Activities of Black Bears in Cherokee National Forest, Tennessee

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Abstract: Radio-collars equipped with activity monitors were attached to 18 black bears (*Ursus americanus*) in Cherokee National Forest, Tennessee. Bears exhibited a crepuscular pattern of activity that varied seasonally. Activity levels were low after bears emerged from dens, escalated rapidly in June and July, reached a peak in August, and diminished gradually until denning. Activities of bears were affected by individual differences among bears, weather factors, and denning. Sex, age, and reproductive classes also affected activity patterns. Adult male bears were the most active group, whereas females with cubs were the least active, although seasonal variation in activity patterns among different age and reproductive classes was evident. The pattern of activity for bears suggested that breeding may occur in early August.

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Conflicting patterns of black bear activity behavior have been reported in the literature. The influences of habitat, human-related activities, food availability and distribution, environmental factors, time of year, time of day, and method of observation or interpretation contribute to the variation reported (Poelker and Hartwell 1973, Amstrup and Beecham 1976, Matula 1976, Rogers 1977, Hamilton 1978, Garshelis and Pelton 1980). Seasonal variation in bear activities also are influenced by differences in age, sex, and reproductive condition (Knudsen 1961, Barnes 1967, Hardy 1974, Alt et al. 1976, Lindzey and Meslow 1977, Garshelis 1978, Brown 1980, Quigley 1982, Villarrubia 1982).

Direct observation of a few easily-visible black bears biased the early interpretation of activity behavior of the species (Barnes and Bray 1967). More recent studies of bear activity have relied primarily on radio-telemetry

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(Beeman 1975, Amstrup and Beecham 1976, Lindzey and Meslow 1976, Garshelis and Pelton 1980). Furthermore, interpretation of bear activity has been enhanced via the use of specialized activity-sensing monitors incorporated into the transmitter of the radio-collar (Garshelis and Pelton 1980). The present study delineates the activity patterns of black bears in Cherokee National Forest (CNF), Tennessee, using the above activity monitors.

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Methods

Research was conducted on a 760-km^2 area in the Tellico Ranger District of CNF (4,905 km^2) roughly bordered by the North Carolina-Tennessee state line, the new Tellico-Robbinsville Road, the Tellico River, and the Little Tennessee River. High, narrow ridge crests and steep, rugged mountains dissected by narrow meandering streams characterize the area. Descriptions of the area are detailed in Belden (1972), Strickland (1972), Villarrubia (1982), and Garris (1983).

Bears were captured in Aldrich spring-activated foot snares (Johnson and Pelton 1980) and immobilized with intramuscular injections of M-99 (Etorphine hydrochloride) (Garris 1983). Each bear was weighed, measured (Cherry and Pelton 1976), sexed, examined for ectoparasites, and reproductive condition determined (Eiler 1981, Wathen 1983). The first premolar was extracted, prepared (Eagle and Pelton 1978), and age determined by the cementum-annuli technique (Willey 1974).

Selected bears were fitted with radio-collars (Telonics, Mesa, Ariz.). Breakaway collars, designed to fall off in 12 to 16 months, were placed on younger and smaller bears. To monitor activity, all transmitters were equipped with a reset motion sensor. Movements by the animal caused these motion-sensitive transmitters to activate a rapid transmission mode (approximately 100 beeps per minute [bpm]). After the cessation of movements and the elapse of a 5-minute reset period, the transmission mode reverted to a slower pulse rate (approximately 75 bpm).

Activity transmissions were recorded via ground tracking during random 24-hour diels. In the field, an animal was noted as active or inactive depending on the transmission rate. However, the programmed timing mechanism of the reset motion sensor may overestimate the active behavior of bears (Quigley et al. 1979). A notation system to compensate for this overestimation of activity was used (Quigley et al. 1979, Quigley 1982, Villarrubia 1982).

Ground and weather conditions were recorded with each activity reading. Time of year was categorized by season, time of day was divided into hours, cloud cover assessed as percent coverage, and temperature delineated in 3° C increments. Ground conditions were classified as wet or dry, while precipitation was noted as none, drizzle, rain, sleet, or snow.

The least-square analysis of variance procedure was used to investigate relationships between activity and environmental factors, reproductive associations, time of day, and time of year. Using the above procedure, activity is designated as the probability of being active under the stated conditions rather than as an actual percentage (Garshelis and Pelton 1980). Statistical significance was determined with the analysis of variance and Student's *t*-test.

Results and Discussion

A total of 5,745 activity readings from 18 different bears was used in the analysis of activity patterns. During 1980, activity readings were obtained from 1 subadult male, 4 adult males, 3 estrous females, 3 subadult females, and 3 females with cubs. In 1981, 6 adult males, 2 yearling females, 4 estrous females, and 1 female with cubs were monitored.

The activities of bears in CNF (1980–1981) were significantly ($P < 0.05$) affected by time of year (month), time of day (hour), season (summer-fall), and the individual behavioral differences among bears (bear) (Table 1). Similar results were reported for bears in Great Smoky Mountains National Park (GSMNP) (Garshelis and Pelton 1980, Quigley 1982) and in CNF (Villarrubia 1982). Inconsistencies in activity among bears were attributed to differences in sex, age, and family associations, as well as individual peculiarities (Garshelis and Pelton 1980, Quigley 1982, Villarrubia 1982).

Bears were less active in early spring and late fall than any other time of the year (Fig. 1). During June and July, activity escalated rapidly, reaching a peak in early August (1 Aug–14 Aug). The level of activity then gradually diminished until denning occurred in December or early January.

Table 1. Analysis of variation in the activities of bears in Cherokee National Forest, Tennessee, 1980–1981, with respect to time of year (month), time of day (hour), season (summer and fall), and individual differences among bears (bear).

Source of variation	df	MS	*F*	$P > F$
Total	5,560			
Bear	17	3.2959	18.61	.0001
Month	10	3.7183	21.00	.0001
Hour	23	6.9367	36.92	.0001
Month x Hour	162	1.7918	10.12	.0001
Bear x Hour	410	0.6479	22.73	.0001
Season	1	19.5705	99.26	.0001

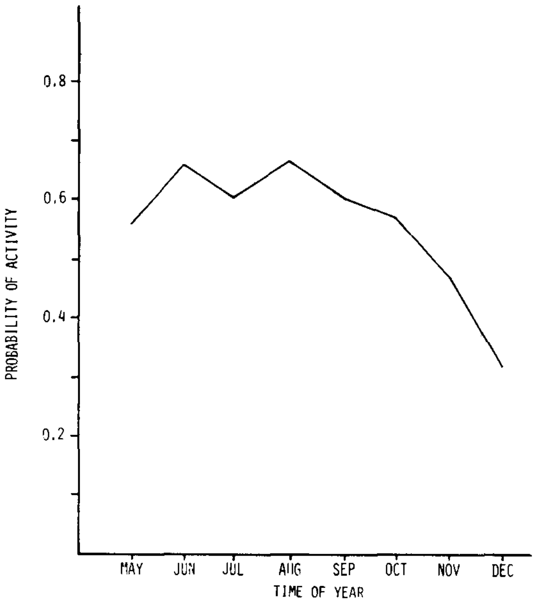

Figure 1. Relationship between time of year (month) and the mean monthly activity probability for black bears in CNF, 1980–81.

A similar pattern of activity was reported for bears in the Bote Mountain area within GSMNP, except that the peak of activity was observed in June (Garshelis and Pelton 1980). Bears in the Bunker Hill area of GSMNP (Quigley 1982) and in CNF (Villarrubia 1982), however, exhibited low levels of activity in the pre- and post-denning periods, rapid increases in activity levels in June and July, and an August peak in activity. The temporal difference in activity peaks with respect to the Bote Mountain area was attributed to its older age composition of bears (Quigley 1982, Villarrubia 1982). Subadult females may exhibit prolonged or recurring estrous causing breeding to occur later into the year than originally suspected (Eiler 1981). Hence, the higher activity levels in August may reflect the breeding activities of younger bears. The younger age of bears in CNF and the adjacent Bunker Hill area may be a result of accessibility and an associated increase in human-related bear mortality (pers. obser.).

Daily activity, averaged over the entire year, indicated that bears are generally crepuscular in CNF. Peaks of activity occurred at 0700 hours and 1900 hours. Bears were significantly ($P < 0.001$) more active during diurnal ($\bar{x} = 0.7$, $N = 4{,}660$) than nocturnal ($\bar{x} = 0.3$, $N = 1{,}031$) periods, combining both sexes, years, and seasons.

In summer, diurnal activity remained high, nocturnal activity was low (especially between 2100–0400 hours), and a distinct crepuscular pattern was evident (Fig. 2). The level of bear activity increased rapidly between 0400–0600 hours, reached a peak between 0600–0800 hours, remained relatively high during the middle of the day, peaked again between 1700–2000 hours,

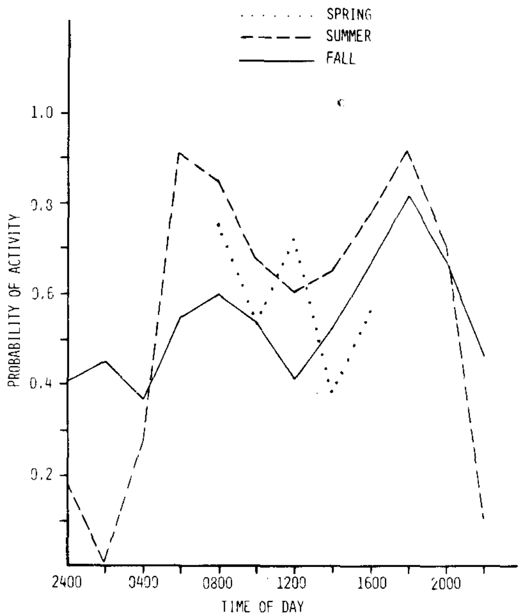

Figure 2. Seasonal variation in the daily activity patterns of black bears in CNF, 1980–81. Spring information includes only the 0800–1600 hour time interval.

and declined sharply to levels of low activity at 2100 hours and 0200 hours. Almost identical patterns of activity were described for bears in GSMNP (Garshelis and Pelton 1980, Quigley 1982) and CNF (Villarrubia 1982) during summer, except that morning and evening peaks were less discernible.

Diurnal activities of bears decreased in fall, while their nocturnal activities increased (Fig. 2). Bears of both sexes were virtually as active during nocturnal ($\bar{x} = 0.4$, $N = 494$) periods as during diurnal ($\bar{x} = 0.5$, $N = 2,221$) periods in fall. Villarrubia (1982) reported a similar pattern of bear activity in CNF (1978–1979), although levels of increased nocturnal activity were not as discernible.

Differences in activity patterns of black bears are likely influenced by the physiological condition of bears, weather conditions, changes in the availability and distribution of foods, and the influence of denning (Garshelis and Pelton 1980). The activities of bears may also be affected by human-related factors. In coastal North Carolina, increased nocturnal activity of bears in the fall was attributed in part to hunters and their dogs (Hamilton 1978). Fall nocturnal activities of bears in CNF may also be influenced by the increased influx of hunters and dogs and other recreationists into bear habitat (pers. obser.).

Temperature, precipitation, and cloud cover significantly influenced ($P < 0.05$) the activities of black bears (Table 2). Using similar techniques, Garshelis and Pelton (1980), Quigley (1982), and Villarrubia (1982) at-

Table 2. Analysis of variance in activity of black bears in Cherokee National Forest, Tennessee, 1980–1981, with respect to differences among individual bears (bear), time of year (month), time of day (hour), weather factors, and differences between years.

Source of variation	df	MS	*F*	*P* > *F*
Total	5,562			
Bear	17	3.0291	16.10	0.0001
Month	6	2.2872	12.16	0.0001
Year	1	3.7728	20.05	0.0001
Hour	23	6.2891	33.43	0.0001
Temperature	12	1.3204	7.02	0.0018
Precipitation	6	0.6622	3.52	0.0001
Cloud cover	3	0.5476	2.91	0.0327

tributed a significant portion of the variance in bear activities to the influence of temperature.

The relationship between temperature and activity in spring was nebulous due possibly to limited sample size. In GSMNP, increased spring temperatures were associated with an increase in bear activity (Garshelis and Pelton 1980). In summer, bear activity increased steadily as the temperature climbed from 16° to 31° C (Fig. 3). If the temperature exceeded 31° C during summer, the active behavior of bears decreased. In fall, activities of bears steadily decreased as temperatures dropped. However, this decrease in bear activity with lower temperatures might also reflect the influence of denning activities.

Although the activities of bears in CNF were statistically related to cloud cover, the relationship between cloud cover and bear activity was not clear. The significance of cloud cover to bear activity may be a function of its relationship to other weather factors.

The level of activity and precipitation was also significantly ($P < 0.05$) correlated. Bears were slightly more active immediately after a rainfall. Bears were the least active when there was a snow cover coupled with sleeting ($N = 70$); however, this relationship between snow and activity may be affected by the concurrent effects of freezing temperatures (Garshelis and Pelton 1980) and the influence of denning.

Adult males were more active ($P < 0.05$) than females with cubs, solitary adult females, and subadult and yearling females. The activity of subadult and yearling females exceeded ($P < 0.05$) that of solitary adult females and females with cubs. The only subadult male tracked in this study was apparently less active than the adult males; however, this contrast was not tested statistically because of the small sample size. Females with cubs were the least ($P < 0.05$) active group when compared with adult males, solitary adult females, and subadult females.

Seasonal changes in activity patterns were evident among different repro-

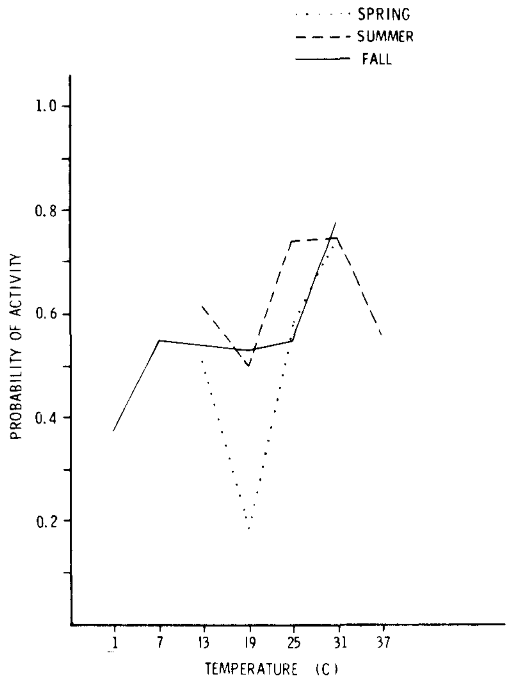

Figure 3. Seasonal relationships between temperature and activity patterns of black bears in CNF, 1980–81.

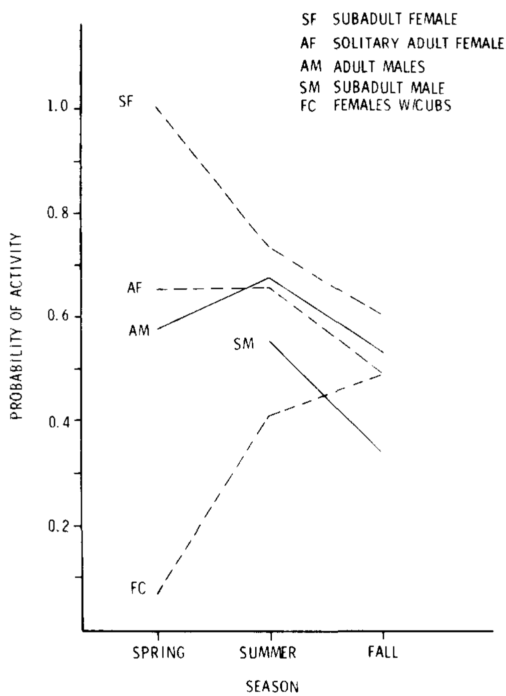

Figure 4. Seasonal relationships among activity patterns of different sex, age, and family groups of black bears in CNF, 1980–81.

ductive groups (Fig. 4). In the spring, females with cubs were the least active ($P < 0.05$) group. In contrast, several authors have suggested that nursing and play behavior by cubs and the subsequent need for adequate nutrition may stimulate spring activity by the mother (Amstrup and Beecham 1976, Garshelis and Pelton 1980). The stimulated activity by the mother, however, may be head and body movements rather than actual locomotion (Alt et al. 1976, Rogers 1976).

Activity levels of females with cubs in spring are difficult to explain. Low levels of spring activity, following den emergence, may reflect the restricted mobility and small size of young cubs as well as the need for prolonged resting periods. Individual peculiarities among females with cubs may also affect the variation in activity patterns.

Females with cubs gradually increased activity from spring to summer to fall; increased size, mobility, and exploratory ability of cubs, coupled with an expanding need to assure adequate nutrition for both self maintenance of the mother and development of the young, may stimulate this activity continuum. In all other sex and age groups, bears are most active in the summer, with activity diminishing in the fall.

In spring, adult males were less active than any group ($P < 0.05$) except females with cubs. This pattern was observed for males in Idaho (Amstrup and Beecham 1976) and GSMNP (Garshelis and Pelton 1980).

Adult males and breeding females coincided their highest level of activity during summer (breeding season) enhancing the probability of successful breeding. In northeastern Pennsylvania, Alt et al. (1976) found that adult males and solitary adult females also synchronized activity peaks in the breeding season. They suggested that synchronization of activity may be important in increasing the probability of successful breeding, particularly in sparsely populated bear range.

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