavities resulting from the injury. Another bear was discovered in a den and killed by a deer hunter in early December.

MANAGEMENT CONSIDERATIONS

Black bears in the Four Peaks study area appear to prefer areas within the chaparral vegetation type for denning. These areas are characterized by adequate cover plus abundant spring forage supplies. Desert scrub at lower elevations than the chaparral produce spring grasses, but cover is limited, whereas pine-oak woodland areas higher than the chaparral provided cover but lack early spring grasses. I have delineated slightly over 5,180 km² of chaparral in central Arizona as being similar to the study area. Therefore, it appears that at present denning habitat is not a limiting factor on black bear populations in central Arizona.

Plans are currently being drafted by the U.S. Forest Service for conversion of some chaparral areas to grassland to obtain increased water yield (Hibbert et al. 1974). At present, approximately 10% of the central Arizona chaparral appears to be suitable for treatment. The remaining 90% was deemed to be too steep, to have too low a vegetative cover to be economically treated, or to be subject to excessive erosion after treatment (Brown et al. 1974). With the abundance of den sites available in the chaparral and the flexibility demonstrated by bears in the selection of dens, it is doubtful if such a treatment would limit den sites or reduce bear populations. However, as water demands for Arizona's growing human population increase, areas now deemed unsuitable for treatment might be reconsidered. If this were done, maintenance of adequate bear denning habitat should be considered in any long-range chaparral conversion treatment program to ensure that den site availability would not become a limiting factor.

LITERATURE CITED

- AMSTRUP, S.C., AND J. BEECHAM. 1976. Activity patterns of radio-collared black bears in Idaho. *J. Wildl. Manage.* 40:340-348.
- BAILEY, V. 1971. *Mammals of the southwestern United States (with special reference to New Mexico)*. Dover Publications, Inc., New York, N. Y. 412pp.

- BARNES, V.G., JR., AND O.E. BRAY. 1966. Black bears use drainage culverts for winter dens. *J. Mammal.* 47:712–713.
- BEECHAM, J.J. 1980. Population characteristics, denning, and growth patterns of black bears in Idaho. Ph.D. Thesis. Univ. Montana, Missoula. 132pp.
- BROWN, D.E., AND C.H. LOWE. 1974. The Arizona system for natural and potential vegetation—illustrated summary through the fifth digit for the North American Southwest. *Arizona Acad. Sci.* 9, Suppl. 3. 56pp.
- BROWN, T.C., P.F. O'CONNELL, AND A.R. HIBBERT. 1974. Chaparral conversion potential in Arizona. Part II: an economic analysis. U.S. Dep. Agric. For. Serv. Res. Pap. RM-127. 28pp.
- CAHALANE, V.H. 1943. Meeting the mammals. Macmillan Co., New York, N.Y. 133pp.
- CRAIGHEAD, F.C., JR., AND J.J. CRAIGHEAD. 1972. Grizzly bear prehibernation and denning activities as determined by radiotracking. *Wildl. Monogr.* 32. 35pp.
- ERICKSON, A.W., J. NELLOR, AND G.A. PETRIDES. 1964. The black bear in Michigan. *Michigan State Univ. Agric. Exp. Stn. Res. Bull.* 4. 102pp.
- FOLK, G.E., JR., A. LARSON, AND M.A. FOLK. 1976. Physiology of hibernating bears. *Int. Conf. Bear Res. and Manage.* 3:373–380.
- HAMILTON, R.J., AND R.L. MARCHINTON. 1980. Denning and related activities of black bears in the coastal plain of North Carolina. *Int. Conf. Bear Res. and Manage.* 4:121–126.
- HARDY, D.M. 1974. Habitat requirements of the black bear in Dare County, North Carolina. M.S. Thesis. Virginia Polytechnic Inst., Blacksburg. 121pp.
- HERRERO, S. 1978. A comparison of some features of the evolution, ecology, and behavior of black bears and grizzly/brown bears. *Carnivore* 1(1):7–17.
- HIBBERT, A.R., E.A. DAVIS, AND D.G. SCHOLL. 1974. Chaparral conversion potential in Arizona. Part I: water yield response and effects on other resources. U.S. Dep. Agric. For. Serv. Res. Pap. RM-126. 36pp.
- JOHNSON, K.G. 1978. Den ecology of black bears (*Ursus americanus*) in the Great Smoky Mountains National Park. M.S. Thesis. Univ. Tennessee, Knoxville. 107pp.
- _____, AND M.R. PELTON. 1979. Denning behavior of black bears in the Great Smoky Mountains National Park. *Proc. Southeast Assoc. Fish and Wildl. Agencies* 33:239–249.
- JONKEL, C.J., AND I.McT. COWAN. 1971. The black bear in the spruce-fir forest. *Wildl. Monogr.* 27. 57pp.
- LECOUNT, A.L. 1977. Some aspects of black bear ecology in the Arizona chaparral. *Int. Conf. Bear Res. and Manage.* 4:175–179.
- LENTFER, J.W., R.J. HENSEL, L.H. MILLER, L.P. GLENN, AND V.D. BERNIS. 1972. Remarks on denning habits of Alaska brown bears. *Int. Conf. Bear Res. and Manage.* 2:125–132.
- LINDZEY, F.G., AND E.C. MESLOW. 1976a. Winter dormancy in black bears in southwestern Washington. *J. Wildl. Manage.* 40:408–415.
- _____, AND _____. 1976b. Characteristics of black bear dens on Long Island, Washington. *Northwest Sci.* 50:236–242.
- LUNDBERG, D.A., R.A. NELSON, H.W. WAHNER, AND J.D. JUNES. 1976. Protein metabolism in the black bear before and during hibernation. *Mayo Clinic Proc.* 51:716–722.
- MATHIES, J. 1972. Discussion. *Proc. East. Workshop Black Bear Manage. and Res.* 1:30.
- NELSON, R.A., H.W. WAHNER, J.D. JONES, R.D. ELLEFSON, AND P.E. ZOLLMON. 1973. Metabolism of bears before, during, and after winter sleep. *Am. J. Physiol.* 224:491–496.
- NOVICK, H.J., J.M. SIPERK, AND G.R. STEWART. 1981. Denning characteristics of eight black bears, *Ursus americanus*, in the San Bernardino Mountains of southern California. *Calif. Fish and Game* 67:52–61.
- PEARSON, A.M. 1975. The northern interior grizzly bear *Ursus arctos* L. *Can. Wildl. Serv. Rep. Ser.* 34. 86pp.
- POELKER, R.J., AND H.D. HARTWELL. 1973. Black bear of Washington. *Washington State Game Dep. Biol. Bull.* 14. 180pp.
- REYNOLDS, D.G., AND J.J. BEECHAM. 1980. Home range activities and reproduction of black bears in west-central Idaho. *Int. Conf. Bear Res. and Manage.* 4:181–190.
- ROGERS, L.L. 1974. Shedding of foot pads by black bears during denning. *J. Mammal.* 55:672–674.
- _____. 1976. Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. *Trans. North Am. Wildl. and Nat. Resour. Conf.* 41:431–438.
- _____. 1977. Social relationships, movements, and population dynamics of black bears in northeastern Minnesota. Ph.D. Thesis. Univ. Minnesota, Minneapolis. 203pp.
- SKINNER, M.D. 1925. Bears in Yellowstone. A.C. McClurg and Co., Chicago, Ill. 158pp.
- SPENCER, H.E., JR. 1955. The black bear and its status in Maine. *Maine Dep. Inland Fisheries and Game, Game Div. Bull.* 4. 55pp.
- STODDART, L.D., AND A.D. SMITH. 1955. Range management. McGraw-Hill Book Co., Inc., New York, N.Y. 433pp.
- TAYLOR, D.F. 1971. A radio-telemetry study of the black bear (*Euarctos americanus*) with notes on its history and present status in Louisiana. M.S. Thesis. Louisiana State Univ., Baton Rouge. 87pp.