HARVEST AND POPULATION CHARACTERISTICS OF BLACK BEARS IN OREGON (1971-74)[1]

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Abstract: Sixty-six percent of black bears (*Ursus americanus*) harvested in Oregon during the 1971-74 sport-hunting seasons were killed by persons hunting other game at the time. Male bears, however, were harvested most heavily during the months when the majority of bears taken were killed by persons hunting exclusively for bears. Most females bred as 3- or 4-year-olds but produced fewer cubs in their first litter than were produced by bears older than 5 years. Survival of females in age-classes 1-5 was significantly higher than survival of males in the same age-classes. Survival did not differ between sexes in bears older than 6 years.

In 1961, the state legislature granted to the Oregon Department of Fish and Wildlife the authority to manage the black bear. The initial management authority excluded those areas of the state where bears could be expected to damage trees. Although the Department has gradually increased its control over management to its present statewide basis, liberal damage control policies still prevail. Biological knowledge necessary for proper management of the bear did not increase proportionately to the Department's increased management authority. Management decisions were based largely on harvest levels of the previous years.

This paper describes characteristics of the annual harvest and demographic characteristics of the hunted population in Oregon between 1971 and 1974 and discusses biases encountered in the analysis of data collected from hunter-killed bears.

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METHODS

Between September 1971 and September 1974, teeth and reproductive tracts were collected from black bears killed in Oregon. Taxidermists, sportsmen's clubs, persons involved in bear damage control programs, and individual sportsmen cooperated by saving either teeth or teeth and reproductive tracts. Questionnaires, requesting information on sex, age, and date and location of kill, were mailed annually between 1972 and 1974 in February or March to persons known to have killed a bear during the preceding sport-hunting season. The sport season for black bears extended from 1 August to 31 December. Most damage control hunting was done between April and August.

The maximum length and thickness of the root of each canine tooth were measured to determine sex of the bear (Sauer 1966, Guenther 1970). Teeth were decalcified and sectioned (Lindzey and Meslow 1972) and age was assigned to each bear on the basis of counts of dark-staining bands in the cementum (Marks and Erickson 1966, Stoneberg and Jonkel 1966).

Reproductive tracts were frozen or preserved in Bouin's fluid until examined. Ovaries were examined macroscopically for rupture sites and then serially sectioned with a razor blade. Measurements were made of corpora lutea and largest follicles. Each cornu of the uterus was cut open and examined for placental scars (Erickson and Nellor 1964, Poelker and Hartwell 1973).

RESULTS AND DISCUSSION

Characteristics of the Annual Harvest

Of the 585 completed questionnaires returned during the study, 66 percent were from persons whose names had been furnished by taxidermists, and the remainder were from persons who had written to us or had responded positively to the bear section of the annual big game harvest questionnaire sent out by the Oregon Department of Fish and Wildlife. Because we felt that these returns may have been biased if persons tended to take only bears of a certain age or sex to taxidermists, we compared the frequency of reported cub, yearling, and adult bears and the frequency of males and females in the taxidermist portion of questionnaires to similar frequencies in the remainder of the questionnaires. Because we found no significant difference in either sex ($P > 0.05$, $X^2 = 0.12$, df = 1) or age ($P > 0.05$, $X^2 = 2.04$, df = 2) frequencies between the two segments, the entire sample was considered representative of the annual harvest.

Between 1971 and 1973, 65.8 percent of bears killed were taken by persons hunting other game animals at the time (incidental harvest). The incidental harvest made up the greatest percentage of monthly kill in October and November, months that included the deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) seasons. Willey (1971:6) found that a sizable percentage of Vermont's annual kill of black bears occurred during the first weekend of the white-tailed deer (*O. virginianus*) season.

Analysis of questionnaire returns indicated that the largest percentages of male bears in monthly harvests occurred during August and December (Table 1), the months with the largest exclusive harvests (94 and 80 percent — bears killed by persons hunting only for bears). Active selection by the hunters for larger bears and increased vulnerability because of feeding habits (Willey 1971:10) undoubtedly contributed to the unequal sex ratio. The tendency of male bears to enter dens later than females (Erickson 1964, Lindzey and Meslow 1976) makes them proportionately more available to hunters during the latter part of the season. The proportions of males and females in the monthly harvests between September and November remained relatively constant. Willey (1971:6) concluded that during the deer season, differential vulnerability was not expressed because bears may simply be shunted from one hunter to another until shot.

Although more male bears were reported to have been killed than females (178:100), we found, as did Erickson (1964:86) in Michigan, that hunters tended to report females as males. Corrected to account for this bias (see below), the proportion of males to females reported in the questionnaires no longer differed significantly from 1:1 ($P > 0.05$, $X^2 = 1.87$, df = 1). This fact, however, assuming that sex report bias is constant through the season, does not negate the apparent differences in harvest levels of the sexes among months.

Reports of age (cub, yearling, adult) on questionnaires are undoubtedly biased (Poelker and Hartwell 1973:126). If we assume that the magnitude of this bias also remains constant through the season, age compositions of the monthly harvest may be compared (Table 2). Few cubs and yearlings were killed during August and December. This result was to be expected if hunters selected for larger bears during these months. Earlier den entrance by yearlings (Lindzey and Meslow 1976) would make them less available to the hunter than adult males during the last part of the hunting season.

Table 1. Sex of black bears and month of harvest in Oregon as reported in questionnaires (1971-73).

Month	Male		Female	
	Number	Percent	Number	Percent
August	38	70.1	16	29.9
September	53	60.9	34	39.1
October	181	63.3	105	36.7
November	51	64.6	28	35.4
December	7	77.8	2	22.2
Total	330	64.1	185	35.9

Table 2. Age of black bears and month of harvest in Oregon as reported in questionnaires (1971-73).

Month	Cub		Yearling		Adult	
	Number	Percent	Number	Percent	Number	Percent
August	1	1.9	5	27.8	38	70.4
September	4	4.7	34	39.5	48	55.8
October	14	4.9	89	31.3	181	63.7
November	6	7.7	18	23.1	54	69.2
December	0	0	1	11.1	8	88.9
Total	25	4.9	157	30.7	329	64.4

Collection of Teeth

Teeth were collected from 349 black bears killed during the 1971-73 sport-hunting seasons and from 150 additional bears killed during damage control programs. Because we lacked data on location of kill for many of the bears, we were unable to divide the sample on the basis of geographical regions of the state. However, over 90 percent came from the region west of the Cascade Mountains.

The possibility of differences in behavior between the sexes, that could cause survival rates to differ (Erickson and Petrides 1964, Jonkel and Cowan 1971, Willey 1971:6), necessitated partitioning the sample into males and females. We tested the validity of using Guenther's (1970) maximum root length measurement for determining sex of bears in a sample. We compared measurements he reported (males = 48-60 mm females = 37-49 mm with measurements of teeth in our sample that were accompanied by a reproductive tract and thus of known sex. Of these comparisons (N = 61), 95.1 percent agreed; the 3 comparisons that disagreed were of teeth accompanied by male reproductive organs but were determined to be those of females by canine root measurement. These samples may have been incorrectly packaged by cooperators, because the maximum root measurement of each (36.0, 34.3, and 43.5 mm) was less than the minimum measurements for males; these bears were 20, 13, and 3 years old, respectively.

Sex was determined for bears represented by teeth in the collection on the basis of the maximum canine root measurement. If the bear was represented in the collection by only an incisor or premolar, or the canine root was shattered or not closed, sex was determined by the following criteria in this order: (1) the reproductive organs that accompanied the tooth, (2) sex recorded by the sportsman or taxidermist, (3) sex reported on questionnaires. Seventy-three teeth, however, either did not have closed canine roots or their maximum root measurements were in the area where measurements for the 2 sexes overlapped and other criteria for determining sex of these bears were not available. Of these teeth, 46 (63 percent) were those of nonreproducing (see below) 1- and 2-year-olds; 11 (15 percent) were from 3-year-olds; and the remainder (22 percent) were from bears 4 years old or older. These 73 bears were apportioned as to sex on the basis of the proportions of males and females already in the respective age-classes.

Because collections of samples from game animals are frequently provided by hunters, and possibly subject to active and inactive biases, we compared sex as based on canine root measurements with hunter reports in an effort to determine where biases occurred and how large they were. Sex of bears as recorded by taxidermists and individual sportsmen (N = 61) agreed with our determinations of the bears' sex 80.3 percent of the time. We found, however, only a 75 percent agreement between sex of bears as reported on questionnaires and our determinations; 80 percent of these discrepancies involved females recorded as males. Hunters taking part in damage control programs were requested either to collect teeth from both sexes but only female reproductive organs or to collect teeth and reproductive organs from both sexes. Of the teeth from the first collecting scheme (not accompanied by reproductive tracts, N = 28), only 60.7 percent of the reports of sex of bears by hunters agreed with our determinations. All disagreements were of bears recorded as males by hunters but classified as females by canine root measurement. Damage control hunters that were requested to collect only female reproductive organs but teeth from both sexes presumably recorded a female bear as a male if they had lost or failed to collect the reproductive organs. The sex of bears recorded by hunters requested to collect reproductive organs and teeth from both sexes agreed 95 percent of the time with our determinations of sex, which suggests a 5 percent error in marking and packaging such samples.

Age Composition of Sample

Because we found no significant difference in the frequencies of 1- and 2-year-olds and older bears among the 2 samples from control programs and the sample from the sport-hunting seasons ($P > 0.05$, $X^2 = 1.39$, df = 2), the 3 subsamples were combined (Table 3). Cubs and yearlings (1-year-olds) combined represented 21 percent, and older bears 79 percent, of the total sample. Analysis of the questionnaires indicated that cubs and yearlings combined made up 36 percent and adults 64 percent of the annual harvest. On the assumption that hunters tended to report cubs as yearlings and yearlings as older bears (adults), but not older bears as cubs or yearlings, the difference between the number of cubs and yearlings in our sample and the number actually harvested, as indicated by questionnaire analysis, may have been even greater than the difference indicated.

For their proportion in the sample to equal the proportion they constituted in the annual harvest (questionnaire), 124 additional bears were required in the cub and yearling age-classes combined. We considered the addition of 124 bears to our sample as a conservative correction of the sample to make it more representative of the annual kill in the cub and yearling age-classes. These 124 bears were distributed equally (31) among the male cub, female cub, male yearling, and female yearling segments of the sample (Table 3).

Reproduction and Recruitment Rates

Age at first breeding, frequency of litters, and litter size are basic reproductive parameters that influence the reproductive potential of a population. Each of these appears variable for the black bear among regions of North America. Female black bears were observed to breed at 3 years of age by Erickson and Nellor (1964), Poelker and Hartwell (1973), and Lindzey and

Table 3. Time-specific life tables for 250 male and 248 female black bears killed in Oregon, 1971-74, and survival rates for males and females combined. Sample data were entered in the d_x column.

Age in years	Males					Females					Males + females	
		d_x	l_x	s_x			d_x	l_x	s_x		s_x	
0	12	43[a]	312	0.862		12	43[a]	310	0.861		0.862	0.785[b]
1	48	79[a]	269	0.706		32	63[a]	267	0.764		0.735	
2		51	190	0.732			33	204	0.838		0.787	
3		36	139	0.741			36	171	0.790		0.768	
4		18	103	0.825			19	135	0.859		0.845	
5		18	85	0.788			19	116	0.836		0.816	
6		18	67	0.731			16	97	0.835		0.793	
7		9	49	0.816			16	81	0.803		0.801	
8		9	40	0.775			11	65	0.831		0.810	
9		7	31	0.774			5	54	0.907		0.859	
10		7	24	0.708			13	49	0.735		0.726	
11		4	17	0.765			6	36	0.833		0.811	
12		3	13	0.769			7	30	0.767		0.767	
13		4	10	0.600	0.772[c]		7	23	0.696	0.811[c]	0.667	0.791[c]
14		1	6	0.833			6	16	0.625		0.682	
15		0	5	1.000			2	10	0.800		0.867	
16		1	5	0.800			2	8	0.750		0.769	
17		0	4	1.000			2	6	0.667		0.800	
18		1	4	0.750			0	4	1.000		0.880	
19		0	3	1.000			1	4	0.750		0.857	
20		0	3	1.000			0	3	1.000		1.000	
21		0	3	1.000			1	3	0.667		0.833	
22		2	3	0.333			1	2	0.500		0.400	
23		1	1	0.000			0	1	1.000		0.500	
24							0	1	1.000		1.000	
25							0	1	1.000		1.000	
26							0	1	1.000		1.000	
27							1	1	0.000		0.000	
Total		312					310					
				s = 0.775[d]					s = 0.818[d]		s = 0.798[d]	

[a] Corrected values to account for bias in the sample (see text).
[b] Survival rate if deaths of orphaned cubs are included (see text).
[c] Average annual survival rate of bears 5 years old and older.
[d] Average annual survival rate.

Meslow (1977), but Stickley (1961) observed a female that bred as a 2-year-old, and Jonkel and Cowan (1971) observed no females younger than 4.5 years of age in estrus or females younger than 6.5-7.5 years of age with cubs. Although female black bears have the potential of producing cubs biennially after their first litter, this frequency may not be realized. Jonkel and Cowan (1971) observed 9 adult females that did not have litters for 3 consecutive years. Size of litters may vary between 1 and 6 cubs (Rowan 1945).

Corpora lutea, mature follicles, and placental scars have been used as estimators of ovulation rates and conception rates, respectively. Erickson and Nellor (1964:34) concluded that it was unlikely that paracorpora lutea or accessory copora lutea would be included in corpora lutea counts, suggesting that counts of corpora lutea should indicate numbers of ova shed. They futher concluded that both ova loss and intrauterine mortality of embryos and fetuses were low. The counts of corpora lutea should provide a relatively unbiased estimate of primary production (cubs born). Jonkel and Cowan (1971) concluded that counts of mature follicles could overestimate ovulation rate. This conclusion was based on finding both atretic and mature follicles and corpora lutea in the ovaries of 2 female bears. The presence of mature follicles may, however, be used as an indicator of sexual maturity of that female, and the frequency of females with mature follicles can indicate the timing of the breeding season.

Erickson and Nellor (1964:23) used counts of placental scars as indicators of conception rates. They found no bear in which the count of recent placental scars was fewer than the young known to have been produced by the female. Hensel et al. (1969:364) found, however, evidence of placental scar disappearance in brown bears (*U. arctos*). They were unable to identify placental scars in the uteri of 2 females killed 8 and 21 months postpartum, whereas scars were obvious in the uteri of 4 females killed 4-15 months postpartum. Although placental scars are valid indicators of previous pregnancies, and, with bears pregnant only once, are valid indicators of the size of the one litter, we feel that the absence of dark placental scars should be cautiously interpreted as indicating that the bears were not pregnant in the preceding 2 years.

Between 1972 and 1974, we collected reproductive tracts from 77 female black bears; about 70 percent of these came from the northwest part of the state. We found no mature follicles (≥ 8 mm, Poelker and Hartwell 1973:77) in ovaries of bears killed before 14 June or after 19 July, or corpora lutea in ovaries of bears killed before 22 July. The peak frequency of occurrence of mature follicles in ovaries was during the first week in July. The youngest bears in which we observed corpora lutea or mature follicles were 3-year-olds, suggesting that females may breed first as 3-year-olds but not before. The average number of corpora lutea in ovary pairs of pregnant females ($n = 17$) was 2.18. This average is below that found in Michigan (2.42, Erickson and Nellor 1964:37) but above the average in western Washington (1.9, Poelker and Hartwell 1973:83) and Montana (1.8, Jonkel and Cowan 1971:27). The average number of corpora lutea per ovary pair was 1.21 in all females 3 years old and older collected after 21 July. All 5-year-old females except 1 had placental scars in their uteri, suggesting that most, if not all, 5-year-old females had been pregnant either as 3- or 4-year-olds. Ovary pairs of the 2 4-year-old females in our collection contained either corpora lutea or mature follicles, indicating that they had or would have bred as 4-year-olds. Uteri of neither of these females, however, contained placental scars to indicate that they had bred as 3-year-olds. Placental scars in these females would have had to persist only 5 and 6 months (parturition occurs about 1 January).

If all female black bears breed either as 3- or 4-year-olds, then the number of 4-year-olds that bred is indicative of 3-year-olds that did not breed. In our sample, we found that a minimum of 22.2 percent (2 of 9) of 3-year-old females did not breed. If we assume that the presence of follicles greater than 4 mm in size (maximum follicle size of bears younger than 3 years) in ovaries of females collected after 12 May (earliest date 4-mm follicles were observed) indicated that a bear would have bred that breeding season, 1 of 7 3-year-olds (14.3 percent) did not breed. The inclusion of a female with follicles only 4.5 mm when collected on 19 June as a nonbreeder would, however, increase the percentage of nonbreeding 3-year-olds to a minimum of 28.6 percent. If the criterion of follicle size is applied to 5-year-olds, 2 (28.6 percent) would not have bred, presumably because they bred as 4-year-olds. The average of the 4 estimates of the percentage of 3-year-old females that did not breed was 23.4

Litter size of 3- or 4-year-old females appeared smaller than that of older females. The average number of placental scars in 5-year-old females, produced by the 1 previous pregnancy, was 1.14. Mean number of corpora lutea per ovary pair was 2.29 in pregnant females 5 years of age and older. The average ovulation rate of all 5-year-old and older females collected after 22 July (15) was 1.07; 47 percent of these females had ovulated. Ransom (1967:118) found yearling white-tailed deer does to have significantly lower ovulation rates than older does. Provost (1958:47) concluded that beavers (*Castor canadensis*) had smaller litters during the first and second years of their reproductive life than later.

Reproductive rate of females 5 years of age and older, based on corpora lutea counts, was 1.07 cubs per female. Younger females, however, bred either as 3- or 4-year-olds and produced an average of 1.14 cubs. Reproductive rates for these age-classes, apportioned on the basis of the frequency of females breeding in each age-class (76.6 percent for 3-year-olds and 23.4 percent for 4-year-olds), were 0.97 and 0.27, respectively.

Although females with cubs were not protected during the term of the study, our experience indicated that many hunters would not shoot females with cubs. Thus, because we relied on hunters to collect reproductive tracts, pregnant females may have been overrepresented in the sample, resulting in overestimation of reproductive rates. We received reproductive tracts from only 2 4-year-olds, the age-class that presumably would include the largest percentage of females with young, while receiving 9 from 3-year-olds and 7 from 5-year-olds. Behavioral traits that may contribute to differing vulnerability of females with and without cubs would similarly bias the determination of percentage of females breeding and therefore bias estimates of total production.

Survival Rates

The time-specific or vertical life table was used to calculate survival rates. The assumptions of stable age distribution and stationary population size were made in the absence of quantitative data to the contrary. We assumed our sample to be a representative sample of ages at death, and thus entered it in the d_x column (Table 3). Implicit in the assumption that this hunter-killed sample represented frequencies of ages at death is that bears dying of other causes die in the same frequency with respect to age-classes. We feel that this assumption was probably not met in the 0 (cub) age-class but was valid for older-aged bears. Natural mortality (mortatlity other than hunter-caused) is difficult to estimate in a hunted population. Lindzey and Meslow (1977), however, observed no natural mortality of bears older than 1 year on an island in southwestern Washington where bears were hunted with bow and arrow. Compensatory mechanisms probably act to decrease natural mortality in a hunted population. We feel that hunting — sport hunting, and damage control hunting combined — is the dominant cause of death of bears older than 1 year in Oregon. Also, we have no reason to suspect that natural mortality would be different from hunter-induced mortality as it affects bears older than 1 year.

Jonkel and Cowan (1971:31, 40) estimated survival rates of black bears between 0.5 and 1.5 years of age as 95 percent when research and hunting mortalities were excluded but as 86 percent when deaths by these causes were included. They estimated an annual survival rate of adults of 86 percent from bears marked as adults or subadults and observed later, and an average annual survival rate of 77.5 percent for the entire population, which included subadults; hunting and handling mortalities were also excluded when these survival rates were calculated. Kemp (1972:30) estimated black bear survival rates in an unexploited population in Alberta, based on a trap-retrap program, to be 73.3 percent, 63.3 percent, and 62.5 percent for cubs, 1-year-olds, and 2-year-old bears, respectively; the average annual adult (over 3 years) survival rate was 87.5 percent. In Michigan, Erickson and Petrides (1964:66) estimated maximum annual survival rates of tagged cubs, yearlings, and older bears of 74, 96, and 79 percent, respectively, and a maximum annual survival rate for the population of 81 percent. Tags returned after the bears had been killed either as nuisances or during the sport-hunting season provided the basis for these calculations. Poelker and Hartwell (1973:129) estimated annual average survival to be between 82 and 85 percent for a tagged sample of black bears killed in Washington.

The average annual survival rate for the population of bears that we sampled was 79.8 percent (Table 3). Survival rates for 2- and 3-year-old bears were 78.7 percent and 76.8 percent, respectively; the average annual survival rate for bears 5 years and older was 79.1 percent. We feel that the survival rate for cubs (86.2 percent) may be an overestimate. Cubs are probably subjected to greater natural mortality, not compensated for by hunting mortality, than older bears and thus the sample of cubs that we collected was probably not proportional to the total deaths of cubs incurred from all causes of mortality. Although Erickson (1959) observed that some cubs orphaned at 6 months of age may live up to 117 days and that 1 cub abandoned at 7.5 months survived for a year, many orphaned cubs undoubtedly die. If we assume that half of the cubs orphaned when their mothers were killed died and were, therefore, not present as 1-year-olds on the next anniversary date (1 April), then cubs produced (Σy_x = 640) were exposed to one-half the age-specific mortality rate of their mothers ($y_x \cdot 1 - s_x \cdot 0.5$). For the purpose of this calculation, survival rates were assumed equal for females with and without cubs. We considered these deaths (N = 60) additive to those previously accounted for and included them in the d_x entry of age-class 0 (Table 3). Accounting for deaths of orphaned cubs in this manner resulted in a reduction of survival rates for the cub age-class to 0.785.

Survival of females in age-classes 1-5 was significantly higher ($P < 0.05$, $X^2 = 10.19$, df = 1) than that of males in these same age-classes (Table 3). Survival did not differ significantly, however, between the sexes ($P > 0.05$, $X^2 = 1.51$, df = 1) in bears 6 years old and older.

LITERATURE CITED

CAUGHLEY, G. 1966. Mortality patterns in mammals. Ecology 47(6):906-918.

ERICKSON, A. W. 1959. The age of self-sufficiency in the black bear. J. Wildl. Manage. 23(4):401-405.

———. 1964. An analysis of black bear kill statistics for Michigan. Michigan State Univ. Agric. Exp. Stn. Res. Bull. 4:68-102.

———, AND J. NELLOR. 1964. Breeding biology of the black bear. Michigan State Univ. Agric. Exp. Stn. Res. Bull. 4:5-45.

———, AND G. A. PETRIDES. 1964. Population structure, movements, and mortality of tagged black bears in Michigan. Michigan State Univ. Agric. Exp. Stn. Res. Bull. 4:46-67.

GUENTHER, K. S. 1970. Black bear related to age and sex. M.S. Thesis. Univ. of Idaho, Moscow. 72pp.

HENSEL, R. J., W. H. TROYER, AND A. W. ERICKSON. 1969. Reproduction in the female brown bear. J. Wildl. Manage. 33(2):357-365.

JONKEL, C. J., AND I. MCT. COWAN. 1971. The black bear in the spruce-fir forest. Wildl. Monogr. 27. 57pp.

KEMP, G. A. 1972. Black bear population dynamics at Cold Lake, Alberta, 1968-70. Pages 26-31 *in* S. Herrero, ed. Bears — their biology and management. IUCN Publ. New Ser. 23.

LINDZEY, F. G., AND E, C. MESLOW. 1972. Developments in wildlife age determinations exemplified by the black bear. Proc. Annu. Conf. Western Assoc. State Game and Fish Commissioners 52:295-307.

———, AND ———. 1976. Winter dormancy in black bears in southwestern Washington. J. Wildl. Manage. 40(3):408-415.

———, AND ———. 1977. Population characteristics of black bears on an island in Washington. J. Wildl. Manage. 41(3):408-412.

MARKS, S. L., AND A. W. ERICKSON. 1966. Age determination in the black bear. J. Wildl. Manage. 30(2):389-410.

POELKER, R. J., AND H. D. HARTWELL. 1973. The black bear of Washington. Washington State Game Dept. Biol. Bull. 14. 180pp.

PROVOST, E. E. 1958. Studies of reproduction and population dynamics in beaver. PhD. Thesis. State Coll. of Washington, Pullman. 78pp.

RANSOM, A. B. 1967. Reproductive biology of deer in Manitoba. J. Wildl. Manage. 31(1):114-123.

ROWAN, W. 1945. Numbers of young in the common black bear and grizzly bear in western Canada. J. Mammal. 26(2):197-199.

SAUER, P. R. 1966. Determining sex of black bears from the size of the lower canine tooth. New York Fish Game J. 13(2):140-145.

STICKLEY, A. I., JR. 1961. A black bear tagging study in Virginia. Proc. Annu. Conf. Southeast. Assoc. State Game and Fish Commissioners 15:43-54.

STONEBERG, R. P., AND C. J. JONKEL. 1966. Age determination of black bears by cementum layers. J. Wildl. Manage. 30(2):411-414.

WILLEY, C. H. 1971. Vulnerability in Vermont's black bear population. Vermont Fish Game Dept. Fed. Aid in Wildl. Restor. Job Prog. Rep., Proj. W-38-R. 40pp.