

# Anatomical Development of Captive Bobcats in Mississippi

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*Abstract:* The eyes of bobcat (*Felis rufus*) kittens opened between 9 and 16 days of age in 3 stages (watering, beginning to open, and complete opening) lasting 1–2 days each. Birth weights averaged 125 g. Growth curves peaked at 60 weeks ( $\bar{x}$  = 10 kg) for males and at 55 weeks ( $\bar{x}$  = 8 kg) for females. Log transformations of nose to rump length, and front leg length were highly correlated with age ( $r \geq 0.94$ ).

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Managers require many techniques to estimate age of mammals and birds (Larson and Taber 1980). Aging criteria for the bobcat have not been described well and age estimates have been based on inferences from similarities in growth to the domestic cat (Jackson et al. 1988) or on a few observations of known-age animals. A known-age tooth eruption and replacement schedule has recently been developed for bobcats up to 30 weeks old (Jackson et al. 1988). However, it is frequently desirable to have several aging criteria to provide a high degree of confidence in the accuracy and reliability of age estimates.

Our objective was to document the relationship between anatomical growth and age of captive bobcats. This manuscript is dedicated to E. A. Gluesing who initiated the study and whose efforts and guidance made this study possible. We thank J. R.

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## Methods

Nine bobcat kittens (5 males and 4 females) were hand-raised in a laboratory at Mississippi State University until 6 months old. Thereafter, they were in an outdoor chain link fence complex. Diets and rearing environments for these kittens were described by Jackson et al. (1988).

Kittens were weighed daily until 6 months of age and then weekly until at least 650 days old. Body measurements, recorded to the nearest mm, were taken weekly until they were at least 650 days old. Measurements included front limb length (from the elbow), hind foot length, nose to rump length, tail length, heart girth, neck circumference, and ear length (from crown at base to tip of cartilage).

## Results

The eyes of the kittens opened in three stages (watering, beginning to open, and complete opening) over a period of 3–5 days. Each stage lasted 1–2 days. On the average, kittens' eyes began to water at about 10 days of age, started to open at 11–12 days of age, and were completely open by 13 days of age, with the ranges being 9–14, 10–15, and 11–16 days, respectively.

Birth weights taken on 4 kittens (1 male and 3 females) averaged 125 g. Weekly weights of female bobcats increased until about 55 weeks of age when they weighed about 8.0 kg ( $\pm 1.4$  kg SE) and were within the 7.7–9.0 kg range of adult female weights. Similarly, weekly weights of male bobcats increased until approximately 60 weeks of age when males weighed about 10.0 kg ( $\pm 2.4$  kg SE) and were within the 8–11 kg range of adult male weights.

Correlations of natural log ( $\ln$ ) transformations showed greater linearity of growth to age in male and female bobcats than did correlations of the nontransformed data or ranked data (Table 1). Log transformations of nose to rump length, front leg length (measured from the elbow), and weight were all highly correlated with age ( $r \geq 0.94$ ,  $P < 0.001$ ), whereas neck circumference of females ( $r = 0.86$ ,  $P < 0.001$ ) and ear length of males ( $r = 0.89$ ,  $P < 0.001$ ) were least correlated. Spearman's rank of the nontransformed data also showed high correlations of nose to rump length and front leg length with age ( $r \geq 0.89$ ,  $P < 0.001$ ). However, tail length of males and hind foot length of females were more highly correlated with age than was weight ( $r = 0.87$ ,  $P < 0.001$ , and  $0.90$ ,  $P < 0.001$ ; respectively). Prediction equations for natural log transformations of nose to rump length, front leg length, and weight are presented in Figures 1 and 2.

**Table 1.** Correlations<sup>a</sup> of various morphological parameters with age in captive male ( $N = 5$ ) and female ( $N = 4$ ) bobcat kittens in Mississippi.

	Pearson Product-moment		Pearson product-moment w/log transformation		Spearman's Rank	
	Male	Female	Male	Female	Male	Female
Total observations	476	325	476	325	476	325
Weight	0.82	0.81	0.95	0.94	0.79	0.88
Nose to rump	0.87	0.86	0.94	0.97	0.92	0.93
Tail	0.84	0.82	0.95	0.94	0.87	0.86
Hind foot	0.78	0.78	0.93	0.93	0.83	0.90
Front limb	0.83	0.83	0.95	0.96	0.89	0.92
Neck	0.74	0.71	0.91	0.86	0.67	0.66
Heart girth	0.72	0.71	0.91	0.90	0.65	0.63
Ear	0.76	0.78	0.89	0.92	0.76	0.88

<sup>a</sup>All correlations were significant at  $P < 0.001$ .

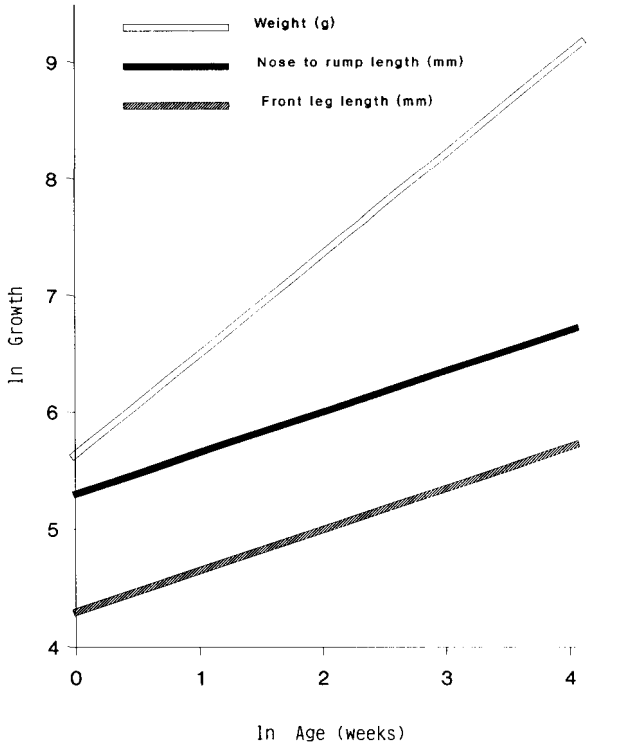
## Discussion

In our study, kittens' eyes opened between 10 and 13 days of age, in contrast to 3 and 11 days of age reported previously (Grinnell et al. 1937, Pollack 1950, Young 1958, McCord and Cardoza 1982). Our data closely approximate that determined for the domestic cat, suggesting that perhaps the younger ages reported previously were from incorrectly aged kittens. The timing of eyes opening should not vary as a result of geographical area or captivity.

The average birth weight (125 g) we found is about the same (128 g) of 3-day-old kittens reported by Gashwiler et al. (1961), but varies considerably from the birth weights (283–340 g) cited by Young (1958). There are 2 possible explanations for these differences in birth weights. First and most likely, are differences among geographical areas. There are anywhere from 8–12 different subspecies of bobcats in the United States (McCord and Cardoza 1982) and each subspecies varies in size, pelage, and habitat preferences. Therefore, bobcats in western states may have larger birth weights than bobcats in Mississippi. A second possibility for the differences in birth weights could be incorrectly aging of kittens found in the wild.

Growth curves peaked slightly later for males (60 weeks) than females (55 weeks), but did not differ as much as those reported by Colby (1974) (71 and 50 weeks, respectively) or Crowe (1975) (71 and 100 weeks, respectively). Weights of male and female kittens were similar for the first 140 days of age rather than 540 days as reported by Colby (1974). Peak weights of males and females (10 kg and 8 kg, respectively) approximated those in Crowe's (1975) study (11 kg and 8 kg, respectively). We did not observe a second growth spurt for males as reported by McCord and Cardoza (1982).

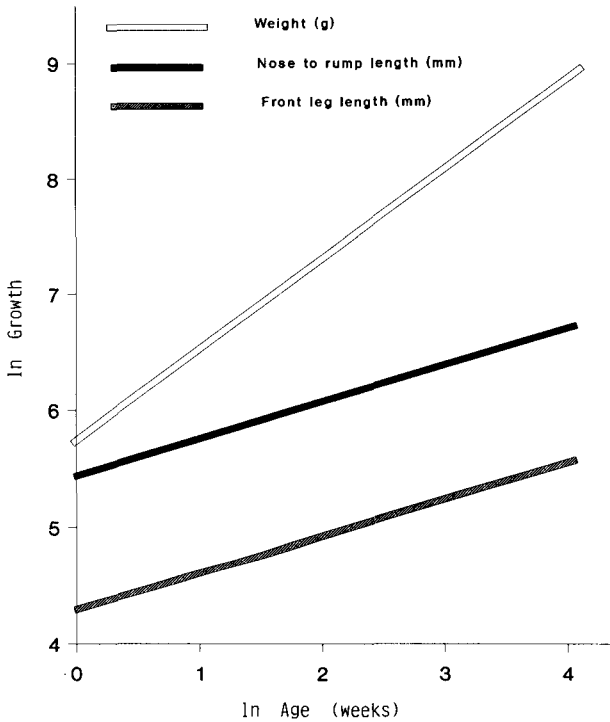
We discounted use of the Richard's growth model on the basis of our acquiring nonlinear regression analysis which requires a priori estimation of the parameters.



**Figure 1.** Regression lines of age on: body weight [ $\ln(Y) = 0.86(\ln x) + 562$ ], nose to rump length [ $\ln(Y) = 0.34(\ln x) + 5.35$ ], and front leg length [ $\ln(Y) = 0.34(\ln x) + 4.26$ ], for 5 captive male bobcats in Mississippi.

For example, in most cases the estimate generated by the model of the asymptote for several morphological characteristics and the respective age when that asymptote is reached were unrealistic. We fitted the data to a flexible growth function (Richards 1954). However, nonlinear regression analysis required concise a priori determination of the parameters to be estimated for the Richard's growth model. Additionally, when poor initial estimates are used in model development, nonlinear regression analysis may be ineffective (Afifi and Clark 1984:202–203). Consequently, when the analysis was performed, biologically unsound estimates were derived. We therefore concluded that application of the Richards growth model, which requires using nonlinear regression analysis, provided both statistically and biologically unsound results and was not used in subsequent analyses or data summarization.

Conley and Jenkins (1969) reported that body measurements are not good indicators of age. Growth rates for any animal can be expected to differ resulting from variation in food supply. The manner that food restrictions affect bobcat growth rates is unknown. However, we found growth rates of well-nourished captive bobcats to be reliable estimators of age. These data coupled with dental eruption patterns



**Figure 2.** Regression lines of age on: body weight [ $\ln(Y) = 0.79(\ln x) + 5.73$ ], nose to rump length [ $\ln(Y) = 0.32(\ln x) + 5.40$ ], and front leg length [ $\ln(Y) = 0.33(\ln x) + 4.26$ ], for 4 female bobcats.

(Jackson et al. 1988) could be used to estimate ages of kittens in the southeastern United States up to 60 weeks of age for males and 55 weeks of age for females.

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