

PANEL 1: THE ECOLOGY, POPULATION CHARACTERISTICS, MOVEMENTS AND NATURAL HISTORY OF BEARS

A Summary of the Black Bear Population Characteristics in Pennsylvania

GARY C. WAKEFIELD

115 Jacobs Place, Marysville, California

SUMMARY

Data available on the age structure of black bear (*Euarctos americanus* Pallas) in Pennsylvania are limited. During the 1967-1968 hunting season, skulls were collected and aged, using the canine tooth sectioning technique. Thirty-seven bears were successfully aged, the oldest being 20.75 years. The mean age of bears harvested during the 1967 season in Pennsylvania was 4.18 years with a standard deviation of 3.39 years. More female bears were killed during the 1967 season than in 1968. The age structure for the sample from the study area indicated a possible overharvest because it was highly skewed toward the younger age classes. An attempt was made to correlate bear age by sex with various skull and canine tooth measurements. This attempt met with limited success.

INTRODUCTION

Limited information is available concerning the sex and age structures of harvested black bear populations. Many different factors govern the structure of the kill of a particular bear population. Erickson, Nellor, & Petrides (1964) state, 'Sex ratios reported by hunters were found to be biased toward males. The degree of bias was directly proportional to the time elapsed between kills and reports of kills. Kills confirmed as to sex were 52% females.' In another instance Troyer (1962), in work with the brown bear, reports—'Males comprise 65.2% of the kill. Hunters selectively hunt for the larger animals, and since female hides rarely measure over $8\frac{3}{4}$ feet, more males are taken than females.'

The canine tooth sectioning technique is now used in aging most carnivores. Sauer, Free, & Browne (1966) report that '... the ages of bears can be determined from the annular layering in the cementum ... Deposition of cementum radially from the dentine continues throughout the bear's life, each subsequent wide layer and narrow dark band representing an additional year.' It is felt that captive bears differ too greatly from wild bears in tooth development for data from them to be considered. Rausch (1961) reported striking difference in growth patterns between captive and wild bears. The captive animals were consistently more mature in bone structure and dentition at comparable ages.

In 1967 a study was initiated on the movements, habitat and population characteristics of the black bear in Pennsylvania. This paper deals with the data collected on population characteristics, principally the sex and age structure.

STUDY AREA

Some of the data were collected on the 16,653-acre study area encompassing the Wycoff Run watershed in southeastern Cameron County, Pennsylvania. The area was located entirely within the 50,000-acre Quehanna Wilderness Area of the Moshannon State Forest. This area is approximately 94 miles northwest of Harrisburg and 108 miles northeast of Pittsburgh.

The wilderness area is essentially a 2,200-foot high sandstone plateau deeply dissected by the major stream drainages, one of which is Wycoff Run. Approximately 80% of the entire area is forested consisting mainly of mixed oak association and less frequently northern hardwood associations. A network of state forest roads, logging roads and right-of-way clearings contributes to the accessibility of the area.

METHODS

Two bear check stations were operated on the Wycoff Run study area during the black bear seasons of 1967 and 1968. In 1967 eight legal bears and three illegal cubs were checked. During the 1968 season nine bears were checked. Hunters checking the bears were asked to donate the skulls of their bears for age determination and many complied with this request. The balance of the skulls were supplied by taxidermists interested in the study.

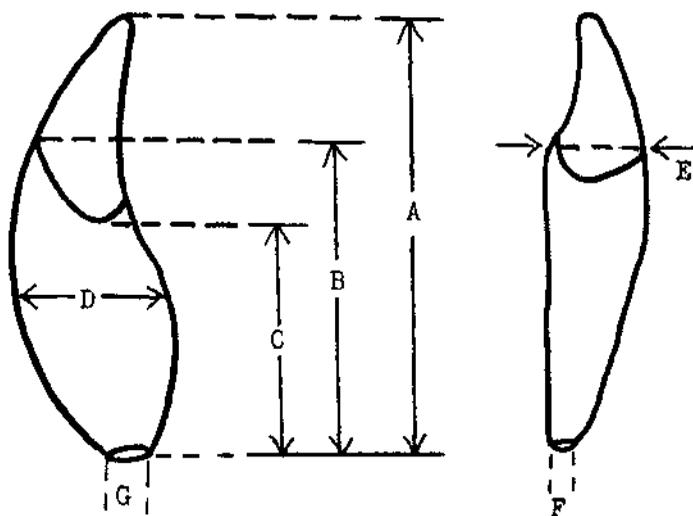
Skulls were measured in a manner similar to the Boone and Crockett Club's official scoring system for North American big game trophies. Seven standard measurements were recorded for each canine tooth. The location of these measurements are shown in Fig. 1 (Sauer 1966). The specimens were aged by canine tooth sectioning.

A total of 30 bears were successfully aged from the 1967 hunting season and seven from the 1968 season. Of the grand total of 37 bears, 12 were harvested on the Wycoff Run study area, six in each year. The oldest animal encountered was a female, number 67-108, killed on the study area during the 1967 season and aged at 20.75 years.

An attempt was made to correlate selected measured characteristics of black bears with their ages. The results of these cross correlations are presented in Tables 1 and 2 for 23 males and 14 females respectively. It was found that the removal of the 20.75 year old female from the data did not significantly change the correlation presentation in Table 2.

The collection and accuracy of data on the sex of hunter-killed bears from throughout the state placed dependence on the individual hunter's ability to determine the sex of the animal and the taxidermist's cooperation in recording the sex correctly on a tag attached to the skull. The major portion of the state-wide kill data were provided by the Pennsylvania Game Commission, Division of Research.

In the case of skulls received from taxidermists which were not identified as to sex, the gender was determined by examination of the skull itself. The presence of the sagittal crest on the skulls is characteristic of male bears and is usually a good criterion for assigning sex. The size of a skull can also often be useful. Whereas the skull width for males and females is essentially the same, the larger skull length of males can often be employed to aid in sex differentiation. Table 3 presents the mean values and standard deviations, by



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|-------------------------|--------------------------------|
| A = Total Length | E = Thickness |
| B = Maximum Root Length | F = Nerve Canal Opening—Width |
| C = Minimum Root Length | G = Nerve Canal Opening—Length |
| D = Width | |

Fig. 1 Location of standard canine tooth measurements.

sex, of the canine tooth measurements, skull measurements, age and field dressed weights of the 37 bears used in the comparison.

RESULTS

The average age of 30 bears harvested during the 1967 bear season was 4.18 years with a standard deviation of 3.39 years. Six of these bears were killed on the Wycoff Run study area and their ages are consistent with the other 24. Fig. 2 illustrates the distribution of the bears by sex in the various age classes. However, the age structure of the 1968 harvest from the study area does not compare at all with that of 1967. Of the six skulls that were received for aging from the study area five were 1.75 years old and the other 2.75 years old. The age structure for this sample from the 1968 harvest indicated that the distribution was not normal but skewed to the younger age classes indicating an over-harvest of the population during the previous year.

The sex structure of the 1967 Pennsylvania bear kill was essentially 96 males to every 100 females with a total reported kill of 278 males and 290 females. The 1968 harvest reflected an opposite trend with a ratio of 100 females to 116 males. The total reported kill included 101 females and 117 males.

Of the total of eight legal adult and three cub bears killed on the study area in 1967 four were males and seven females reflecting the trend of the statewide harvest. The 1968 study area kill again reflected the statewide trend with seven of the nine legal bears killed being males.

TABLE 1. PRODUCT-MOMENT CORRELATION COEFFICIENTS OF MALE BLACK BEAR MEASUREMENTS AND AGE.

	Age (A)	Field Dressed Weight (FDW)	Skull Width (SW)	Skull Length (SL)	Canine Tooth Length (CTL)	Canine Tooth Width (CTW)	Canine Tooth Thick. (CTT)
(A)	1.0000						
(FDW)	0.8249**	1.0000					
(SW)	0.8775**	0.8010**	1.0000				
(SL)	0.8239**	0.8497**	0.9347**	1.0000			
(CTL)	0.6971**		0.8167**	0.8732**	1.0000		
(CTW)	0.5387*	0.7104*	0.6653**	0.7296**	0.8055**	1.0000	
(CTT)	0.3391	0.4647	0.4481	0.5561*	0.6714**		1.0000

* Significant at the 95% level of confidence (d.f. = 22).

** Significant at the 99% level of confidence (d.f. = 22).

TABLE 2. PRODUCT-MOMENT CORRELATION COEFFICIENTS OF FEMALE BLACK BEAR MEASUREMENTS AND AGE.

	Age (A)	Field Dressed Weight (FDW)	Skull Width (SW)	Skull Length (SL)	Canine Tooth Length (CTL)	Canine Tooth Width (CTW)	Canine Tooth Thick. (CTT)
(A)	1.0000						
(FDW)	0.0303	1.0000					
(SW)	0.1320	0.2571	1.0000				
(SL)	0.1585	0.4750	0.2049	1.0000			
(CTL)	0.0766	0.5027	0.1521	0.8097*	1.0000		
(CTW)	-0.0181	-0.0174	-0.0843	-0.3296	-0.1439	1.0000	
(CTT)	-0.2539	-0.4166	-0.2818	-0.3652	-0.2855	0.5291	1.0000

* Significant at the 95% level of confidence (d.f. = 13)

TABLE 3. MEANS AND STANDARD DEVIATIONS OF BLACK BEAR MEASUREMENTS AND AGE BY SEX.

	Age (Years)	Field Dressed Weight (Pounds)	Skull Width (MM)	Skull Length (MM)	Tooth Length (MM)	Tooth Width (MM)	Tooth Thick. (MM)	Sample Size
Male	Mean	2.88	194	160	269	66	19	23
	Standard Deviation	1.12	85	20	30	6	2	1
Female	Mean	5.18	170	158	262	58	17	14
	Standard Deviation	4.64	63	15	13	5	1	1

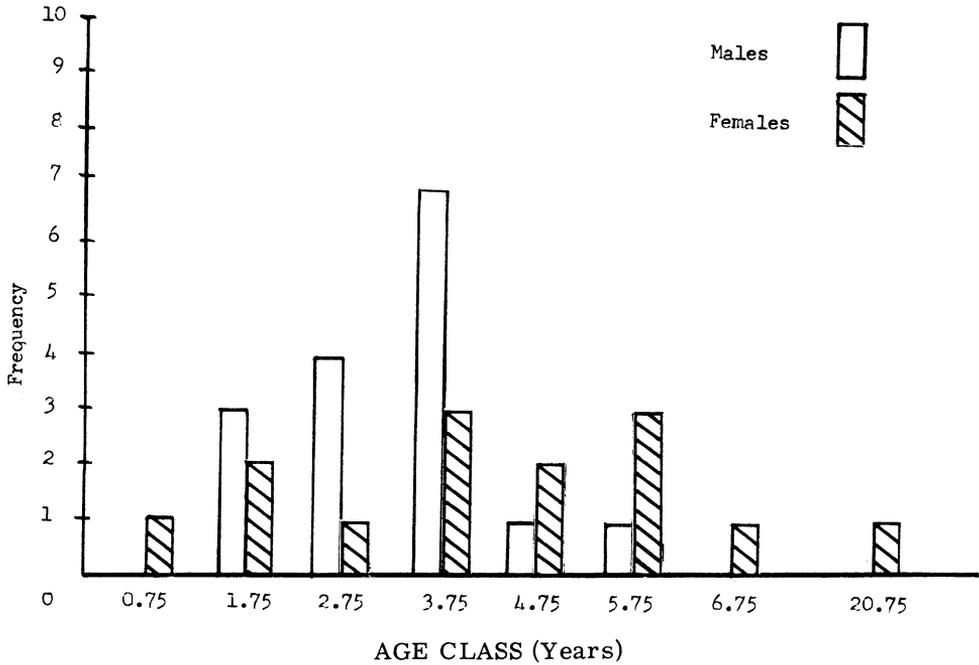


FIG. 2. Age structure of the 1967 bear harvest.

The data show that there was a varying degree of sexual dimorphism among the various skull and canine tooth measurements recorded. Tremendous individual variation, indicated by large standard deviations, accompanying sexual dimorphism, complicates attempts to determine sex through the use of these anatomical measurements. The correlation coefficient of the sex-skull length relationship, -0.1625 , best reflects this variation. Of the 14 female skulls the longest measured was 276 mm, whereas nine or 39.1% of the 23 males exceeded this measurement. The largest male skull measured 332 mm long. However, as a general rule of thumb skulls longer than 279 mm usually could be correctly sexed as males.

DISCUSSION

The correlation coefficients are sometimes misleading in that they fail to consider the overlapping measurements and the characteristically higher and lower measurements separately. For example, the correlation coefficient from Table 4 of the sex-canine tooth length relationship, -0.5246 , is strongly negative. However, the length can be of limited use in determining sex. The longest female canine tooth was 64 mm long. Of the 23 male canines 11 or 47.8% exceeded this measurement, the largest was 78 mm long.

The correlation coefficients of sex-skull width -0.0282 , sex-canine tooth width -0.4124 and sex-canine tooth thickness -0.5108 , indicate that these characteristics cannot be used as a characteristic of either sex, although a small degree of sexual dimorphism is exhibited even in these measurements.

TABLE 4. PRODUCT-MOMENT CORRELATION COEFFICIENTS OF MEASUREMENTS AND AGES OF 37 HUNTER KILLED BLACK BEARS FROM THE 1967 AND 1968 HUNTING SEASONS.

	Age (A)	Sex ^a (S)	Field Dressed Weight (FDW)	Skull Width (SW)	Skull Length (SL)	Canine Tooth Length (CTL)	Canine Tooth Width (CTW)	Canine Tooth Thick. (CTT)
(A)	1.0000							
(S)	0.3496	1.0000						
(FDW)	0.1556	-0.1493	1.0000					
(SW)	0.2592	-0.0282	0.6670**	1.0000				
(SL)	0.2012	-0.1625	0.7768**	0.8018**	1.0000			
(CTL)	-0.0137	-0.5246	0.6752**	0.5656**	0.7916**	1.0000		
(CTW)	-0.0208	-0.4124	0.5821**	0.5047**	0.6201**	0.7312**	1.0000	
(CTT)	-0.2151	-0.5108	0.2691	0.2396	0.4036*	0.6136**	0.7502**	1.0000

^a Males assigned value 1.00 and females 2.00 in computer program.

* Significant at the 95% level of confidence (d.f. = 36).

** Significant at the 99% level of confidence (d.f. = 36).

However, certain relationships were found to be highly significant. Skull width has a highly significant correlation at the 99% level of confidence with skull length (0.8010). The skull length and canine tooth length correlation coefficient (0.7916) is also significant at the 99% level of confidence. The canine tooth length-width and the canine tooth width-thickness relationships are also significant at this level possessing correlation coefficients of 0.7312 and 0.7502 respectively.

When the measurements were separated by sex and the cross correlations computed there were some interesting findings. The males in Table 1 with 22 degrees of freedom exhibited several correlations significant at the 99% level of confidence. These correlations were as follows: age-field dressed weight (0.8249); age-skull width (0.8775); age-skull length (0.8239); field dressed weight-skull length (0.8497); skull length-width (0.9347); skull length-canine tooth length (0.8732); skull width-canine tooth length (0.8167); and, canine tooth length-width (0.8055). The highest correlation outside of the skull width-skull length relationship was the age-skull width correlation (0.8775). The second highest was skull length-canine tooth length (0.8732).

On the other hand, females in Table 2 with only 13 degrees of freedom had only one relationship which was significant at the 95% level of confidence. This was the correlation between skull length and canine tooth length (0.8097). When both sexes were lumped together in Table 4 this was again the highest correlation (0.7916) next to the skull length-width correlation (0.8018).

The 1967 bear kill, in conformance with the cyclic character of bear harvests, should have been a year in which only 300 bears were shot. However, due to the presence of tracking snow, the first in many years during the bear season, and a great many hunters afield, the harvest soared to 568 animals.

It is also believed that the bears killed on the study area in 1968 were immigrants from other sections of the north-central Pennsylvania bear range. The lack of bear sign that had been noted in the study area prior to September cannot be ignored. With the beginning of the mast fall, signs of bear activity began to increase as a result of the animals moving onto the plateau section of the Quehanna area to take advantage of the mast, which was absent from much of the adjacent range. The fact that 84% of the bears checked were males would support the immigration premise since the females would be expected to remain nearer their normal denning areas than the more aggressive males. The sex ratio of the 1967 harvest favored females slightly but the 1968 figures demonstrated an opposite trend. Moreover, the average of the two years results in a near even number of males and females harvested.

A drastic decline in the population was indicated by the size of the 1968 harvest, 218 animals, and observations by personnel in the field. The number of black bears in Pennsylvania was felt to be far below the carrying capacity of the usable range. The age structure data provided definite information as to the condition of the bear population. When the 1968 sample was compared against the 1967 sample it was evident that the population had been overharvested.

As a result either directly or indirectly the 1969 season was reduced in length from the regular six day season to a three day season. Apparently the action was justified for the 1969 harvest was only 250 bears, well below the 29 year average of 384 animals per year. This was followed in 1970 by a complete closure of the bear season.

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