

# ACTIVITY AND BEHAVIOR OF DENNED BLACK BEARS IN THE LOWER MISSISSIPPI RIVER VALLEY

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**Abstract:** From 1979 to 1982, dormancy behaviors of black bears (*Ursus americanus*) were studied in a bottomland hardwood forest in Arkansas, an area with relatively mild winters. Mean activity level of radio-collared bears declined from 53% to 29% between mid-October and early December, before the denning period began. In 40 of 42 (95%) cases, bears denned for extended periods, ranging from 37 to 141 days. The transition to dormancy began before den entry, and a shift in behavior toward activity commenced before den emergence. Mean level of activity of denned bears (5.5%) was significantly lower than that of bears before denning (37%) and following den emergence (34%). Most activities of denned bears were momentary movements. Activity bouts occurred at a mean rate of 1.8/hour, but short bouts often appeared in series and probably were parts of longer activity periods. Most bears observed in dens were in a hibernating posture and did not react to my presence. Nine of 14 cases of den abandonment were attributed to research activities, 4 to flooding, and 1 case was unexplained. The likelihood of den abandonment was related to the timing of disturbances in relation to den entry and to den type. Dormancy behaviors of black bears in Arkansas are similar to those reported in other portions of the species' range. Differential denning chronology and probability of den abandonment between geographic regions may be explained by phenological development and exposure of denned bears, respectively.

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Casual observations of winter activity by black bears in mild climates have often led to the notion that the degree of dormancy in this species follows an environmental gradient and that bears in the southern portions of the species' range experience a milder state of dormancy than those in northern regions. Early understanding of dormancy in black bears was based on incidental observations of winter sign and occupied dens (Aldous 1937; Morse 1937; Matson 1946, 1954). Later, data from harvest and tagging studies (Spencer 1955; Rausch 1961; Erickson 1964, 1965; Jonkel and Cowan 1971) permitted broad interpretations of dormancy, but only in recent years, through radiotelemetry techniques (Taylor 1971; Lindzey and Meslow 1976a, 1976b; Hamilton and Marchinton 1980; Johnson and Pelton 1980, 1981; Tietje and Ruff 1980; Novick et al. 1981; Beecham et al. 1983; LeCount 1983; O'Pezio et al. 1983) have many dormancy behaviors been described and comparative data on the denning ecology of black bears in a variety of habitats become available. Concomitantly, laboratory investigations of captive bears (Nelson et al. 1973, 1984; Folk et al. 1976; Lundberg et al. 1976; Nelson and Beck 1984) have contributed substantially to the understanding of hibernation physiology in bears and of dormancy behaviors observed in natural environments.

Although denning behaviors such as denning chronology, den selection, and responses to den disturbance may vary between individuals and years in a given population, data from telemetry studies clearly

demonstrate that the length of the dormant period increases with the length and, possibly, the severity of winters. Black bears living in mild climates may be active into midwinter (Beeman 1975, Hamilton and Marchinton 1980, Johnson and Pelton 1980) or, occasionally, not den at all (Novick et al. 1981, Carney and Vaughan 1984); they also appear to readily abandon dens when disturbed (LeCount 1983). In Arizona, black bears were observed loafing and feeding outside their dens in late February (LeCount 1983), and Taylor (1971) reported that black bears in Louisiana intermittently left and returned to dens during dormancy.

The correlation between climatic conditions and denning chronology and observations of midwinter activity and den abandonment in mild climates have led some to the notion that the degree of dormancy in black bears follows an environmental gradient. Statements or implications that black bears living in relatively warm, southern portions of their range experience a milder state of dormancy than those in colder, northern regions or do not become dormant at all frequently appear in the popular literature (Walker et al. 1964, Duffy 1971, Lowery 1974, Willey 1978, Sealander 1979, Schwartz and Schwartz 1981). Such deductions appear to be more intuitively than empirically based, however. Quantitative data on the activity and physiology of denned black bears, parameters that probably are better indices of dormancy than denning chronology and responses to disturbance, are limited. Activity patterns of radio-instrumented black bears were monitored through the denning period in Tennessee (Johnson and Pelton 1979) and North Carolina (Hamilton and Marchinton 1980), but neither study specifically addressed

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activity levels of denned bears. Craighead et al. (1971) used radiotelemetry to monitor the rectal temperature of an undisturbed black bear in Yellowstone National Park, and Beecham et al. (1983) reported on respiratory rate, heart rate, and rectal temperature of black bears immobilized in dens in Idaho.

I present data on the activity level of undisturbed, denned black bears and their responses to research activities in eastern Arkansas, an area with relatively mild winters, and discuss the relevance of these observations to the concept of geographic variation in the degree of dormancy in black bears.

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#### STUDY AREA

The study was conducted on the White River National Wildlife Refuge (Refuge) in eastern Arkansas. The Refuge encompasses 46,000 ha and extends for 87 km along the lower White River to within 10 km of its confluence with the Mississippi River. Topography of the area is flat; elevations of the Refuge range from 41 to 49 m. Overflows of the White and Mississippi rivers typically inundate as much as 85% of the Refuge for 2–4 months in late winter and spring.

The Refuge lies within 1 of the few large tracts of bottomland hardwood forest remaining in the Lower Mississippi River Valley. Interspersed within the 39,000 ha of forest on the Refuge are 4,000–6,000 ha of lakes, baldcypress (*Taxodium distichum*) swamps, beaver (*Castor canadensis*) impoundments, sloughs, and seasonal streams.

Hot humid summers, mild winters, and abundant rainfall characterize the area's climate. Temperatures range from a winter mean of 7.8°C to a summer mean of 26.1°C. Annual precipitation averages 128 cm; June–October is relatively dry, and November–May relatively wet. Snow accumulation is uncommon, rarely exceeding 15–20 cm or persisting for more than a few days.

#### METHODS

Bears were captured in modified Aldrich foot snares set in cubbies and immobilized with Etorphine (M-99) or a ketamine-rompun compound. Between

July 1979 and August 1981, 28 bears were fitted with radiotransmitters affixed to collars (Telonics, Inc., Mesa, Ariz.). Radio-collared bears were located by air (80%) and ground-tracking; observers used a portable receiver and 2- or 3-element directional antennas. Individual bears were located at a mean interval of 5.2 days outside the denning period. Date of den entry was designated as the median date between the 1st of 2 consecutive locations at a den site and the last location preceding it. Similarly, date of den emergence was defined as the median date between the last location at a den site and the 1st location away from it. The mean error for dates of den entry and emergence was 2.2 days and 2.3 days, respectively.

Locations of denned bears were verified at irregular intervals, generally every 7–10 days, by radiotelemetry at a short distance (<200 m) from the den. During January and February I frequently inspected dens of females (all elevated tree cavities) to determine whelping dates. During these inspections, I climbed the den tree, directed a flashlight beam into the den cavity, lowered a microphone to within 2 m of the bear, and recorded vocalizations for 15 minutes. Except for 1 adult male, which we immobilized to remove his radiocollar, we did not handle bears in dens.

Radiotransmitters were equipped with a motion sensor with a 2-min reset mechanism. Activity (i.e., body movement) of radio-collared bears was detected by a change in the radio signal mode from a base (Inactive) rate of approximately 70 pulses per minute (PPM) to an alternate (Active) rate of approximately 100 PPM. Subsequent movement within a 2-min period caused the motion sensor to reset in the Active mode without interruption; if no movement occurred within 2 min, the signal returned to the Inactive mode.

Activity of radio-collared bears was monitored by 2 methods: continuous monitoring, in which all changes in radio signal mode from 1 bear were recorded over periods of varying length, and hourly monitoring, in which activity of several bears was recorded at hourly intervals over a 24-hour period. Continuous monitoring was conducted from the ground in the immediate vicinity (25–200 m) of the den. Hourly monitoring was conducted from an elevated (13-m) platform equipped with an 11-element directional antenna mounted on a rotating mast that extended 14 m above the platform.

Level (percentage) of activity during continuous monitoring was based on the proportion of the total

monitoring time that the radio signal remained in the Active mode. Two minutes were subtracted for each activity bout to account for the reset interval of the motion sensor mechanism. Activity bouts in progress at the beginning or end of continuous monitoring sessions were included in calculations of percentage activity but excluded from analyses of length of activity bouts.

For hourly monitoring, activity was determined from the sequence of radio signal modes received at each hourly sampling moment. If the Inactive mode was initially heard, the bear was considered inactive because at least 2 min had passed without a body movement. If the Active mode was initially heard, a 2nd check of the signal was made 2–5 min later. If the Active mode was heard at that time, the bear was considered active; if the mode had changed to Inactive, the bears was considered inactive by the reasoning given above. Percentage activity during hourly monitoring was based on the proportion of hourly samples in which the bear was Active. The *t*-test was used to determine statistical significance in all comparisons.

## RESULTS AND DISCUSSION

Movements of radio-collared bears were monitored through 42 bear-winters: 5 in the winter of 1979–80, 19 in 1980–81, and 18 in 1981–82. Sex and age samples included 2 yearling males, 4 subadult (2–3 years old) males, 15 adult males, 2 subadult females, 2 barren adult females, 9 pregnant females, and 5 females with yearlings. In 40 (95%) cases bears entered dens. Den entry occurred between 9 December and 28 February and emergence between 1 March and 1 May. Mean length of the denning period was 90 days, ranging from 37 to 141 days (Smith 1985:103–06).

### Activity Level of Denning Bears

On 10 occasions between 14 October 1980 and 16 April 1981, I monitored activities of radio-collared bears ( $\bar{x} = 10$ , range 3–15) at hourly intervals over a 24-hour period. During the 1st 4 sessions, which preceded initiation of the denning period, mean percentage activity declined from 53% to 29% (Fig. 1). After the bears entered dens, their level of activity fell sharply. Mean percentage activity of denned bears (5.5%,  $N = 48$ ) was significantly lower than that of bears before denning (37%,  $N = 30$ ) and following den emergence (34%,  $N = 9$ ) ( $P < 0.001$ ). Variation in the activity level of denned bears was not attrib-

utable to age, sex, or reproductive condition. There was no significant difference between the mean percentage activity of males (3.8%,  $N = 19$ ) and females (5.7%,  $N = 29$ ), adults (5.1%,  $N = 36$ ), and subadults (5.8%,  $N = 12$ ), or pregnant (6.1%,  $N = 14$ ) and barren (5.4%,  $N = 15$ ) females ( $P > 0.1$ ).

During January and February 1980, I conducted 11 continuous-monitoring sessions of activity of bears in tree dens. Monitoring periods ranged from 2.4 to 14.5 hours ( $\bar{x} = 4.4$  hrs), and 4 individuals (2 adult males, 1 2-year-old male, and 1 female with a yearling) were represented in the sample (Table 1). Percentage activity for all continuous monitoring ( $N = 48.8$  hrs) was 13.8%. The level of activity of individual bears varied considerably between monitoring sessions and apparently was not related to age or sex. Percentage activity was 17.2% ( $N = 10.3$  hrs) for the 2-year-old male, 11.2% ( $N = 17.7$  hrs) for adult males, and 14.4% ( $N = 20.8$  hrs) for the female with a yearling.

The difference between mean level of activity in continuous monitoring and that in hourly monitoring may be explained by procedural biases in interpreting radio signal modes. In continuous monitoring, there is a bias toward activity because all receptions of signals in the Active mode are recorded as activity, and momentary (i.e.,  $< 1$  min) body movements are classified as 1-min activity bouts. In contrast, hourly monitoring is biased toward inactivity because isolated, momentary body movements generally are not interpreted as activity; if the radio signal changes from the Active to the Inactive mode during a sampling moment (2–5 min), the Active mode is ignored, and the bear is considered inactive. The actual mean

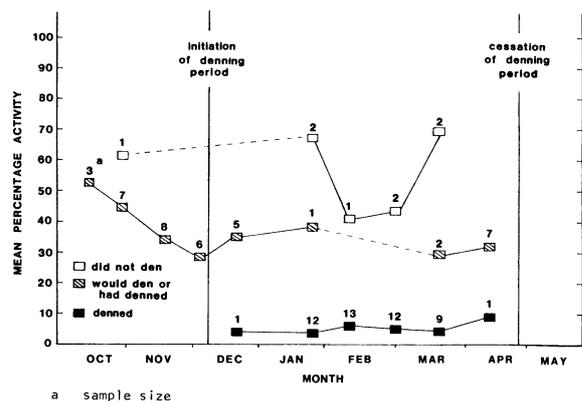


Fig. 1. Mean percentage activity of radio-collared black bears determined by hourly monitoring of activity over 24-hour periods, White River National Wildlife Refuge, Arkansas, 1980–81.

Table 1. Activity of denned radio-collared black bears during continuous activity-monitoring sessions, White River National Wildlife Refuge, Arkansas, Jan–Feb 1980.

Bear	Sex	Age	Time monitored (hrs)	Percentage activity	Activity bouts			
					<i>N</i>	Rate (no./hr)	$\bar{x}$ length (min)	$\bar{x}$ interval between bouts (min)
407	M	adult	12.8	13.2	14	1.1	7.2	31.5
411	M	adult	4.9	6.1	13	2.6	1.4	16.2
412	M	subadult	10.3	17.2	19	1.9	6.1	21.4
415	F	adult <sup>a</sup>	20.8	14.4	42	2.0	4.2	19.7
Totals								
$\bar{x}$				13.8		1.8		20.9
<i>N</i>			48.8		88			77

<sup>a</sup> Accompanied by 1 yearling.

percentage activity of denned bears in my study probably was between these estimates of 5.5% and 13.8%.

In Tennessee, activity levels of radio-collared bears between 1 January and 1 April, when most bears were denned, ranged from approximately 5% to 20% (Johnson and Pelton 1979). In coastal North Carolina (Hamilton and Marchinton 1980), monthly mean percentage activity of denned bears, whose behaviors apparently were not affected by research activities, ranged from 0% to about 15%. These data indicate that there is little difference between the level of activity of denned bears in Arkansas, North Carolina, and Tennessee. Winter climates in these areas are relatively similar, however, and presently there are no available data for comparing activity levels of bears in these mild climates with those of bears denning under more severe winter conditions.

Activity bouts of denned bears occurred at an overall rate of 1.8/hour, ranging from 1.1 to 2.6/hour for individual bears (Table 1). The mean length of activity bouts was 4.7 min ( $N = 88$ , range 1–57 min); however, most bouts were shorter. The modal length of activity bouts was 1 min, and the median length was 2 minutes. Thus, most activity of denned bears was momentary movements, possibly comfort shifts. These movements often occurred in a series and appeared to be parts of longer activity periods. Occasionally, extended periods of activity (17–57 min) were noted, but no movement from tree den cavities was observed or detected by radiotelemetry during continuous monitoring.

These findings may be relevant to the question of how dormant bears avoid problems with calcium metabolism and muscle atrophy. Physiologists (Folk et al. 1976, Nelson and Beck 1984) have been interested in this phenomenon for years, largely because of in-

cidental observations of captive, hibernating bears, which appeared not to change positions for several weeks or months. The level and frequency of activity exhibited by denned black bears in Arkansas suggest that dormant black bears may be considerably more active inside their dens than previously assumed.

#### Transition To and From Dormancy

Data from hourly activity monitoring demonstrated that the activity level of radio-collared bears was significantly reduced while they were denned, but the interval between these monitoring sessions ( $\bar{x} = 21$  days) was too long to determine how quickly transitions to and from dormancy occurred. Incidental field observations indicated, however, that these transitions occur gradually.

In mid-December 1981, I observed a pregnant female bedded on the ground 125 m from a den tree that she entered 5–6 days later. From a distance of approximately 50 m, she sensed me, slowly raised her head and shoulders, and then lethargically dropped her body. In early December, a female periodically climbed from the floor of her 9-m-deep tree den cavity to lay at its entrance. I also observed freshly worn areas on limbs or forks of 10 other den trees during initial den inspections, indicating that bears commonly moved in and out of tree den cavities early in the denning period.

Late in the denning period, I commonly ( $N = 7$ ) observed bears lying or walking on limbs outside their tree den cavities. I also disturbed 2 females from ground beds near ( $\leq 25$  m) their den trees late in the denning period; in both cases, the bear returned to its tree den and remained there for 2 weeks before permanently leaving the den site. During the last

week of denning, I found fresh scats or beds under 4 occupied den trees, indicating that activity of these bears increased before den emergence.

Apparently, black bears experience a gradual transition to and from dormancy throughout their range. Steady declines in activity before den entry and increases in activity after den emergence were observed in Idaho (Beecham et al. 1983), North Carolina (Hamilton and Marchinton 1980), Tennessee (Johnson and Pelton 1979), and Washington (Lindzey and Meslow 1976a). In Tennessee, bears began to decrease activity as much as 1 month before denning; before emerging from dens, the frequency of their head movements slowly increased. In Idaho, Beecham et al. (1983) observed marked lethargic behavior by black bears in the vicinity of their dens approximately 1 week before den entry; they also reported that bears continued to exhibit activity after entering dens and that the metabolic shift was reversed before den emergence. LeCount (1983) reported that black bears in Arizona began to emerge from their dens and exhibit limited activity on a daily basis late in the denning period. In Montana, Jonkel and Cowan (1971) noticed a marked behavioral change toward activity in black bears before den emergence. Thus, available data uniformly support the conclusions of Nelson and Beck (1984) that hibernation, a physiological condition, and denning, a behavioral adaptation, are not synonymous and that the metabolic state of hibernation gradually begins before the denning period and is not fully reversed until after den emergence.

#### Responses of Denning Bears to Research Disturbances

Occupants of 19 tree dens were visible from the cavity entrance. Of these, 15 (79%) were lying in a curled position, and 4 were sitting on their haunches. Most (68%) denning bears did not react when I directed a flashlight beam on them from the cavity entrance; 2 of those observed in a hibernating posture and all 4 of those on their haunches lethargically raised their heads at my presence. No bears exhibited agonistic behavior during den inspections. Nine bears abandoned their dens following research activities such as climbing den trees or closely approaching ground dens. Four bears abandoned dens that were flooded; 1 case of den abandonment was unexplained.

The probability of den abandonment following research activities was related to the proximity of the

disturbance to the time of den entry and to den type. Six of 9 (67%) females abandoned their elevated tree dens when the dens were inspected  $\leq 2$  weeks after den entry; when inspections were withheld until  $\geq 4$  weeks after den entry ( $N = 12$ ), no abandonment occurred. All inspections ( $N = 7$ ) of tree dens occupied by radio-collared males were made at least 4 weeks following den entry, and in only 1 case (a bear immobilized and handled in his den) did abandonment occur. Bears denning on the ground (only males) appeared to be more susceptible to disturbance than those denning in elevated tree cavities. Two radio-collared males abandoned ground dens (nestlike structures in forest gaps) when I inadvertently approached to within 25 m of them. When I maintained a distance of 50–100 m during locations of ground dens ( $N = 6$ ), no abandonment occurred. In contrast, all tree dens were approached to their base several times during the denning period, but this procedure alone was never followed by den abandonment. In all cases of den abandonment, the bear entered an alternate den within 2 days and remained there until spring. Bears that abandoned dens following research disturbances did not appear to be adversely affected. No deaths occurred following den abandonment, and 4 of 6 adult females disturbed from initial dens subsequently whelped cubs in alternate dens.

In Idaho, Beecham et al. (1983) found that the likelihood of den abandonment following research disturbances was inversely related to the length of time that the bear had been denning; 58% of the black bears that they disturbed (i.e., immobilized and handled)  $< 1$  week after entry abandoned their dens, whereas only 2 ( $N$  not given) did so after being denning for several weeks. Black bears in Alberta (Tietje and Ruff 1980) and brown bears in Alaska (Reynolds et al. 1976) were most likely to abandon dens when disturbed during or shortly after den construction. Tietje and Ruff (1980) believed that the disproportionately high percentage of abandonment by females in their study area probably was due to relatively early inspections of female's dens; they also found that abandonment was more likely following immobilization and handling (17%) than after approaches outside dens to observe behavior (6%).

In Tennessee, black bears occupying ground dens were more easily aroused (Johnson and Pelton 1979) and likely to abandon dens (Pelton et al. 1980) than those denning in elevated tree cavities. Hamilton and Marchinton (1980) reported that all of their attempts to observe bears in open ground dens (nests) in North

Carolina resulted in den abandonment. Black bears also are easily disturbed from open ground nests in swamps in Virginia (M. Vaughan, pers. commun.) and Florida (J. Mykytka, pers. commun.).

I believe that the high incidence of abandonment by black bears in open (ground) dens, compared to (secluded) tree cavities in the southeastern United States indicates that concealment, in addition to the timing and type of disturbance, largely affects the probability of den abandonment. Because these 3 factors have not been consistent in denning studies, the comparative value of existing data on den abandonment from different geographic regions is limited.

## CONCLUSIONS

Dormancy behaviors of black bears in Arkansas are similar to those reported for this species in other portions of its range. Most bears entered dens. Those that denned exhibited depressed levels of activity, lethargic behavior, and when not disturbed by researchers, strong fidelity to dens. Outside of the very early and late stages of the denning period, bears did not leave and return to dens. If disturbed, bears moved to alternate dens, where they remained until spring.

Differences in denning chronology of black bears between geographic regions may be explained by phenological development and food availability (Erickson and Youatt 1961, Jonkel and Cowan 1971, Johnson and Pelton 1980, Beecham et al. 1981, O'Pezio et al. 1983) and appear to be only indirectly related to the length and severity of winters. Mid-winter activity and the relatively high frequency of den abandonment by black bears in mild climates may be related to the exposure of dens. In northern regions, black bear dens often are concealed by snow cover, which provides insulation from disturbances as well as severe weather. If disturbed, however, bears frequently abandon these dens. In southern regions, where snow accumulation is rare and dens often are exposed, ground-level structures, bears are easily aroused and readily abandon dens.

My observations in Arkansas support the conclusions of Johnson and Pelton (1980) that casual observations of winter activity in mild climates have biased conclusions regarding dormancy behavior of black bears in southern portions of their range and that the degree of dormancy in this species probably does not vary substantially between geographic regions and climates. Furthermore, the anorexic con-

dition of hibernating black bears, which do not eat, drink, urinate, or defecate (Nelson and Beck 1984), intuitively appears to be an all-or-none situation that is not readily and intermittently attained in response to fluctuating weather.

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