

CHRONOLOGY OF BLACK BEAR DENNING IN THE CATSKILL REGION OF NEW YORK¹

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Abstract: In radio-telemetry studies of black bears (*Ursus americanus*) in the Catskill region of New York State during 1975–79, denning chronology was recorded for 62 den entries and 38 exits by 35 male and female bears 1 to 17 years of age. The median den entry date for female bears with cubs (22 November) was somewhat earlier than that for pregnant females (24 November) and barren females (30 November). Collectively, females denned significantly earlier than males (24 November versus 10 December). Median den emergence dates also varied with sex and reproductive status. Males were the first to leave their dens (26 March), followed by females with yearlings (5 April) and barren females (8 April). Females with cubs left their den site significantly later (15 April) than males and females with yearlings. Although autumn temperatures, snowfall, and snow depths differed significantly between years, they appeared unrelated to denning dates.

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Successful black bear population management depends on formulation of appropriate harvest strategies. Many variables must be considered in designing hunting seasons which assure achievement of management objectives. Denning chronology is a variable of increased concern to black bear resource managers. Lindzey and Meslow (1976) reported that sexual variation among black bear denning dates is a significant factor in population management programs. Willey (1978) recognized the potential management implications of early denning of female bears.

Differential den entry and/or emergence has been reported for black bears by several researchers. Erickson et al. (1964) reported that adult males denned about 2 weeks after females and juveniles. Lindzey and Meslow (1976) reported adult males denning approximately 1 month after females. They also observed that yearlings differed from both adult groups, having an intermediate denning date. Jonkel and Cowan (1971) concluded that adults left their dens in the spring before subadults. Amstrup and Beecham (1976) reported that females with young were the last to leave the den. In New York denning chronology has become an important consideration in designing hunting seasons for black bears inhabiting the Catskill region, where hunting annually accounts for more than 90% of all documented mortality (McCaffrey et al. 1976).

STUDY AREA

The Catskill Bear Range is the 2nd largest of New York's 3 black bear ranges. It is located in the southeastern portion of the state and encompasses approximately 3,300 km², presently occupied by an estimated 400 bears. Geographic distribution of the bear harvest, other mortalities, and radio telemetry locations indicate the existence of 2 subpopulations of Catskill bears. The southern subpopulation is the smaller of the 2, occupying 1,080 km², and is contiguous with a bear population in northeastern Pennsylvania.

The northern Catskill subrange, where radio-telemetry studies were concentrated, consists of about 2,250 km² and is presently occupied by approximately 300 bears. The range is characterized by mountainous relief with elevations ranging from 300 to 1,281 m (McCaffrey et al. 1976). The northern range contains a major portion of the Catskill Forest Preserve (948 km²) with extensive tracts of northern hardwoods and red spruce (*Picea rubens*) at higher elevations (Stout 1958). Vehicular access is restricted to the valleys; however, there is little bear range that is more than 2 miles from a road.

Soils are classed as poor to moderately productive, of glacial origin derived from sandstone and conglomerate (Howe 1935). The highlands support little or no agriculture. Average July temperatures are between 18 C and 21 C with January averages ranging between -7 C and -4 C. Annual precipitation is between 100 and 125 cm

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with about half occurring during the growing season. Annual snowfall averages from 100 to 150 cm (R.H. Smith, unpubl. rep., New York Fed. Aid Proj. W-23-R, 1954). Precipitation in the High Peaks area is typically much greater. Averages for 1 High Peaks weather station, in the center of the study area, were 175 cm total precipitation and over 300 cm of snow (Natl. Oceanic and Atmospheric Admin. 1975–1979).

Resident human population density is low and generally restricted to the lowland and valleys. People are most numerous in summer and fall, when visitors come to the region to hike, camp, and vacation.

METHODS

Black bears were captured primarily with Aldrich cable foot snares; a few were captured in culvert traps. Etorphine hydrochloride or ketamine hydrochloride was used to immobilize captured bears. Selected bears were fitted with radio-tracking transmitters, operating at 148 or 151 MHz. Radio locations were sought weekly but obtained only as permitted by weather and aircraft availability.

Den entry dates were defined as midpoints between the last autumn movement and the first of a series of stationary locations indicating denning. Den sites were visited each winter to initially document site characteristics, determine reproductive status, and replace radio collars. Reproductive status was determined by examining den occupants or through analysis of audio tape recordings made within the dens using a portable cassette recorder and omnidirectional microphone. Den emergence dates were defined as midpoints between the last winter denning date and the first spring movement. Midpoints were selected to describe the denning and emergence of bears because they are probably least biased. We have no reason to suspect that actual denning or emergence dates tended to occur on either side of these midpoints. Furthermore, utilization of medians rather than means to describe the activity of a class of bears will be less influenced by individual variations among den entry or emergence dates.

In some instances den emergence data were supplemented with the aid of a time-lapse camera (a modified Kodak Analyst camera; G. Slocum,

unpubl. rep., New York Fed. Aid Proj. W-89-R-22, 1977) positioned to permit photography of the den entrance and surrounding area.

Weighted average den entry and emergence dates were calculated with equal weight given to each class average.

A test for the equality of medians (Daniel 1978) was employed to identify differences between years and classes. Average temperatures, snowfall, and snow depths were evaluated by analysis of variance. The levels of significance were $P \leq 0.05$.

RESULTS

Sixty-two dennings were documented between 1975 and 1979 for 35 individual telemetered bears of known age, sex, and reproductive status. Male bears 3 years old and under were considered subadult, while barren females were considered subadult through age 4 years. Over the 5-year period this sample consisted of 16 males (9 adult and 7 subadult), 18 pregnant females, 15 barren females (8 adult and 7 subadult), and 13 females denning with cubs. Males were not represented in this sample as frequently as females because adult males were captured at a much lower rate and those captured experienced higher mortality rates. Bears in the sample varied in age from 1 to 16 years old (Table 1) as aged by cementum annulation (Sauer *et al.* 1966).

The sample of bears emerging from dens was reduced from 62 to 38 through a variety of causes: 2 lost collars; 5 radios failed; 6 dens were disturbed, possibly inducing premature emergency; and 11 bears were still in their 1979–80 dens as of this writing. The remaining sample consisted of 11 males (6 adult and 5 subadult), 13 females with cubs of the year, 10 barren females (5 adult and 5 subadult), and 4 females emerging with yearlings. These bears ranged in age from 2 to 17 years (Table 1).

The interval between confirmed movement and confirmed denning varied between seasons, years, and individuals because of differences in flying conditions, other work assignments, the ability to locate a particular individual, and aircraft availability. The average width of the interval surrounding the mid-range date for all bears was approximately ± 9 days in autumn and slightly less than ± 5 days in spring.

Table 1. Age, sex, and reproductive status of 35 transmitter-equipped black bears monitored entering and/or emerging from winter dens in the Catskill region of New York, 1975–1979.

Age (years)	Number entering dens			Number emerging from dens				
	Females with cubs	Pregnant females	Barren females	Males	Males	Barren females	Females with yearlings	Females with cubs
1			2	4				
2			1	3	3	2		
3	1		4	2	2	1		
4	1	2	1	1	1	2		2
5	3	2	1	2	1	1		3
6	1	2	2	2	1	1	1	
7			2			1	1	2
8		2			1	1		1
9	2	2		1	1			2
10	1	1						
11	2	2					1	1
12	1							2
13			1					
14	1		1			1		
15							1	
16				1				
17					1			
Totals	13	18	15	16	11	10	4	13

Females with Cubs

Thirteen telemetered females accompanied by cubs, born the previous winter, were tracked to their winter dens. Although 4 years of data were available for this class, there were insufficient data to compare between years. Most data were available from 1979 when the median den entry date for females with cubs was 10 December. The median entry date for all females in this class during 1976–1979 was 22 November (Fig. 1). A peak denning period cannot be readily identified from these data. Den entry dates appear to be uniformly distributed about the median.

Emergence data were available for only 4 females leaving their dens with yearlings. These females did so between 2 and 12 April (median = 5 April, Fig. 1). Small sample sizes precluded comparisons between years.

Pregnant Females

Eighteen pregnant female bears were tracked to their winter dens. The earliest den entry for this class was 31 October (1979) and the latest was 10 December (1977). The median den entry date for all pregnant female bears was 24 November (Fig. 1). Median den entry dates for 1976, 1977, and 1978 were, respectively, 13 November, 2 December, and 30 November. Only 1 denning each was documented in 1975 and 1979; these dates were 24 November and 31 October. A test for equality of medians detected no significant difference between years.

Pregnant females were the least variable of all classes; their entry dates were uniformly distributed from 7 November to 17 December.

Emergence data were available for 13 bears in this class. All females with cubs stayed at their den site through the end of March. Most data were available for the spring of 1979 when 7 emergence dates were obtained (median = 15 April). The median emergence date for all bears was also 15 April (Fig. 2). No statistical difference was detected between emergence dates for this class in 1978 versus 1979.

Time-lapse photographs of 3 family groups suggested that the adult females and their cubs spent a portion of the 2 weeks prior to leaving their den sites loafing and playing in the immediate vicinity. It appeared that all family members returned to their dens in late afternoon, presumably remaining there until mid-morning of the following day when they might again leave the den.

Barren Females

Fifteen barren females (8 adult and 7 subadult) were tracked to their winter dens during the 5 years data were collected (median = 30 November, Fig. 1). Median entry dates for adults and subadults were 29 November and 2 December. Den entry dates ranged from 4 November (1977) to 27 December (1978). Significant differences were not detected between annual medians or age class medians.

Barren females also entered dens during a very wide period; however, there was a noticeable

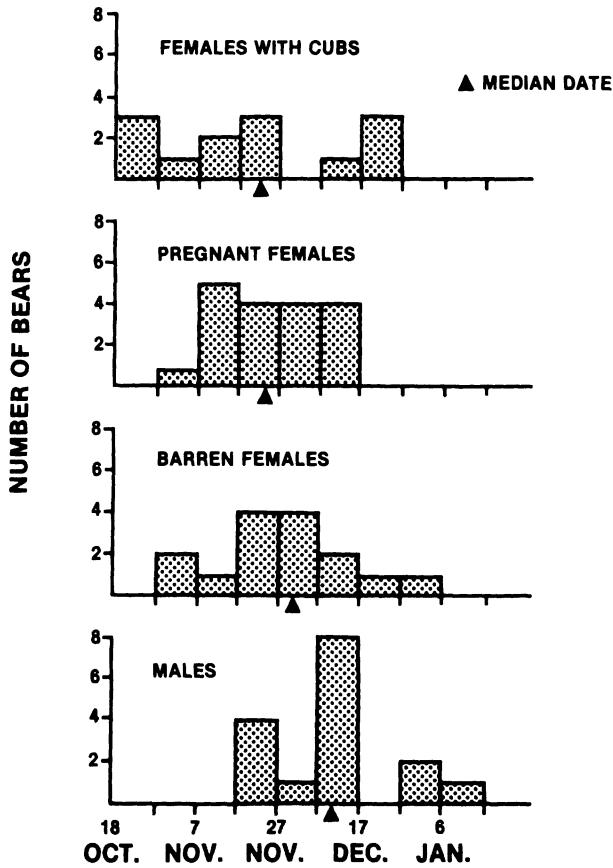


Fig. 1. Frequency distribution and median dates of den entry by Catskill black bears in 4 classes, 1975-1979.

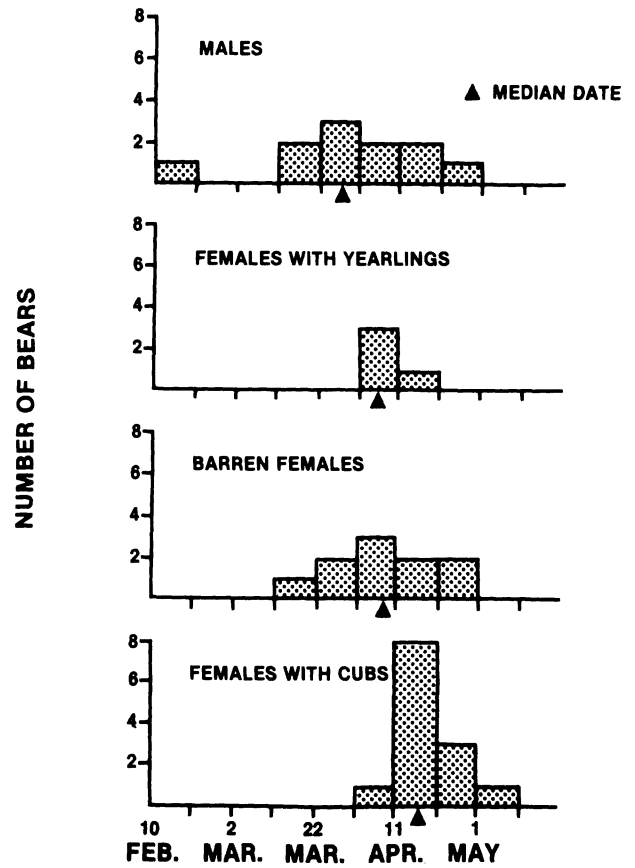


Fig. 2. Frequency distribution and median dates of den emergence by Catskill black bears in 4 classes, 1976-1979.

peak and a pattern resembling a normal distribution about the median. Peak denning for this class occurred between 17 November and 7 December. This variation may likely result from the tendency of adult barren females to den earlier than subadult females. Although this difference was not significant, the smaller sample sizes made it difficult to detect differences.

Emergence data were available for 10 bears (5 adult and 5 subadult) in this class (median = 8 April, Fig. 2). Bears began to emerge as early as 15 March (1979) and continued to do so through 28 April (1979). Most data (4 observations) were collected in the spring of 1978. Fewer emergences (3, 2, and 1) were documented in 1976, 1979, and 1977, respectively. Statistical differences were not detected between annual medians or age class medians.

Males

Eight of 16 male bears (9 adult and 7 subadult) entered dens during the 2nd week of December (median = 10 December, Fig. 1). The other males entered their dens between 19 November and 11 January. Most of the data were collected in 1977 (7 observations). In 1976 there were 4 observations, in 1978 there were 3 and in 1975 and 1979 there was only one each year. Tests for equality of medians for 1976 versus 1977, and 1977 versus 1978, did not reveal statistical differences, nor did a test of medians for adult versus subadult males. Despite the extreme variability among male denning dates, there was a noticeable peak denning period narrowly surrounding the median.

Emergence data were available for 11 male bears (6 adult and 5 subadult). The median

emergence date for all males was 26 March (Fig. 2), while that for adults was 25 March and for subadults, 14 April. All bears stayed in their dens later in 1978 than any other year. Despite this apparent difference, no significant difference was detected between emergence dates for 1978 and any other year. Moreover, differences were not detected between other years of age class medians.

Entry Dates Between Classes

Females with cubs, pregnant females, and barren females exhibited statistically similar median den entry dates of 22, 24, and 30 November, respectively. Pregnant females and barren females each denned significantly earlier than males (median = 10 December; $z = 2.44$, $P < 0.01$, and $z = 2.15$, $P < 0.02$). However, there was no significant difference between median den entry dates for females with cubs (the first to den) and males (the last to den). In more general terms, all females ($N = 46$) denned significantly earlier (median = 24 November) than all males ($N = 16$, median = 10 December; $z = 2.32$, $P < 0.02$).

Emergence Dates Between Classes

Median den emergence dates for males (26 March), females with yearlings (5 April), and barren females (8 April) were not statistically different, nor were emergence dates for females with cubs (15 April) and barren females. Females with cubs emerged from their dens significantly later than females with yearlings ($z = 2.09$, $P < 0.02$) and males ($z = 2.00$, $P < 0.03$).

In more general terms, females with cubs had a significantly later emergence date than all other bears collectively ($N = 25$, median date = 2 April; $z = 3.19$, $P < 0.001$). Emergence data for each class showed a normal distribution surrounding the median (Fig. 2).

DISCUSSION

Unlike Lindzey and Meslow (1976) or Jonkel and Cowan (1971), we did not observe significant differences in annual or conglomerate den entry data between adult and subadult classes. Moreover, we did not detect statistical differences be-

tween subadult classes of the same or different sex, or between subadults and each adult reproductive class. It is possible that fragmentation of the data by age classes or by calendar years has so reduced sample sizes that real differences between den entry or emergence dates are difficult or impossible to detect.

Den entry dates for 1976–1979 were compared with 3 indicators of autumn weather for those years: total snowfall, average snow depth, and average temperature during October–December (Table 2). Analysis of variance showed several significant differences ($P \leq 0.05$) between years for these weather data (1977 vs. 1979 for snowfall; 1976 vs. 1977, 1976 vs. 1979, 1977 vs. 1978, 1977 vs. 1979, and 1978 vs. 1979 for snow depth; and 1976 vs. 1977, 1976 vs. 1978, and 1976 vs. 1979 for temperature). However, there was no significant correlation between these variables and the onset of denning (Spearman rank correlation coefficients, $r' = -0.1$ for snowfall, -0.3 for snow depth, -0.1 for temperature). The weighted average den entry date for all bears in 1979 was 22 November, the earliest observed during the 4 years that sufficient data were available. During the last quarter of 1979, abnormally high temperatures (average 2.2 C) were accompanied by the smallest snowfalls and average snow depths measured during this study (Table 2). During the coldest and snowiest last quarters, 1976 and 1977 (Table 2), weighted den entry dates were 8 December and 23 November. These findings are contrary to the reports by Erickson et al. (1964) and Northcott and Elsey (1971) that weather, particularly snow and/or low temperatures, initiated denning.

Food availability and/or physical condition of the bears have been considered significant elements contributing to the regulation of denning among black bears (Spencer 1955, Lindzey and Meslow 1976, Willey 1978). Physical indices of bear condition are collected during autumn hunts. However, hunting seasons were suspended in 1976 and 1977, thus precluding normal data collections. The abundance of summer foods was believed to be relatively stable during the study, and predenning body fat deposition was assumed to vary with the abundance and distribution of autumn mast. Although no attempt had been

made to quantify the abundance and distribution of mast, subjective evaluations have been recorded annually. Relative mast abundance was similar for all years except 1976, when acorns were exceptionally plentiful. Perhaps the late denning observed in 1976 (weighted average for all bears = 8 December) was in part a function of mast abundance that year. Late denning in 1978 (8 December) cannot be explained in the same manner. Likewise, the early den entry observed in 1977 and 1979 (23 and 22 November, respectively) cannot be explained by a notable shortage of autumn foods.

Craighead and Craighead (1972) reported that female grizzly bears (*Ursus arctos*) emerging with cubs are the last to leave the den site, after adult males, adult females, and females with yearlings. We observed a similar pattern of emergence by females with cubs. Lindzey and Meslow (1976) also reported that females remained at the den site longer than other bears.

The timing of den emergence may be influenced by early spring temperatures. For the 3 years that adequate emergence data were available (1977, 1978, and 1979), there was an insignificant positive correlation ($R^1 = 0.5$) between emergence dates and combined monthly average temperatures for March and April. The coldest March–April occurred in 1978 (average temperature = -1.2 C, significantly colder than the average in 1977 or 1979; analysis of variance, $P \leq 0.05$). In that year the weighted average emergence date for all bears was 14 April, the latest emergence date for the 3-year period. The remaining 2 years, 1977 and 1979, were warmer and not significantly different from each other (average = 2.0 C in 1977 and 1.6 C in 1979). Weighted average emergence dates for these years were also very similar: 7 April and 5 April, respectively. The small differences between temperatures, between emergence dates in 1977 and 1979 and the late emergence observed in 1978 may indicate that a realistic correlation between spring temperatures and emergence dates exists.

Rogers (1974) believed that emergence of bears in Minnesota was associated with temperatures greater than 10 C and the accompanying rapid snow melt. Temperatures above 10 C were observed on only 3 occasions during the 2 weeks preceding median emergence dates (twice in 1977

Table 2. Black bear den entry dates and weather conditions during the corresponding October–December quarter in the Catskill region of New York, 1976–1979.

Year	Average den entry date ^a	Quarterly weather ^b		
		Total snowfall (cm)	Average daily snow depth (cm)	Average temperature (C)
1976	8 December	77	6.29	-2.8
1977	23 November	112	12.04	0.4
1978	8 December	76	6.18	0.7
1979	22 November	17	1.60	2.2

^a Weighted average for all classes of bears.

^b Climatological data recorded at the Slide Mountain weather station (U.S. Climatological Report, October, November, and December, 1976, 1977, 1978, and 1979).

and once in 1979). This suggests that if a temperature threshold exists for bear emergence it must be below 10 C in the Catskill region of New York.

CONCLUSIONS

Estimates of bear population size and dynamics are frequently derived from bear harvests. When hunting seasons occur during or after the denning period, harvest data may be influenced by the chronology of den entry and emergence. Failure to recognize this leaves the wildlife manager vulnerable to underestimates of populations and misinterpretations of sex and age data.

These preliminary findings of the Catskill bear study were applied in formulating the 1979 and 1980 Catskill bear hunting seasons. These seasons were designed to allow a late autumn hunting opportunity, affording an increased probability of protection for the pregnant female segment of the bear population. The resulting increase in population productivity was necessary to sustain the Catskill bear population at the experimental level achieved through 2 recent consecutive closed annual bear hunting seasons. Knowledge of denning chronology will be refined, as additional data are collected, and applied to the future management of the Catskill black bear resource.

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