

Characteristics of Black Bear Cubs in the Southern Appalachians

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Abstract: Female black bears (*Ursus americanus*) were captured and radio collared in Cherokee National Forest (CNF) and Great Smoky Mountains National Park (GSMNP) from 1980 to 1982. Whereas most females den in inaccessible tree cavities high above ground, during the 1981-82 winter, 66% in the CNF and GSMNP denned on the ground affording scientists the opportunity to directly examine 15 litters. Litter sizes ranged from 1 to 4 ($\bar{x} = 2.58$), were comparable with litter sizes reported from other parts of the United States, and were similar among age classes of females. Estimated litter sizes based on recorded vocalizations were probably low; reliability may be enhanced by recording soon after cubs are born. Weights of cubs and yearlings averaged 1.82 kg and 8.8 kg, respectively. These weights are lighter than those reported from other studies and may reflect a less abundant and/or less reliable source of fall foods. Sex ratios and stages in development of cubs were observed and are reported.

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Information on the reproductive biology of a species is an important aspect of wildlife management. Data on natality provide the wildlife manager with evidence of the general health of the population, habitat quality, and the level of mortality sustainable without a decline in population size (Downing 1980). Female black bears generally reach sexual maturity at 3 to 4 years of age and produce litters only once every 2 years (Erickson and Nellor 1964). This relatively low productive rate suggests that accurate information on reproduction in black bears is especially important where bears are a wildlife management concern.

Studies on the reproductive ecology of black bears in the Tennessee portion of the Southern Appalachian Region (SAR) were initiated in 1978 by

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Eiler (1981). Because female black bears in SAR extensively utilize tree cavities high above ground as dens, unique difficulties were encountered in determining the size of litters, sex ratio of offspring, and general characteristics of offspring (Eiler 1981). Eiler (1981) resolved some of these difficulties by devising a method for estimating the litter size by analyzing taped recordings of cub vocalizations.

Reproductive studies were continued from 1980 to 1982. The 1981–82 winter was anomalous in that the majority (65.5%) of females denned on the ground (Wathen 1983). Scientists were, therefore, able to directly examine the litters of 15 adult female black bears and were also afforded the opportunity to evaluate the reliability of estimating litter size by tape recording cub vocalizations. In this paper are presented results of data collected on litters of black bear cubs and yearlings in 1981 and 1982. P. Carr, B. Collavo, J. Eiler, S. Garris, D. Gray, B. Hastings, K. Johnson, V. Major, B. Nottingham, P. Petko-Seus, J. Richardson, P. Springer, R. Strong, and C. Villarrubia are acknowledged for their assistance in field data collections and support. Special thanks is extended to R. Wathen for her help and support during all stages of this project. Funding was provided by McIntire-Stennis Project No. 27, Agricultural Experiment Station and Department of Forestry, Wildlife, and Fisheries, University of Tennessee, Knoxville; Tennessee Wildlife Resources Agency; and the Great Smoky Mountains Natural History Association.

Study Area

The study was conducted in the Great Smoky Mountains National Park (GSMNP) and adjacent Cherokee National Forest (CNF). The vegetation, topography, and climate of the study area are described by Garshelis et al. (1983). Field work was primarily conducted in the northwestern quadrant of the GSMNP and the Tellico Ranger District of CNF, comprising 994 km². Four major sections are recognized in the study area: 1) Sugarland Mountain/Elkmont section (Sugarland Mtn.), 2) Bote Mountain/Defeat Ridge/Tremont section (Bote Mtn.), 3) Parson Branch Road/Bunker Hill section (PBR), and 4) Tellico Ranger District of the CNF (designated as Cow Camp Ridge).

Methods

Adult black bears were initially captured with Aldrich spring-activated foot snares or barrel traps and immobilized with an intramuscular injection of etorphine hydrochloride (M99, D-M Pharmaceuticals, Rockville, Md.).

Captured bears were marked with ear tags and a lip tattoo for future identification (Johnson and Pelton 1980). Weight and standard body measurements were obtained from each animal and general body condition was recorded. A first premolar tooth was extracted for aging purposes. Teeth were sectioned and stained as described by Eagle and Pelton (1978) and ages as-

signed according to the cementum annuli technique described by Willey (1974). Selected females were radio-instrumented with reset motion sensor transmitters (Telonics, Mesa, Ariz.) for monitoring during the denning period.

Dens of radio-instrumented females were located and visited during the winter and the reproductive condition of the female was determined as being with newborn cubs, with yearling cubs, or without offspring. Methods of determining the reproductive condition of the female depended on the type of den that was occupied. Females that occupied ground dens were sedated with a 100 mg:200 mg:20 mg mixture of Rompun (Xylazine, Haver Lockhart, Inc., Shawnee, Kans.), Ketaset (Ketamine hydrochloride, Bristol Laboratories, Syracuse, N.Y.), and Carbocaine-V (Mepivacaine hydrochloride, Winthrop Laboratories, New York, N.Y.). The drug mixture was administered at approximately 1.0 cc per 22.7 kg body weight. Newborn cubs in ground dens were sexed, weighed, and marked with roto ear tags (Nasco, Ft. Atkinson, Wis.). Body markings and developmental stages of growth such as degree of eye opening, cutting of teeth, and locomotor coordination also were recorded. Yearlings present in ground dens were sedated prior to handling, marked with ear tags and a lip tattoo, weighed, and measured.

Females and family groups which occupied tree dens were considered too inaccessible to attempt sedation. Therefore, tree dens were climbed using climbing ropes and clog ascenders (Eiler 1981), and reproductive condition of the female was determined. The number of yearlings present with a female was estimated visually. Newborn cubs were not easily observed; their presence and estimated litter size were determined by analysis of recorded vocalizations (Eiler 1981). Recording sessions generally lasted for 1 hour. On occasions in which a litter was recorded and then later observed visually, analysis of the recording was performed by a trained individual who had no knowledge of the actual litter size.

Statistical analysis of data was accomplished using the Student's *t* distribution and analysis of variance (ANOVA). In ANOVA, variables were compared using the least-squares means (LSMEAN) procedure which calculates the expected class means for a balanced design (SAS 1982).

Results and Discussion

Litter Size

Litter sizes of newborn cubs examined in winter dens or observed after spring emergence ranged from 1 to 4 ($\bar{x} = 2.58$, $N = 19$). Litters of 2 ($N = 8$, 42.1%) and 3 ($N = 8$, 42.1%) were most frequent. Two litters of 4 and 1 of a single cub were also observed. Analysis of variance revealed no significant differences ($P < 0.19$) in litter sizes of newborn cubs among different age classes of females. The mean litter size ($\bar{x} = 2.58$) observed during this study is similar to that reported by Eiler (1981; $\bar{x} = 2.60$) for the same study area, and also compares favorably with mean litter sizes reported in other areas of

the eastern United States ($x = 2.15$ to 2.9 ; Spencer 1955, Harlow 1961, Stickley 1961, Erickson and Nellor 1964, Collins 1973, Rogers 1976, Alt 1982).

Estimated litter sizes based on recordings of vocalizations were probably low. The average observed litter size ($\bar{x} = 2.58$) was significantly larger ($P < 0.01$) than the average minimum estimated litter size based on tape recordings ($x = 1.80$). Of 8 occasions in which the size of a litter was estimated by analysis of a recording and then later observed, 3 underestimated the actual litter size (Table 1).

During the winter of 1982, 6 females had an estimated litter size of 1 based on analysis of recordings. One female was observed with a single cub at a later date, but 2 females were later observed with larger litters than had been estimated (Table 1). The other 3 females were not observed subsequently. However, judging by the observed frequency of litters of 1 (1 of 19 litters), it seems unlikely that all 3 had only a single cub.

Discrepancies between estimated litter sizes and actual litter sizes may be due to too short a recording session or to recording during a lull in vocal activity (Eiler 1981). Also females during the winter of 1982 (following an autumn of abundant hard mast) were generally in good physical condition and may have more easily satisfied their cubs' requirement for milk, resulting in fewer vocalizations by cubs. It is also possible that cubs become less vocal as they become older and better developed. Three of 4 litters which were taped on or before 15 February 1982 were later confirmed to have the same litter size as had been estimated from the recording. However, 2 of 4 litters recorded after 15 February 1982 were later determined to have been underestimated. Observations of newborn cubs in winter dens and observations of early emergence by females with cubs during the spring of 1982 (Wathen 1983) indicated that cubs were in excellent condition and developing rapidly. There may have been an associated decrease in vocalizations with this rapid development.

Though tape recording vocalizations of cubs may sometimes be unreliable

Table 1. Litter sizes estimated by analysis of recorded vocalizations and later observed for confirmation of the estimates.

Bear no.	Date recorded	Estimated litter size	Date observed	<i>N</i> cubs observed
F21	4 Feb	≥2 ^a	8 Mar	3
487	5 Feb	≥3	2 Mar	3
421	8 Feb	≥2	4 Mar	2
456	15 Feb	≥2	15 Feb	2
408	18 Feb	≥2	18 Apr.	2
429	18 Feb	≥1 ^a	Summer	2
326	24 Feb	≥1	18 Mar	1
665	26 Feb	≥1 ^a	22 Apr	3

^a Litter size underestimated by analysis of recording.

for estimating litter sizes, it is an effective means for detecting the presence of cubs in winter dens. Reliability of estimates of litter sizes may be improved by recording soon after the cubs are born, especially during winters following a good mast yield.

Characteristics of Offspring

Sex Ratio of Offspring.—There was no evidence during the study of an unequal sex ratio in litters of offspring. The sex ratio of litters of newborn cubs and yearlings was 45:55 (18 males, 22 females) and 50:50 (6 males, 6 females), respectively.

Weight of Cubs.—Weights of 40 cubs were obtained from 15 litters in winter dens. One litter of 2 females and a male was examined on 7 March 1981. One female cub weighed only 0.91 kg while the other female and the male weighed 1.13 kg each. This litter likely did not survive, since the adult female had 2 cubs again the following winter; these cubs were examined on 14 January 1982 and weighed 0.45 kg each.

The remaining 35 cubs were weighed during a 20-day period from 28 February to 19 March 1982. Cubs from litters of 4 ($\bar{x} = 1.23$ kg) were lighter ($P < 0.0001$) than cubs from litters of 3 ($\bar{x} = 1.89$ kg) or 2 ($\bar{x} = 2.15$ kg) (Fig. 1). The range in weight between the smallest and largest cubs of a litter varied significantly ($P < 0.02$) among different litter sizes (Fig. 2). However, small ranges occurred in litters of 2 ($\bar{x} = 0.17$ kg) and 3 ($\bar{x} = 0.22$ kg).

The mean weight of cubs (1.82 kg) observed during the present study was similar to the mean weight of 10 cubs (1.84 kg) observed by Eiler (1981) for the same time period (28 Feb to 19 Mar) from 1978 to 1980. Eiler's average did not include the weights of 2 cubs (1.1 kg) weighed on 17 March 1979 which were presumed to have died sometime before the breeding season since the female had cubs again the next year.

There are few reports on the weights of black bear cubs. Miller (1963) and Alt (1980) reported a negative correlation between litter size and cub weights. Rogers (1976) also found that cubs of larger litters weighed less, although the relationship was attributed to the color phase of the adult female; brown phase females produced larger litters that weighed less than the smaller litters produced by black phase females.

Weights of Yearlings.—Ten yearlings of 4 litters from GSMNP were weighed from 24 January to 6 February 1981. The mean weight of the yearlings was 8.8 kg, but there was considerable variation among litters (Table 2). One litter of a 16-year-old female weighed on 4 February 1981 averaged only 5.8 kg; these yearlings appeared to be in very poor physical condition. With the exclusion of this litter, the mean weight of yearlings in winter dens was 10.0 kg. During the winter of 1979, 4 yearlings weighed an average of 9.9 kg in the same study area (Eiler 1981).

There are few reports in the literature on the winter weights of yearlings. However, it appears that the weights observed in GSMNP and CNF are light

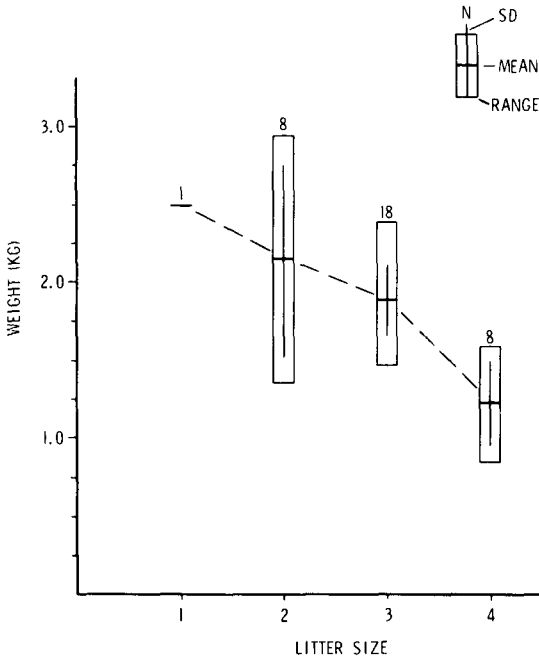


Figure 1. Mean, standard deviation (SD), and range of weights of newborn cubs weighed in winter dens, 28 February to 19 March 1982, in the GSMNP and CNF.

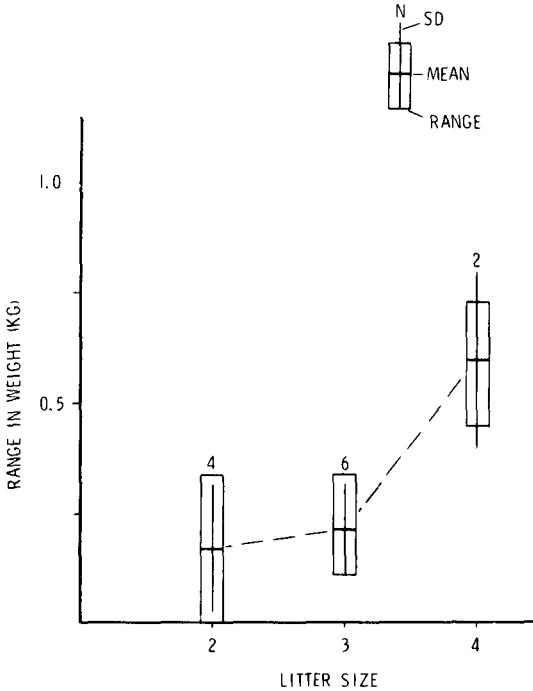


Figure 2. Mean, standard deviation (SD), and range of the difference in weights between the smallest and largest cubs in 12 litters examined in winter dens 28 February to 19 March 1982, in the GSMNP and CNF.

Table 2. Weights (kg) of yearling cubs examined in winter dens in the GSMNP and CNF.

Litter size	Date weighed	Individual weights			Mean weight of litter
		Yearling no.	Sex	Weight	
3	24 Jan 81	531	F	11.8	11.5
		532	F	10.9	
		533	M	11.8	
3	4 Feb 81	534	F	5.9	5.8
		536	F	6.8	
		540	F	4.8	
		542	M	11.3	
1	6 Feb 81	537	M	6.8	8.2
3	6 Feb 81	538	F	7.7	
		539	M	10.0	

compared to other areas. Fall predenning weights of cubs in Yosemite National Park averaged slightly over 30.0 kg (Graber 1981). In Pennsylvania, weights of male and female yearlings in dens averaged 37.3 kg and 30.0 kg, respectively (Alt 1980). The accelerated growth rate of yearlings in Pennsylvania was attributed to an abundant and reliable food source (Alt 1980).

The effects of slower growth on the survival of yearlings in the GSMNP and CNF are unknown. Rogers (1976) observed that mortality of lightweight yearlings in Minnesota was not as great as that for lightweight cubs. However, 2 yearlings weighing below the median weight of 13.4 kg in March did die (Rogers 1976). All 10 yearlings examined in the present study weighed below 13.4 kg. Of these, 4 were known to den the following year as 2-year-olds. Three of these were examined in dens and found to be in good physical condition.

The fate of a litter of 3 yearlings which averaged 5.8 kg in weight was unknown. However, during a routine post-emergence inspection of the den on 18 April 1981, 1 yearling was observed. The movements of the yearling were slow, and it appeared emaciated. This yearling may not have survived.

Other Characteristics of Cubs in Winter Dens.—Different stages in development of cubs were observed throughout the progression of the winter of 1982. Two cubs examined on 14 January were altricial but already had well-developed claws. Seven of 12 cubs examined from 28 February to 2 March 1982 had opened their eyes, and all cubs examined after March 1982 ($N = 23$) had open eyes. By contrast, 3 cubs examined on 7 March of the previous winter (1981) had closed eyes.

Reports on when the eyes of cubs open have varied, ranging from 28 days (Butterworth 1969) to 44 days (Hulley 1976). Butterworth (1969) reported that the eyes of a hand-reared male cub opened slightly at 28 days of age but were not fully open until 35 days. Matson (1954) stated that the eyes of cubs open at 40 days of age; this appears reasonable. However, it does not seem reasonable to try to extrapolate dates of birth from the dates of eye

opening. Smith (1946) reported that cubs of the same litter opened eyes at different dates as much as 10 days apart.

Teeth were not observed in cubs until 18 March 1982, when siblings of 1 litter had erupting canines and incisors. Cubs of a litter examined on 19 March 1982 had erupting canines, premolars, and incisors. Rausch (1961) reported that no tooth eruption had occurred in a 22-day-old captive-born cub. Butterworth (1969) observed the eruption of 2 maxillary incisors in a male cub at 47 days of age, and Hulley (1976) reported canine eruptions at 51 days of age in 2 captive-born cubs.

Noticeable differences in the coordination and mobility of cubs were observed. The mobility of cubs was restricted until 18 March when the cubs of 2 litters were able to stand and move short distances on their own. Movements at this time were still uncoordinated, however.

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