Journal of the Arkansas Academy of Science

Volume 44 Article 30

1990

Analysis of the Fall and Winter Diet of the Bobcat in Eastern Arkansas

C. Renn Tumlison
Oklahoma State University

V. Rick McDaniel
Arkansas State University

ANALYSIS OF THE FALL AND WINTER DIET OF THE BOBCAT IN EASTERN ARKANSAS

RENN TUMLISON[1]
Department of Zoology
Oklahoma State University
Stillwater, OK 74078

V. RICK McDANIEL
Department of Biological Sciences
Arkansas State University
State University, AR 72467

ABSTRACT

Food habits of the bobcat *(Felis rufus)* in eastern Arkansas were examined based on stomach contents of 148 specimens. Rabbits (*Sylvilagus floridanus* and *S. aquaticus*) were the primary food source for males, females, and kittens. Rice rats *(Oryzomys palustris)*, nutria *(Myocastor coypus)*, and several species of waterfowl are first reported as food of bobcats in Arkansas. Cotton rats *(Sigmodon hispidus)* and muskrats *(Ondatra zibethica)* were more common in bobcat diets in eastern versus western Arkansas. Adult males did not use smaller prey but this food source was common in kittens; females were intermediate in their use of smaller prey.

INTRODUCTION

Many of the published studies of bobcat *(Felis rufus)* food habits do not treat sexes and ages independently, and generally those that do find little or no difference between these groups (Progulske, 1955; Korschgen, 1957; Gashwiler *et al.*, 1960; Kight, 1962; Bailey, 1972; Hall, 1973; Miller, 1980; Storey *et al.*, 1982). Differences between sexes or ages have, however, been documented (Fritts and Sealander, 1978; Litvaitis *et al.*, 1986) but the cause of the differences is still debated. A study was initiated in eastern Arkansas to examine the nature of prey consumed by bobcats and to add insight on the potential causes of any difference between sexes or between age classes.

MATERIALS AND METHODS

Stomachs were removed from carcasses of bobcats collected in eastern Arkansas during December-January trapping seasons of 1979 - 1981 and categorized as distended, half full, or empty. Procedures of food habit analyses were as described by Korschgen (1980). Diagnostic materials such as hair, bones, teeth, beaks, feet, and feathers were recovered for identification and enumeration. Frequency of occurrence was based on the total number of individuals of a prey taxon consumed rather than on the number of stomachs containing the prey. Identification was based on comparison with vertebrate collections housed at Arkansas State University (ASUMZ), a reference collection of dorsal guard hair, and several keys (Mathiak, 1938; Mayer, 1952; Moore *et al.*, 1974; Tumlison, 1983a). The minimum number of individuals of each prey taxon was estimated from conservative interpretation of prey fragments (Rotenberry, 1980; King, 1981).

Trapped bobcats tend to ingest almost anything within their reach (Fritts, 1973); therefore trap debris (mud, feces, plant parts, rocks) was not included in the analysis. Food habits data were recorded by percent occurrence, but volumetric analysis was not attempted due to bias. For example, variation in time between capture and death causes variation in the degree of digestion, affecting validity of volumetric analyses. An alternative approach used to examine diet based on consumed biomass was derived using "standard" weights of prey taxa acquired from literature sources (Tumlison, 1983b). The standard weight was the mean expected weight of a prey taxon. Yoakum (1965) noted that bobcats would ingest the entire biomass of a prey item up to ¾ the size of a jackrabbit *(Lepus californicus)*. This information was used to estimate a critical maximum consumable weight of 2025 g. We used the standard weight, with the size limitation, in lieu of volumetric data because it is thought to depict more adequately the importance of a food item. This approach will theoretically over-estimate the relative importance of some foods. For example, when two rabbits are found but their combined volume could not have been consumed, rabbits may be favored in the analysis. Only one rabbit usually was encountered, therefore the effect of this problem was minimal. Prey taxa weighing more than 2025 g were treated at this critical limit.

Prey taxa encountered in dietary analyses are often more indicative of availability than of preference, thus prey use was further analyzed according to size classes. Mammals were segregated into categories of small (< 400 g), medium (401 - 1000 g), and large (> 1000 g) and birds into small (< 500 g) or large (> 500 g). Analysis of prey size selection provides better insight into the meaning of the frequency distribution of food taxa. Because rabbits are apparently of near optimal size and have been identified as primary food items in many previous studies (Fritts, 1973; Hall, 1973; Bailey, 1979), they were treated separately from other members of their size class.

Analyses were conducted to discern dietary differences between sexes (adults only) and between age groups (kittens and adult females or adult males). Kittens may have food habits more similar to females because kittens remain with their mothers until fall or winter (Hamilton, 1942; Erickson, 1955). This possibility was evaluated by contingency table analysis (Sokal and Rohlf, 1981) and with the Sorenson similarity coefficient (Korschgen, 1980). Because kittens in our sample were about half the size of adults, and therefore had less gastric capacity, the critical consumable weight was treated at one-half the value of adults.

RESULTS

A total of 148 stomachs was obtained. Of these, 33 (22.3%) contained no identifiable remains. The remaining 115 (77.7%) contained remains ranging from a few hairs to entire undigested prey. The number of items recovered from individual stomachs averaged 1.5 (range 1-4). One prey item occurred in 74 stomachs, 2 in 32, 3 in 6, and 4 in 3. Stomachs with 3 or more items consistently contained smaller sized taxa (< 300 g). Stomachs at least half full occurred in 40.5% of the sample. Food items were 82.0% mammal, 17.4% bird, and 0.6% fish. Of the mammalian prey, rabbits (*Sylvilagus floridanus* and *S. aquaticus*) were the primary items by frequency and estimated weight (Tables 1-3). Small mammals were the second most important group by occurrence, but were least important by weight. Cotton rats *(Sigmodon hispidus)* and rice rats *(Oryzomys palustris)* comprised 69.0% of this group. Larger mammalian food items, third in importance by occurrence but second by weight, were dominated by deer *(Odocoileus virginianus)* and muskrat *(Ondatra zibethicus)*, together totalling 74.0% of the items in the group. The medium size class, represented by squirrels, was the least impor-

[1]Present address: Department of Biology, Henderson State University, Arkadelphia, AR 71923

tant mammalian class by occurrence and third by weight.

Small birds were twice as important as large birds by occurrence, but large birds were about 6 times as important by weight. A total of ten taxa of small birds were identified; most of the larger birds were waterfowl (Tables 1-3).

Table 1. Prey recovered from stomachs of male bobcats from eastern Arkansas, 1978-79 through 1980-81.

Prey	Freq. of Occurrence	% Occurrence	Estimated Weight (g)	% Weight
Small mammals	1	1.96	55.4	0.08
Glaucomys volans	1	1.96	55.4	0.08
Medium mammals	5	9.80	2925.0	4.02
Sciurus niger	3	5.88	2031.0	2.79
Sciurus carolinensis	2	3.92	894.0	1.23
Rabbits (*Sylvilagus* sp.)	25	49.02	42500.0	58.41
Large mammals	16	31.37	26428.5	36.32
Ondatra zibethicus	7	13.73	8228.5	11.31
Odocoileus virginianus	5	9.80	10125.0	13.92
Myocastor coypus	2	3.92	4050.0	5.57
Didelphis virginiana	1	1.96	2000.0	2.75
Ovis aries	1	1.96	2025.0	2.78
Small birds	3	5.88	190.9	0.26
Eastern Meadowlark	1	1.96	104.0	0.14
Red-winged Blackbird	1	1.96	50.0	0.07
Unident. Passerine	1	1.96	36.9	0.05
Large birds	1	1.96	658.3	0.90
Shoveler	1	1.96	658.3	0.90

Table 2. Prey recovered from stomachs of female bobcats from eastern Arkansas, 1978-79 through 1980-81.

Prey	Freq. of Occurrence	% Occurrence	Estimated Weight (g)	% Weight
Small mammals	6	13.95	553.8	1.13
Sigmodon hispidus	4	9.30	401.2	0.82
Peromyscus spp.	1	2.33	23.1	0.05
Mustela frenata	1	2.33	129.5	0.26
Medium mammals	4	9.30	2708.0	5.53
Sciurus niger	4	9.30	2708.0	5.53
Rabbits (*Sylvilagus* sp.)	21	48.84	35700.0	72.95
Large mammals	3	6.98	6075.0	12.40
Odocoileus virginianus	3	6.98	6075.0	12.40
Small birds	5	11.63	423.4	0.87
Sparrow	1	2.33	24.6	0.05
Bobwhite Quail	1	2.33	209.4	0.43
Unident. Passerine	2	4.65	36.9	0.08
Common Grackle	1	2.33	152.5	0.31
Large birds	4	9.30	3477.7	7.11
Wood Duck	2	4.65	1353.0	2.76
Pintail	1	2.33	947.0	1.93
Mallard	1	2.33	1178.0	2.41

Table 3. Prey recovered from stomachs of bobcat kittens from eastern Arkansas, 1978-79 through 1980-81.

Prey	Freq. of Occurrence	% Occurrence	Estimated Weight (g)	% Weight
Small mammals	22	33.85	1643.3	5.05
Sigmodon hispidus	10	15.38	1003.0	3.08
Oryzomys palustris	5	7.69	252.5	0.78
Peromyscus spp.	2	3.08	46.2	0.14
Microtus pinetorum	2	3.08	51.2	0.16
Neotoma floridana	1	1.54	264.8	0.81
Reithrodontomys sp.	1	1.54	11.2	0.03
Mus musculus	1	1.54	14.4	0.04
Medium mammals	2	3.08	1124.0	3.45
Sciurus niger	1	1.54	677.0	2.08
Sciurus carolinensis	1	1.54	447.0	1.37
Rabbits (*Sylvilagus* sp.)	24	36.92	24300.0	74.64
Large mammals	3	4.62	3037.5	9.33
Procyon lotor	1	1.54	1012.5	3.11
Didelphis virginiana	1	1.54	1012.5	3.11
Ondatra zibethicus	1	1.54	1012.5	3.11
Small birds	10	15.38	646.9	1.99
Sparrow	3	4.62	73.8	0.23
Unident. Passerine	2	3.08	73.8	0.23
Wood Thrush	1	1.54	50.6	0.16
American Kestrel	1	1.54	112.6	0.35
Domestic Pigeon	1	1.54	250.0	0.76
Brown Thrasher	1	1.54	66.3	0.20
Carolina Wren	1	1.54	19.8	0.06
Large birds	4	6.15	1803.1	5.54
Mallard*	3	4.62	1178.1	3.62
Barred Owl	1	1.54	625.0	1.92

* three apparent litter-mates partitioned one Mallard drake, therefore weight was treated as one duck

Adult male bobcats were represented by 49 samples, of which 41 contained remains. The mean number of items recovered per stomach was 1.2 (range 1-2). One prey item occurred in 33 stomachs and 2 were found in 8 stomachs. Stomachs at least half full occurred in 52.0% of the specimens.

Food selection by adult males (Table 1) indicated rabbits to be the primary prey by occurrence and weight. Large mammals exclusive of rabbits were the second ranking food source by occurrence and weight; combined with rabbits these accounted for 80.4% of the fall and winter diet of male bobcats. Small mammals were apparently selected against by adult males.

Fall and winter diet of adult female bobcats was determined from 41 stomachs, of which 33 contained prey remains. Stomachs contained a mean of 1.3 items (range 1-3). One prey item occurred in 24 stomachs, 2 in 8, and 3 in 1. Stomachs at least half full occurred in 29.3% of the specimens.

Food selection by adult females (Table 2) indicated rabbits to dominate by occurrence and weight. Small mammals were second in importance by occurrence, followed closely by small birds, large birds and medium mammals, and large mammals. By weight, rank of importance was large mammals, large birds, medium mammals, small mammals, and small birds.

Foods of kittens was determined from 51 stomachs, of which 36 contained prey remains. Stomachs contained a mean of 1.8 items (range 1-4). One prey item occurred in 14 stomachs, 2 in 15, 3 in 4, and 4 in 3. Stomachs at least half full occurred in 45.1% of the specimens.

Food selection by kittens (Table 3) indicated rabbits to dominate by occurrence and weight. However, small mammals were very close to rabbits in importance by occurrence, although they were third by weight. Kittens more often consumed small mammals and small birds than did adults. Small mammals were most often represented by cotton rats and rice rats.

Contingency table analysis of frequencies indicated that females and kittens did not select significantly different sets of prey ($G = 7.339$, $df = 5$) but males and females ($G = 14.967$, $df = 5$) and males and kittens ($G = 20.502$, $df = 5$) differed in frequencies of size classes taken. Analysis by weight suggested similar relationships (female:kitten, $G = 4.662$, $df = 5$; male:female, $G = 18.781$, $df = 5$; male:kitten, $G = 28.310$, $df = 5$). The critical value of G at $P = 0.05$ is 11.07.

DISCUSSION

In the Delta region of eastern Arkansas, rabbits are the principal food base for the bobcat population. These results are consistent with some other studies (Progulske, 1955; Korschgen, 1957; Gashwiler *et al.*, 1960; Bailey, 1972; Hall, 1973; Fritts and Sealander, 1978; Storey *et al.*, 1982), although rabbits are sometimes of secondary importance to rodents (Kight, 1962; Miller, 1980) or deer (Hamilton and Hunter, 1939; Marston, 1942, Westfall, 1956).

Importance of rabbits as bobcat prey in the Gulf Coastal Plain (52.3% occurrence) and Interior Highlands (30.0% occurrence) of Arkansas (Fritts, 1973) is complemented by results of this study (Tables 1-3). Difference in frequencies may be due to chance, or they might reflect responses to changes in prey abundance (Bailey, 1972; Beasom and Moore, 1977). Optimal foraging theory suggests that prey should be selected which provide maximal energetic gains through minimal expenditures (Pianka, 1978). Changes in prey abundance may cause suboptimal foraging similar to (but not as deleterious as) that observed in Canada lynx — snowshoe hare cycles. Due to its size and prevalence as bobcat prey, it is likely that the rabbit is near the peak of the optimal range of prey sizes for bobcats.

White-tailed deer are large prey for bobcats to subdue, although there are numerous references to deer predation in the literature (Young, 1928; Foote, 1945; Matson, 1948; Erickson, 1955; Fritts, 1973). Eight stomachs in our study contained deer remains. Deer seasons in Arkansas are coincident with trapping seasons, and it is probable that deer are often taken as carrion or that hunter-wounded animals are taken. This argument is supported by the observation that maggots were present in the meat in 1 stomach. Other research has suggested a relationship between deer hunting seasons and bobcat food use (Pollack, 1951; Progulske, 1955; Fritts, 1973).

The results of the present study and those of Fritts (1973) do not agree in some respects, probably due to the geographic coverage of the samples. Deltaic eastern Arkansas is heavily agricultural and is along the Mississippi Flyway for waterfowl. As a result, cotton rats and muskrats were more common in bobcats from eastern Arkansas, and rice rats, nutria and waterfowl are additions to the known food list. The waterfowl may have been injured by hunters prior to capture by bobcats.

Occurrence of fish was indicated by a few cycloid scales in 1 stomach. The scales could have been ingested as trap debris, therefore fish were not considered to be a real food item. Yoakum (1964, 1965) indicated that bobcats can catch fish but they are seldom eaten.

Clearly, mammalian prey were the most important energy source for bobcats as evidenced by occurrence (82.0% of total foods) and weight (94.5% of total foods). The most important size class was the large mammal category (rabbits included). However, relative importance of taxa or size classes differed among males, females, and kittens.

Adult male bobcats relied more heavily on large mammal and rabbit groups (80.4% combined occurrence, 94.7% combined weight) than did females (55.8%, 85.4%) or kittens (41.5%, 83.9%). Male bobcats are larger than females, which may help them subdue larger or more difficult prey (only males consumed nutria and muskrat). The occurrence of only 1 or 2 prey items in males indicates the ability to satisfy energetic requirements with single captures. Further, the male is free to hunt alone, while females are seasonally burdened with kittens, and this may decrease the number of opportunities for females to successfully hunt larger or more wary prey.

Lack of use of small mammals by adult males could be due to availability of larger prey, diminishing any requirement of small mammals as a buffer food source. It is unlikely that sex-related differences in the diet occur to relieve intraspecific competition for food sources for two reasons. Firstly, the occurrence of rabbits between sexes is nearly identical. If indirect (exploitation) competition occurs between sexes and availability of primary prey items is limited, we expect little overlap (dominant prey will differ between competitors). Secondly, the bobcat is generally solitary as an adult. Same-sex home ranges show little overlap and, except during the breeding season, adult females and males are not in contact (Bailey, 1972; Guenther, 1980; Hamilton, 1982). Therefore areas of range overlap are partitioned temporally. Direct (interference) competition for a local food resource should not occur due to behavioral segregation.

Females used small mammals and small birds more often than males. Due to the size of these organisms, the relative importance of rabbits to females (by weight) was inflated compared to that of males. With respect to energetic needs, this may mean that rabbits are more important to females because females get most of their energy from that food source. Occurrence of smaller prey may also be a function of teaching foraging strategy to the young. Kittens are small and inept in predatory tactics, so mothers may use smaller, more easily caught prey to teach hunting and killing techniques. Potential losses of energy the female might otherwise gain could be invested in reproductive success by insuring survival of young. The observed low percentage of females with fuller stomachs could be due to partitioning captured prey with kittens. If this is true, the importance of rabbits in female diets is overemphasized. The partial loss of rabbit meals could also explain the need for females to consume smaller prey items, and therefore the difference between foods consumed by males versus females.

The Sorenson similarity coefficient indicated the diet of kittens to be more similar to that of females (40.0%) than to that of males (28.6%). Bobcat kittens consumed almost as many small mammals as they did rabbits, and the range and mean number of prey items in kitten stomachs further indicated the importance of small mammals. In contrast, Fritts (1973) found few rats and mice in the diets of kittens. He concluded that, because rabbits are the principal food brought to kittens by the parent, kittens concentrate on that food resource early in life. The importance (by weight) of rabbits to kittens is similar to that calculated for females. It seems plausible to assume that rabbits are of paramount importance in providing nutritional and energetic requirements to kittens for growth and development, and that kitten survival may depend on the availability of rabbits (Bailey, 1972). Stomachs were full more often in kittens than in females because smaller items fill smaller stomachs.

LITERATURE CITED

BAILEY, T.N. 1972. Ecology of bobcats with special reference to social organization. Unpubl. Ph.D. Dissert. Univ. Idaho, Moscow, 82 pp.

BAILEY, T.N. 1979. Den ecology, population parameters and diet of eastern Idaho bobcats. Pp. 62-69, *in* Proc. Bobcat Research Conf. Natl. Wildl. Fed. Scientific and Tech. Ser. 6, 137 pp.

BEASOM, S.L. and R.A. MOORE. 1977. Bobcat food habit response to a change in prey abundance. Southw. Nat. 21:451-457.

ERICKSON, A.W. 1955. An ecological study of the bobcat in Michigan. Unpubl. M.S. thesis. Michigan State College, East Lansing, 133 pp.

FOOTE, L.E. 1945. Sex ratio and weights of Vermont bobcats in autumn and winter. J. Wildl. Manage. 9:326-327.

FRITTS, S.H. 1973. Age, food habits, and reproduction of the bobcat *(Lynx rufus)* in Arkansas. Unpubl. M.S. thesis. Univ. Arkansas, Fayetteville, 80 pp.

FRITTS, S.H. and J.A. SEALANDER. 1978. Diets of bobcats in Arkansas with special reference to age and sex differences. J. Wildl. Manage. 42:533-539.

GASHWILER, J.S., W.L. ROBINETTE, and O.W. MORRIS. 1960. Food of bobcats in Utah and eastern Nevada. J. Wildl. Manage. 24:226-229.

GUENTHER, D.D. 1980. Home range, social organization, and movement patterns of the bobcat, *Lynx rufus,* from spring to fall in south-central Florida. Unpubl. M.S. thesis. Univ. South Florida, 66 pp.

HALL, H.T., JR. 1973. An ecological study of the bobcat in Southern Louisiana. Unpubl. M.S. thesis. Louisiana State Univ., Baton Rouge, 131 pp.

HAMILTON, D.A. 1982. Ecology of the bobcat in Missouri. Unpubl. M.S. thesis. Univ. Missouri, Columbia, 152 pp.

HAMILTON, W.J., JR. 1942. Mammals of the eastern United States. Comstock Publ. Co., Ithaca, New York. 432 pp.

HAMILTON, W.J., JR. and R.P. HUNTER. 1939. Fall and winter food habits of Vermont bobcats. J. Wildl. Manage. 3:99-103.

KIGHT, J. 1962. An ecological study of the bobcat, *Lynx rufus* (Schreber), in west-central South Carolina. Unpubl. M.S. thesis. Univ. Georgia, Athens, 52 pp.

KING, A.W. 1981. An analysis of the winter trophic niches of the wild canids of northeast Arkansas. Unpubl. M.S. thesis. Ark. St. Univ., State Univ., 117 pp.

KORSCHGEN, L.J. 1957. Food habits of coyotes, foxes, house cats and bobcats in Missouri. Missouri Cons. Comm., Fish Game Div., P-R Series No. 15. 64 pp.

KORSCHGEN, L.J. 1980. Procedures for food-habits analyses. Pp. 113-127, *in* Wildlife management techniques manual (S.D. Schemnitz, ed.) the Wildlife Society, Washington, 686 pp.

LITVAITIS, J.A., A.G. CLARK, and J.H. HUNT. 1986. Prey selection and fat deposits of bobcats *(Felis rufus)* during autumn and winter in Maine. J. Mamm. 67:389-392.

MARSTON, M.A. 1942. Winter relations of bobcats to white-tailed deer in Maine. J. Wildl. Manage. 6:328-337.

MATHIAK, H.A. 1938. A key to the hairs of the mammals of Southern Michigan. J. Wildl. Manage. 2:251-268.

MATSON, J.R. 1948. Cats kill deer. J. Mamm. 29:69-70.

MAYER, W.V. 1952. The hair of California mammals with keys to the dorsal guard hairs of California mammals. Amer. Midl. Nat. 38:480-512.

MILLER, S.D. 1980. The ecology of the bobcat in south Alabama. Unpubl. Ph.D. Dissert. Auburn Univ., Auburn, Alabama, 156 pp.

MOORE, T.D., L.E. SPENCE, and C.E. DUGNOLLE. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Wyoming Game Fish Dept. Bull. No. 14. 177 pp.

PIANKA, E.R. 1978. Evolutionary ecology. Harper and Row, New York, 397 pp.

POLLACK, E.M. 1951. Observations on New England bobcats. J. Mamm. 32:356-358.

PROGULSKE, D.R. 1955. Game animals utilized as food by the bobcat in the southern Appalachians. J. Wildl. Manage. 19:249-253.

ROTENBERRY, J.T. 1980. Dietary relationships among shrubsteppe passerine birds: competition or opportunism in a variable environment? Ecol. Monog. 50:93-110.

SOKAL, R.R. and F.J. ROHLF. 1981. Biometry, 2nd ed., W.H. Freeman and Co., New York, 859 pp.

STORY, J.D., W.J. GALBRAITH, and J.T. KITCHINGS. 1982. Food habits of bobcats in eastern Tennessee. J. Tennessee Acad. Sci. 57:29-32.

TUMLISON, C.R. 1983a. An annotated key to the dorsal guard hairs of Arkansas game mammals and furbearers. Southw. Nat. 26:315-323.

TUMLISON, C.R. 1983b. Harvest trends, dietary ecology, reproduction, and population demographics of the bobcat *(Felis rufus)* in Arkansas. Unpubl. M.S. Thesis, Ark. St. Univ., State Univ., 158 pp.

WESTFALL, C.Z. 1956. Foods eaten by bobcats in Maine. J. Wildl. Manage. 20:199-200.

YOAKUM, J. 1964. Observations on bobcat-water relationships. J. Mamm. 45:477-479.

YOAKUM, J. 1965. Observations of feeding habits of captive bobcats. Murrelet 46(3):37-39.

YOUNG, S.P. 1928. Bobcat kills deer. J. Mamm. 9:64.