MICHIGAN DEPARTMENT OF NATURAL RESOURCES
Wildlife Division Report No. 2960
December 1983

USE OF LOWER CANINE TEETH FOR DETERMINING THE SEX OF BOBCATS IN MICHIGAN

by
Paul D. Friedrich, George E. Burgoyne, Jr.,
Thomas M. Cooley, and Stephen M. Schmitt

Introduction

Since 1980, annual surveys using entire bobcat (Felis rufus) carcasses obtained from cooperating hunters and trappers have been conducted in Michigan. Future collections could be more efficient and economical if the lower canine teeth of bobcats, which are used to estimate age, could also be used to determine sex. Johnson et al. (1981) indicated that maximum root thickness of canine teeth could be used to determine the sex ratio of adult bobcats harvested in Kansas. Sexual dimorphism of canine teeth has also been demonstrated in black bear (Ursus americanus) by Sauer (1966), raccoon (Procyon lotor) by Grau et al. (1970), and fisher (Martes pennanti) by Parsons et al. (1978). The purpose of this study was to evaluate the feasibility of using measurements of lower canines for determining the sex of Michigan bobcats.

Materials and Methods

Bobcats harvested during the fall and winter of the 1981-82 and 1982-83 seasons were aged by examining permanent lower canine teeth for open root canals and by counting cementum annuli (Crowe 1975, Friedrich et al. 1981). The reproductive histories of females were established by ovarian inspection (Cooley et al. 1982, 1983). Maximum root width and maximum root thickness of permanent lower canines were measured to the nearest 0.01mm following the methods of Parsons et al. (1978) and Sauer (1966). The means and standard deviations for these values were determined for each sex and age class, compared for significant differences (analysis of variance and Student's t-test), and used to compute dividing points between the sexes. Preliminary criteria for determining the sex of juveniles ($\leq$ 1 yr.) and adults (> 1 yr.) were developed from the analysis of data from the 1981-82 bobcat season. These criteria were tested with an independent data set collected from the 1982-83 season. Final criteria were developed by pooling the two data sets.

Results and Discussion

A total of 191 bobcats were examined during the two seasons of collection: 37 juvenile males; 25 juvenile females; 76 adult males; and 53 adult females. In the initial analysis of the 1981-82 data set, measurements of maximum root width and maximum root thickness were used to develop separate criteria for determining the animal's sex. While these criteria performed reasonably well, it appeared that simultaneous consideration of both measurements would provide more reliable criteria to differentiate the sexes of bobcats. A new variable was created by multiplying the maximum canine root width by the maximum root thickness for each bobcat. This value is approximately proportional to the maximum cross-sectional area of the tooth root and reflects the shape of the

tooth. This composite variable, hereafter denoted as MRA, was used for the remainder of the analysis.

The mean MRA's for the bobcats examined were significantly ($P \leq 0.01$) different by age (juveniles and adults) and sex. Based on the 1981-82 data (Table 1), juveniles having MRA's less than or equal to 37.71mm^2 were most likely to be females, while juveniles with larger MRA's were most likely to be males. Adults having MRA's less than or equal to 41.64mm^2 were most likely to be females, while adults with larger MRA's were most likely to be males.

The independent 1982-83 data set was collected to test these criteria. It was found that 87.5% (14/16) of the 1982-83 juveniles classified as males were, in fact, males, and 91.7% (11/12) classified as females were, in fact, females (Table 2). Similarly, 97.5% (39/40) of the 1982-83 adults classified as males were, in fact, males, and 96.8% (30/31) classified as females were, in fact, females (Table 2). Overall, 94.9% (94/99) of the 1982-83 specimens were correctly classified to sex based on criteria developed from the 1981-82 MRA's.

Since comparison of the 1981-82 and 1982-83 data revealed no significant differences in the MRA means ($P \leq 0.01$), it was decided to pool the two data sets and derive refined criteria for determining the sex of bobcats (Table 3). Combining the two data sets resulted in a dividing point of 38.46mm^2 for juveniles and 41.48mm^2 for adults. In each case animals having MRA values larger than their respective criterion were more likely to be males and those having values smaller than or equal to the criterion were more likely to be females.

From the pooled sample of 1981-82 and 1982-83 data, the performance of the refined criteria was as follows: For juveniles, 89.5% (34/38) classified as males were, in fact, males, and 87.5% (21/24) classified as females were, in fact, females (Table 4). For adults, 97.4% (74/76) classified as males were, in fact, males, and 96.2% (51/53) classified as females were, in fact, females (Table 4). Overall, 88.7% (55/62) of the juveniles and 96.9% (125/129) of the adults were correctly sexed. Combined, 94.2% (180/191) of the bobcats examined were correctly sexed by the refined criteria.

It was assumed in this study that there were no significant errors in using open and closed canine root canals for identification of juvenile and adult bobcats respectively. This assumption was supported by the fact that none of the females examined in this or previous surveys (Cooley 1980, Cooley et al. 1981, 1982, 1983, Hoppe 1980) with open canine root canals had completed a reproductive cycle. All of the females with closed root canals had completed at least one reproductive cycle. These findings are different than those reported by Johnson et al. (1981), where it was found that juvenile bobcats in Kansas could not be reliably aged by open canine root canals. Fifteen percent of the females so aged had undergone one reproductive cycle and therefore may not have been juveniles. This difference may be due to an inability of odd age juvenile bobcats to survive the more severe Michigan winter.

The use of MRA for differentiating bobcat sexes resulted in error rates of 11.3% for juveniles and 3.1% for adults. Although these errors made the determination of sex for individual animals problematic, the technique was

sufficiently accurate for survey purposes. The sex ratios estimated by this method did not differ significantly from the actual ratios of the sample.

Management Application

Age and sex distributions of bobcats harvested in Michigan can be determined from the roots of their permanent lower canine teeth, eliminating the necessity of collecting entire carcasses.

Acknowledgements

We thank the bobcat trappers and hunters for their voluntary cooperation, and the DNR biologists and technicians for gathering the bobcat carcasses. Thanks are also extended to R. D. Earle, E. E. Langenau, and J. N. Stuht for their many helpful suggestions, and to J. S. Miller who assisted in the preparation of this report.

Literature Cited

Cooley, T. M. 1980. Unpublished data. Wildlife Pathology Laboratory, Michigan Dept. Nat. Resour.

_____, S. M. Schmitt, and P. D. Friedrich. 1981. Bobcat survey 1980-81. Michigan Dept. Nat. Resour. Wildl. Div. Rep. No. 2894. 13pp.

_____, _____, and _____. 1982. Bobcat survey 1981-82. Michigan Dept. Nat. Resour. Wildl. Div. Rep. No. 2916. 14pp.

_____, _____, and _____. 1983. Bobcat survey 1982-83. Michigan Dept. Nat. Resour. Wildl. Div. Rep. No. 2948. 13pp.

Crowe, D. M. 1975. Aspects of aging, growth, and reproduction of bobcats from Wyoming. J. of Mammal. 56:177-198.

Friedrich, P. D., R. D. Earle, and T. M. Cooley. 1981. Comparison of bobcat age estimates from annuli in the cementum of incisor and canine teeth. Michigan Dept. Nat. Resour. Wildl. Div. Rep. No. 2895. 6pp.

Grau, G. A., G. C. Sanderson, and J. P. Rogers. 1970. Age determination of raccoons. J. Wildl. Manage. 34:364-372.

Hoppe, R. T. 1980. Population dynamics of the Michigan bobcat (Lynx rufus) with reference to age structure and reproduction. M.S. Thesis. Michigan State Univ., East Lansing. 53pp.

Johnson, N. F., B. A. Brown, and J. C. Bosomworth. 1981. Age and sex characteristics of bobcat canines and their use in population assessment. Wildl. Soc. Bull. 9:203-206.

Parsons, G. R., M. K. Brown, and G. B. Will. 1978. Determining the sex of fisher from the lower canine teeth. N.Y. Fish and Game J. 25:42-44

Sauer, P. R. 1966. Determining sex of black bears from the size of the lower canine tooth. N.Y. Fish and Game J. 13:140-145.

Table 1. Maximum root width (mm) x maximum root thickness (mm) of permanent lower canines from bobcats harvested in Michigan during the 1981-82 season.

Age	Sex	N	Mean (mm^2)	Standard Deviation (mm^2)	Dividing Point Between Sexes (mm^2)	No. of Standard Deviations from Means
≤ 1 yr.	Male	22	43.68	5.87	37.71	1.017
	Female	12	33.95	3.70		
> 1 yr.	Male	36	48.66	5.00	41.64	1.405
	Female	22	35.92	4.07		

Table 2. Test of MRA (Maximum canine root width x thickness) criteria from 1981-82 data using 1982-83 individual MRA's.

Number of Juvenile Bobcats:

Anatomical Sex		Classified by MRA as: Male	Female
		16	12
Male	15	14	1
Female	13	2	11

Number of Adult Bobcats:

Anatomical Sex		Classified by MRA as: Male	Female
		40	31
Male	40	39	1
Female	31	1	30

Table 3. Maximum root width (mm) x maximum root thickness (mm) of permanent lower canines from bobcats harvested in Michigan during the combined 1981-82 and 1982-83 seasons.

Age	Sex	N	Mean (mm^2)	Standard Deviation (mm^2)	Dividing Point Between Sexes (mm^2)	No. of Standard Deviations from Means
≤ 1 yr.	Male	37	43.77	5.25	38.46	1.012
	Female	25	33.75	4.65		
> 1 yr.	Male	76	48.87	4.89	41.48	1.511
	Female	53	36.10	3.56		

Table 4. Overall performance of MRA (Maximum canine root width x thickness) criteria from pooled 1981-82 and 1982-83 data vs. individual MRA's.

Number of Juvenile Bobcats:

Anatomical Sex		Classified by MRA as: Male	Female
		38	24
Male	37	34	3
Female	25	4	21

Number of Adult Bobcats:

Anatomical Sex		Classified by MRA as: Male	Female
		76	53
Male	76	74	2
Female	53	2	51