BEHAVIOR AND POPULATION DYNAMICS OF BOBCATS

IN OKLAHOMA

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CHAPTER I

INTRODUCTION

This thesis is composed of 3 manuscripts written in formats suitable for submission to selected scientific journals. Each manuscript is complete without supporting materials. The arrangement of each manuscript is text, literature cited, tables, and figures. Chapter II, 'Social organization and movements of an exploited bobcat population', is written in the format of the JOURNAL OF MAMMALOGY. Chapters III AND IV, 'Bobcat population dynamics in Oklahoma' and 'Bobcat habitat use and activity patterns in southeastern Oklahoma', are written in the format of the JOURNAL OF WILDLIFE MANAGEMENT.

CHAPTER II

SOCIAL ORGANIZATION AND MOVEMENTS OF AN EXPLOITED BOBCAT POPULATION

Robert E. Rolley

ABSTRACT.-This study describes social organization of an exploited population of bobcats in southeastern Oklahoma. Mean home range size of 4 adult female and 7 adult male bobcats was 16.3 km^2 and 43.2 km^2, respectively. Home range shifts of 2 adult bobcats were observed. Home ranges of adult bobcats showed little to no intrasexual overlap. Dispersal of 3 juvenile bobcats occurred during late winter and early spring. Possible effects of harvest on social organization of bobcats are discussed.

The social organization of a bobcat (Lynx rufus) population was first described by Bailey (1974). Subsequently others have reported variations in home range size and the amount of intrasexual home range overlap (Hall and Newsom 1978, Zezulak and Schwab 1979). Bailey (1981) proposed that the social organization of bobcat populations was influenced by environmental parameters, including climate, habitat, food, and population density. In addition, exploitation of bobcats could affect social organization. Most studies of social organization to date have dealt with protected populations of bobcats. Movement patterns and social organization of an exploited bobcat population in southeastern Oklahoma were investigated from January 1980 through June 1982 as part of a broader study on the dynamics of an exploited bobcat population.

STUDY AREA

The study was conducted primarily on the Choctaw and Kiamichi Districts of the Ouachita National Forest, LeFlore County in southeastern Oklahoma (Figure 1). The study area extended onto privately owned forested land south of the national forest. The region is characterized by rugged low mountains and narrow valleys at elevations of from 150 m to 810 m. The primary vegetation type is oak-pine forest. Dominant tree species on north slopes include white oak (*Quercus alba*), red oak (*Q. rubra*), mockernut hickory (*Carya tomentosa*), and black hickory (*C. texana*). South slopes are dominated by short-leaf pine (*Pinus echinata*), blackjack oak (*Q. marilandica*), and post oak (*Q. stellata*).

Approximately 25% of the 1108 km^2 within the Forest Service boundary is privately owned, consisting mainly of cleared pastures within the valleys. Timber management practices on the Ouachita National Forest include limiting the size of clear-cuts to 32-40 ha. The privately owned forested land is characterized by larger clear-cuts of 200-240 ha. All the privately owned forested land is open to bobcat trapping and hunting, as is all but 7% of the National Forest.

Average annual rainfall on the study area is 112-127 cm (U. S. Forest Service, unpublished data). The mean July temperature is 28.2 C and the mean January temperature is 5.0 C.

METHODS

Bobcats were trapped during January 1980 through March 1980, October 1980 through March 1981, and October 1981 through January 1982. Bobcats were captured in no. 2 and no. 3 coil spring leg-hold traps, immobilized with ketamine hydrochloride, weighed, measured, ear tagged, radio-collared, and released. Rolley (1983) describes trapping methods in more detail. Captured bobcats were subjectively classified as kittens, transients, and resident adults (Bailey 1974) based on tooth wear, weight, body size, date of capture, and movement pattern, as discussed below. Transients were assumed to be young individuals dispersing from their maternal home ranges (Bailey 1981).

Radio-collared bobcats were located with hand held receiving equipment using standard triangulation methods and by the method described by Mech (1974) using aircraft mounted receiving equipment. Locations were first plotted on U. S. Geological Survey 1:24,000 topographic maps and later transformed into grid coordinates.

Home range size was calculated using the minimum-perimeter polygon method (Mohr 1947) and a computer program by Hatfield (1978). Excursions by resident adults, "unusual" movements outside of the animals "normal" range (Niewold 1974, MacDonald et al. 1980), were identified by examinations of plots of locations and deleted from home range calculations. Activity centers were calculated by the method described by Hayne (1949). Statistical analyses were performed using the Statistical Analysis System (Helwig and Council 1979).

RESULTS

Twenty-two bobcats were captured and radio-collared between January 1980 and January 1982 (Table 1). Movement patterns were not analyzed for 7 bobcats, each located less than 15 times, since the number of locations was insufficient to determine the existence or size of a home range. The remaining 15 bobcats were classified by sex and social classes as follows: 9 males (7 resident adults, 2 kittens) and 6 females (4 resident adults, 1 transient, 1 kitten).

Home range size was calculated for 4 resident adult females and 7 resident adult males (Table 2). Home ranges of one female and one male shifted during the tracking period, as discussed below. The larger of the 2 ranges for each of these 2 bobcats were used in calculating mean home range size.

Home range size was highly variable for both sexes. Female home range size varied from 7.3 km^2 to 28.5 km^2. The size of adult male home ranges varied between 17.1 km^2 to 72.1 km^2. Some of this variation was due to differences in the number of locations used to calculate home range size. A multiple regression with sex and number of locations accounted for 59% of the variation in home range size (r^2=0.59, $P<0.03$). Despite the high variation in home range size within sexes, mean home range size of adult male bobcats (43.2 km^2) was significantly larger ($P<0.01$) than the mean home range size of adult females (14.8 km^2). Male home ranges were approximately 3 times larger than female ranges.

Home ranges of adult female bobcat no. 1 and adult male bobcat no. 31 shifted during the period that they were tracked (Figure 2).

Bobcat no. 1, a 6.5 kg female, was trapped on 18 January 1980. Between her capture and late August 1980 she ranged over a 25.3 km^2 area on the north slope of Winding Stair Mountain and into the Holson Valley. During September 1980 through January 1981 she gradually shifted the area over which she ranged to the northwest. Between September 1980 and October 1981, when radio contact was lost, she ranged over a 28.5 km^2 area located on the lower north slope of Winding Stair Mountain, Holson Valley, and the south facing slope of Blue Mountain. The activity center of bobcat no. 1 during September 1980 through October 1981 was 2.0 km northwest of her activity center during January 1980 through August 1980.

Bobcat no. 31, an 11.3 kg adult male, was trapped on 17 January 1981. Between capture and early March 1981 he moved over a 23.9 km^2 area, south of Cedar Lake and on the north slope of Winding Stair Mountain. On 16 March 1981, bobcat no. 31 was located 13.5 km southeast of his location on 11 March 1981. Between mid March 1981 and late January 1982, bobcat no. 31 inhabited a 72.1 km^2 area, extending from Winding Stair Mountain in the north to the Kiamichi Mountains to the south. The activity center of bobcat no. 31 during the period March 1981 through January 1982 was 11.3 km southeast of the center of activity from January 1981 to March 1981. The home ranges occupied by bobcat no. 31 during these 2 periods did not overlap.

Only 2 of the 4 adult females occupied adjacent home ranges. As described above, female bobcat no. 1 occupied a 28.5 km^2 home range extending from the north slope of Winding Stair Mountain to the south slope of Blue Mountain. She was last located on 13 October 1981. On 25 October 1981, female bobcat no. 103 was captured. Between this date and 23 April 1982, bobcat no. 103 ranged over a 13.5 km^2 area just east of the area occupied by bobcat no. 1. It is unknown whether bobcat no. 1 remained in her home range after radio contact was lost in October 1981, although bobcat tracks were found in this area in mid November 1981. The home range of no. 1 during September 1980 and October 1981 did not overlap with that of female no. 103, during October 1981 and April 1982 (Figure 3).

Similarly, home ranges of resident adult males essentially did not overlap. During winter 1980-81, 3 adult male bobcats occupied adjacent, non-overlapping ranges north of Winding Stair Mountain (Figure 4). The home ranges of 2 other adult males, followed during spring and summer 1981, were likewise adjacent and non-overlapping (Figure 5). During winter 1981-82 and spring 1982, 3 adult male bobcats occupied home ranges south and west of Rich Mountain (Figure 6). The ranges of no. 41 and no. 131 did not overlap. The home ranges of no. 131 and no. 31 overlapped by only 0.1 percent.

Only one instance of intersexual home range overlap was observed. The home ranges of adult female no. 1 overlapped the range of adult male no. 3 by 25.4 percent.

The female kitten and the 2 male kittens, each dispersed from their apparent natal areas and became transients. Bobcat no. 5, a 5.4 kg juvenile female, was captured on 22 February 1980 inside of the home range of adult female no. 1. She was located on 29 February 1980 and again on 4 March 1980, still within the home range of bobcat no.

1. By 9 March 1980 she had moved 7.5 km east, near Horse Thief Springs (Figure 7). She was again located in this area on 12 March 1980. Six days later she had moved west 11.4 km, to the area near Deadman Gap. She was located in the same area on 19 March, but by 22 March she had returned to the area around Horse Thief Springs. She remained in the area around Horse Thief Springs through 3 April 1980. By 23 April 1980 she had again returned to the area near Deadman Gap. She was not located after this date presumably due to radio failure. She was killed by a trapper in late January 1981 near the Sycamore Lookout Tower, approximately 8 km from her initial capture site.

Bobcat no. 133, a 5.7 kg juvenile male, was captured on 1 January 1982. From 9 January through 16 March 1982, he was located over a 6.3 km^2 pre-dispersal range, southeast of Honobie Mountain. This range almost completely overlapped the home range of adult female no. 123. On 22 March bobcat no. 133 began a dispersal move (Figure 8). He continued to move west until 27 March. From 27 March through 5 April he was located within a 2.7 km^2 area. The center of activity during this period was 11.2 km west of his activity center prior to dispersal. Between 6 April and 23 April, bobcat no. 133 was located 7 times as he moved approximately 4.5 km to the southeast and then returned to the area occupied in late March and early April. He remained in this area until 14 June 1982, when he began moving north. Bobcat no. 133 was last located on 22 June 1982, at which time he had not returned to the temporary range that he had occupied during late March and early June.

Juvenile male bobcat no. 135 was trapped on 2 January 1982. He weighed 7.3 kg at capture. Between 11 January and 29 March he ranged over a 17.6 km^2 area that largely overlapped the home range of adult male no. 121, southeast of Little River Mountain (Figure 9). By 31 March he had moved approximately 6.6 km west of his pre-dispersal range. During the interval from 31 March to 5 April he was repeatedly located within 0.5-0.6 km of juvenile no. 133. On 6 April, the day juvenile no. 133 moved to the southeast, juvenile no. 135 returned to the area he occupied prior to his dispersal. He remained in this area through late May. On 22 June 1982 bobcat no. 135 was located 5.6 km east of his pre-dispersal range. He was last located on 23 June 1982, 0.5 km further west.

Female bobcat no. 109 was trapped on 29 October 1981. At capture she weighed 5.6 kg, greater than the weights of juvenile females no. 5 and no. 35, trapped on 22 February 1980 and 24 January 1981, respectively (Table 1). She was classified as a transient, based on her intermediate weight and size and erratic movements (Figure 10). From 1 November 1981 through 11 November she was located along Tram Ridge and the north slope of Winding Stair Mountain. On 14 November she had moved 5.1 km to the southeast. She had returned to Tram Ridge on 15 November. By 19 November she had moved 8.7 km to the northwest, along the north slope of Winding Stair Mountain. She remained in this area through 1 December. On 2 December bobcat no. 109 was located 5.6 km to the north, on Blue Mountain. She had returned to the north slope of Winding Stair Mountain by 20 December. On 21 December she was again located along Tram Ridge. She returned to the area that she had occupied during late November by 31 December 1981. She dropped the radio-collar in this area in early January 1982. During this 2 month period of erratic movements, bobcat no. 109 tended to be located along the edges of the home ranges of adult female bobcats no. 1 and no. 103.

Movements of female no. 109 were similar in distance and variability to those of female no. 5 after she dispersed from her natal area and became a transient. Movements of female transients tended to be more nomadic than movements of resident adult females. The mean $\pm$ SE distance between locations of the 2 transient female bobcats (2.50 $\pm$ 0.48 km) was significantly greater ($P<0.01$) than the distance between locations of the 4 resident adult female bobcats (1.18 $\pm$ 0.06 km). In addition, distances between locations varied significantly more ($P<0.001$) for transient female bobcats than between locations of resident adult females.

Distances between locations were significantly greater ($P<0.001$) and significantly more variable ($P<0.001$) for resident adult males than for juvenile males, due probably to the very large home ranges of some adult males. The juvenile males could readily be differentiated from adult males based on lower weights, shorter total body length, and dispersal from natal areas.

DISCUSSION

Reported home range sizes of resident adult bobcats have varied widely. The smallest home ranges have been observed in southeastern United States and southern California. Provost et al. (1973)

estimated that the mean home range size of bobcats on the Savannah River Plant in South Carolina was 3.6 km^2 in the mid 1960's. In bottomland hardwood habitat in Louisiana, the average male and female home range size was 4.9 km^2 and 1.0 km^2, respectively (Hall and Newsom 1978). Similar sized mean home ranges of females (1.4 km^2) and males (2.0-6.0 km^2) were reported for chaparrel-dominated southern California (Lembeck and Gould 1979). The largest home ranges, determined by radio-telemetry methods, were reported from Minnesota (Berg 1979). Berg calculated a mean home range size for males of 62 km^2 and 38 km^2 for females.

Mean home range size of females on Bailey's (1974) study area in southeastern Idaho was 19.3 km^2 and mean home range size of males was 42.1 km^2. Average home range size of both female (14.8 km^2) and male (43.2 km^2) resident adult bobcats observed in this study were similar to those reported by Bailey (1974).

Buie et al. (1979) observed that home range size of bobcats on the Savannah River Plant had increased considerably by the late 1970's over those reported for the same area in the mid 1960's (Provost et al. 1973). This was associated with a decreased density of bobcats on the Savannah River Plant that resulted from successional changes of the area (Jenkins et al. 1979). The large sizes of home ranges determined in this study suggest a relatively low bobcat density in southeastern Oklahoma (Rolley 1983).

It is not clear whether the large home ranges and low density of bobcats in southeastern Oklahoma result from low quality habitat, high harvest pressure, or both. The relatively small home ranges of the 2 adults that resided on privately owned forested land suggest that low habitat quality may be at least partly responsible for the observed large home ranges. The large clear-cuts on this portion of the study area supported dense populations of eastern cottontail rabbits (Sylvilagus floridanus) and hispid cotton rats (Sigmodon hispidus). Rolley (1983) suggested that already low density bobcat populations may be further reduced by heavy harvest pressure which increases adult mortality rates.

Highly variable amounts of intrasexual home range overlap have been reported by other investigators. Bailey (1974) noted that adult female bobcats occupied nearly exclusive ranges on his study area while male ranges overlapped each other to a greater extent. This pattern of exclusive female home ranges and overlapping male ranges has been noted by Berg (1979) in Minnesota and by Lembeck and Gould (1979) in southern California. Zezulak and Schwab (1979) observed overlapping male ranges in the Mojave Desert of southern California but they also noted considerable overlap of female home ranges on their northern California study area. The nearly complete lack of intrasexual home range overlap of adult resident male bobcats observed in this study is likely related to high harvest pressure and low population density. Similarly, Buie et al. (1979) found less intrasexual home range overlap than did Provost et al. (1973) on the Savannah River Plant after the population decline. In Brown's (1964) model of the evolution of territoriality, territorial behavior is favored by increased defensibility of resources. Reduced densities resulting from exploitation may reduce the intrasexual competition, increase resource defensibility, and favor territorial behavior. This pattern is inconsistent with Crowe's (1975) prediction that harvested bobcat populations would show less rigid territorial structure.

The low amount of intersexual home range overlap observed was probably due to the relatively low number of females that were tracked. The pre-dispersal home range of juvenile bobcat no. 135 greatly overlapped the home range of adult male no. 121. In addition, juvenile female no. 35 was captured within the home range of adult male no. 13 prior to the date of the earliest observed dispersal moves. These patterns suggest greater overlap of adult male and female home ranges than was observed. However, one would expect that poor habitat quality and low population density would favor increased intersexual territoriality in the non-breeding season. Bailey (1981) suggested that larger male body size and home range size may be related to differential resource use and intersexual competition.

The home range shifts of adult female no. 1 and adult male no. 31 occurred following the severe drought in summer 1980. The drought was likely responsible for reduced abundance of major prey species, eastern cottontail rabbits and hispid cotton rats, on the study area following summer 1980 (Rolley 1983). Similar shifts of adult bobcat home ranges following a rabbit population decline were observed in southeastern Idaho (Bailey 1981). It is likely that periodic removal of resident adults by harvest would increase the tendency of bobcats to shift their home ranges into better habitats. Bailey (1981) suggested that a familiar area was less critical for males than for females and that males should be more flexible in their movements.

This hypothesis is supported by the greater distance of the home range shift of adult male no. 31.

The dispersal of juvenile bobcats from natal areas in late winter and early spring, observed in this study, is consistent with the time of dispersal reported by others. In Idaho, at least one family group remained together through the winter (Bailey 1981). Kitchings and Story (1979) described the dispersal of a juvenile male bobcat in early April. Dispersal of juvenile bobcats in South Carolina was observed in early spring (Griffith et al. 1980). Bailey (1981) suggested that harvest of adult females before juveniles become self-sufficient and disperse may be detrimental to survival of juvenile bobcats. While additional information on the impact of harvest of adult females on juvenile survival is needed, it should be noted that the fur harvest season in Oklahoma and other states in southeastern United States is in December and January, well before the time that dispersal apparently occurs.

Crowe (1975) predicted that annual harvest of bobcats may reduce the need for widespread dispersal. Dispersal distances could not be accurately measured in this study since transients were not followed until they established permanent home ranges. However, the tendency for transient bobcats to return frequently to areas they had previously occupied suggests that dispersal distances of bobcats in southeastern Oklahoma are relatively short.

Despite the apparent short dispersal distances, the duration of dispersal in the exploited population appears to be long. Male bobcats no. 133 and 135 followed for 3 months and female no. 5

followed for 2 months after dispersal did not establish permanent home ranges. Additionally, one transient bobcat captured in late October was followed for 2 months, during which her movements remained nomadic. Since changes in the dispersal characteristics and survival rates of transient bobcats probably have the greatest effect in compensating for harvest mortality, a better understanding of dispersal is needed to better evaluate the effect of harvest on bobcat populations.

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Table 1.--Description of bobcats radio-collared on or near the Ouachita National Forest between January 1980 and January 1982.

Animal No.	Date Captured	Sex	Social Class[a]	Weight (kg)	Total Length (mm)	Number of Locations	Fate
1	18 Jan 1980	F	Res	6.5	884	352	Survived at least until 13 Oct 1981-Lost signal
3	18 Feb 1980	M	Res	8.2	960	197	Survived at least until 29 May 1981-Lost signal
5	22 Feb 1980	F	Kit	5.4	795	25	Lost signal Apr 80-Killed by trapper Jan 1981
13	29 Oct 1980	M	Res	7.8	945	19	Survived at least until 30 Jan 1981-Lost signal
29	6 Jan 1981	M	Und[b]	7.5	927	0	Killed by trapper Jan 1981
31	17 Jan 1981	M	Res	11.3	1015	90	Survived at least until 26 Jan 1982-Lost signal
35	24 Jan 1981	F	Kit	4.4	790	4	Dropped collar Feb 1981
41	16 Feb 1981	M	Res	10.7	994	72	Survived at least until 23 April 1982-Lost signal
43	20 Feb 1981	M	Res	7.6	864	26	Dropped collar Jul 1981-Killed by humans Jan 1982
103	25 Oct 1981	F	Res	5.4	786	75	Dropped collar Apr 1982
107	29 Oct 1981	F	Res	6.1	845	16	Killed by trapper Dec 1981
109	31 Oct 1981	F	Tran	5.6	806	23	Dropped collar Jan 1982
115	5 Dec 1981	M	Und[b]	7.8	912	6	Dropped collar Jan 1982

Table 1. Continued.

Animal No.	Date Captured	Sex	Social Class	Weight (kg)	Total Length (mm)	Number of Locations	Fate
119	5 Dec 1981	F	Und[b]	6.2	910	5	Died of capture injury Jan 1982
121	9 Dec 1981	M	Res	10.7	957	78	Survived at least until 30 June 1982
123	9 Dec 1981	F	Res	5.6	854	95	Survived at least until 24 June 1982
125	18 Dec 1981	F	Und[b]	5.7	880	5	Died of capture injury Jan 1982
127	18 Dec 1981	F	Und[b]	5.9	885	6	Killed by humans Jan 1982
129	19 Dec 1981	F	Und[b]	5.6	838	2	Died of capture injury Jan 1982
131	9 Jan 1982	M	Res	8.8	914	61	Died of capture injury Apr 1982
133	1 Jan 1982	M	Kit	5.7	847	95	Survived at least until 24 June 1982
135	2 Jan 1982	M	Kit	7.3	860	53	Survived at least until 23 June 1982

[a] Social class (kitten, transient, and adult) determined by tooth wear, weight, size, date of capture, and movement pattern.

[b] Social class undetermined due to insufficient number of locations.

Table 2.--Home range size of resident adult bobcats on or near the Ouachita National Forest, Oklahoma, as determined by radio-telemetry. Home range size was calculated by the minimum-perimeter-polygon method (Mohr 1947).

Animal No.	Dates tracked	Number of Locations	Home range size (km^2)
Female			
1[a]	18 Jan 1980-29 Aug 1980	314	25.3
1	6 Sep 1980- 7 Oct 1981	38	28.5
103	25 Oct 1981-23 Apr 1982	74[b]	13.5
107	29 Oct 1981-21 Dec 1981	16	7.3
123	9 Dec 1981-24 Jun 1982	95	10.0
Mean (± SE)			14.8 (± 4.10)
Males			
3	18 Feb 1980-29 May 1981	196[b]	64.3
13	29 Oct 1980-30 Jan 1981	19	44.2
31[a]	17 Jan 1981-11 Mar 1981	12	23.9
31	16 Mar 1981-26 Jan 1982	78	72.1
41	16 Feb 1981-23 Apr 1982	72	49.5
43	20 Feb 1981- 8 Jul 1981	26	17.1
121	30 Dec 1981-22 Jun 1982	73[b]	29.4
131	13 Jan 1982-21 Apr 1982	60[b]	26.0
Mean (± SE)			43.2 (± 7.12)

[a] Home ranges of bobcats no. 1 and no. 31 shifted between indicated dates. The larger of the 2 home ranges was used for calculation of mean home range size.

[b] Apparent excursions were deleted from home range calculation.

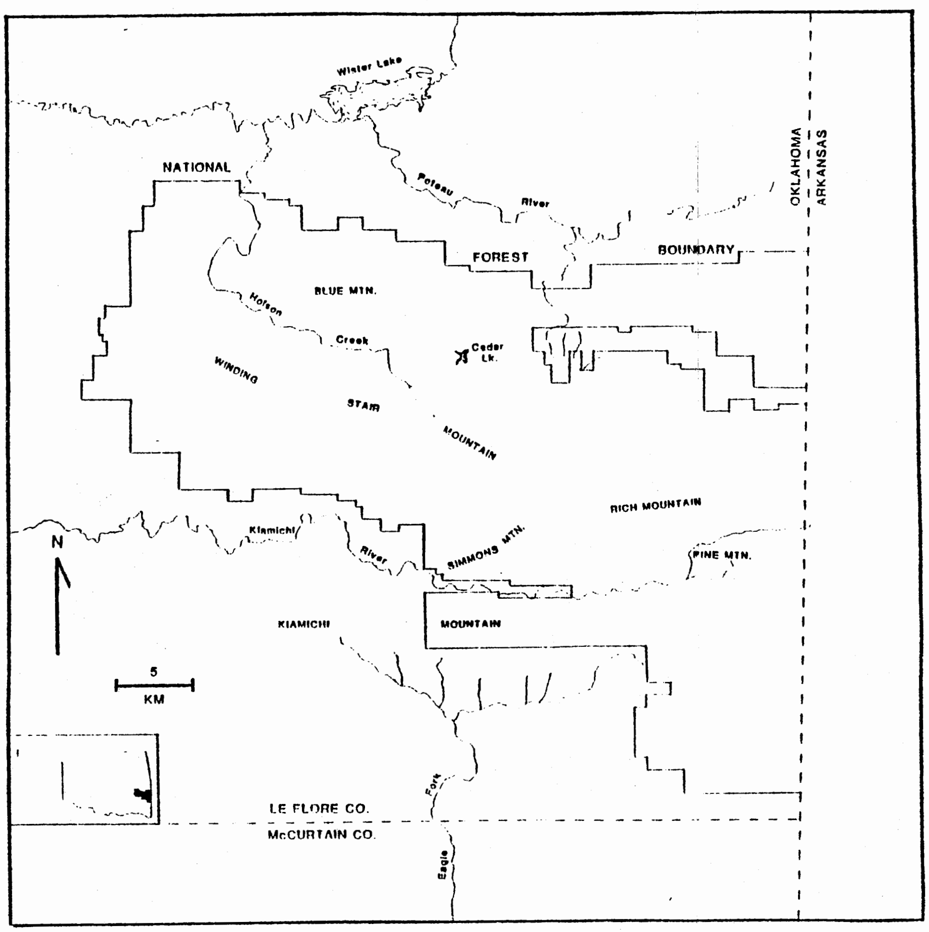

Figure 1. Location of Quachita National Forest study area in southeastern Oklahoma.

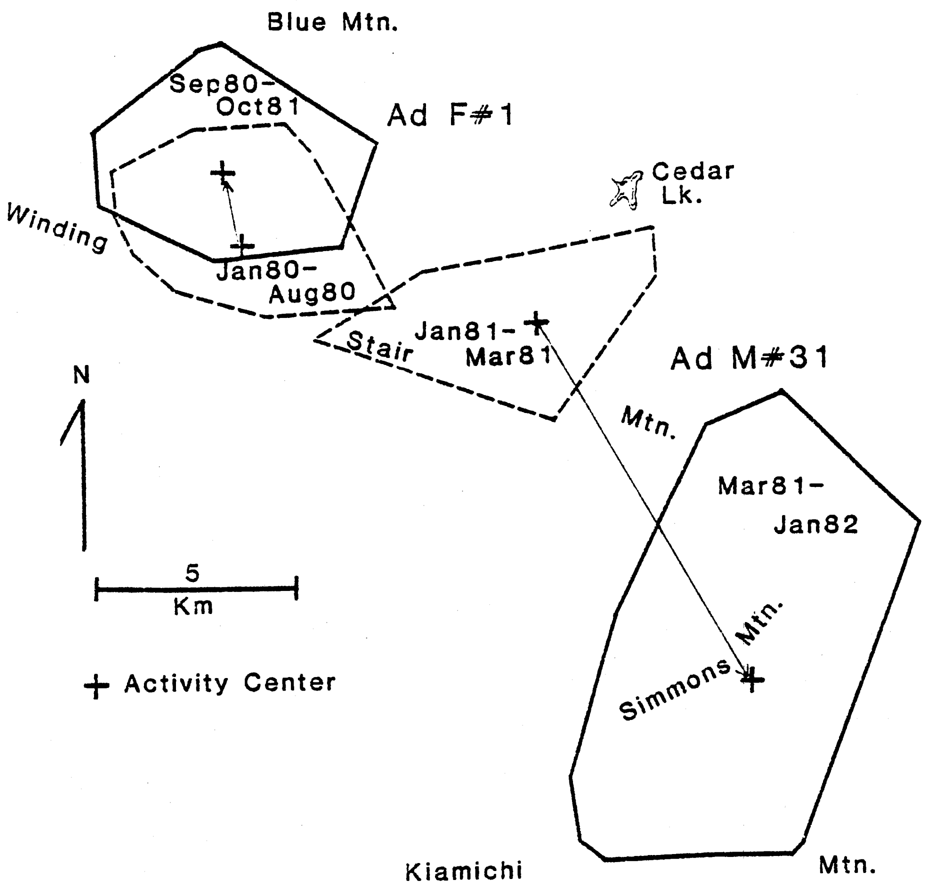

Figure 2. Home range shifts of adult female no. 1 in fall 1980 and adult male no. 31 in spring 1981.

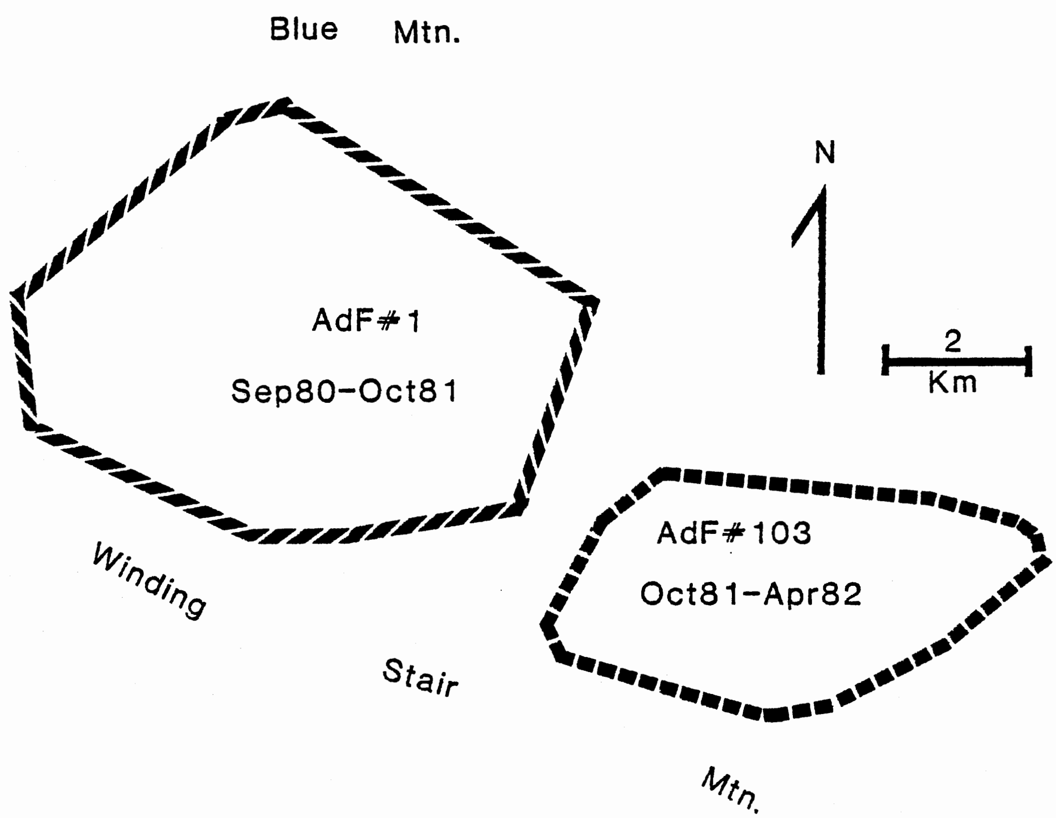

Figure 3. Non-overlapping home ranges of adult females no. 1 and no. 103.

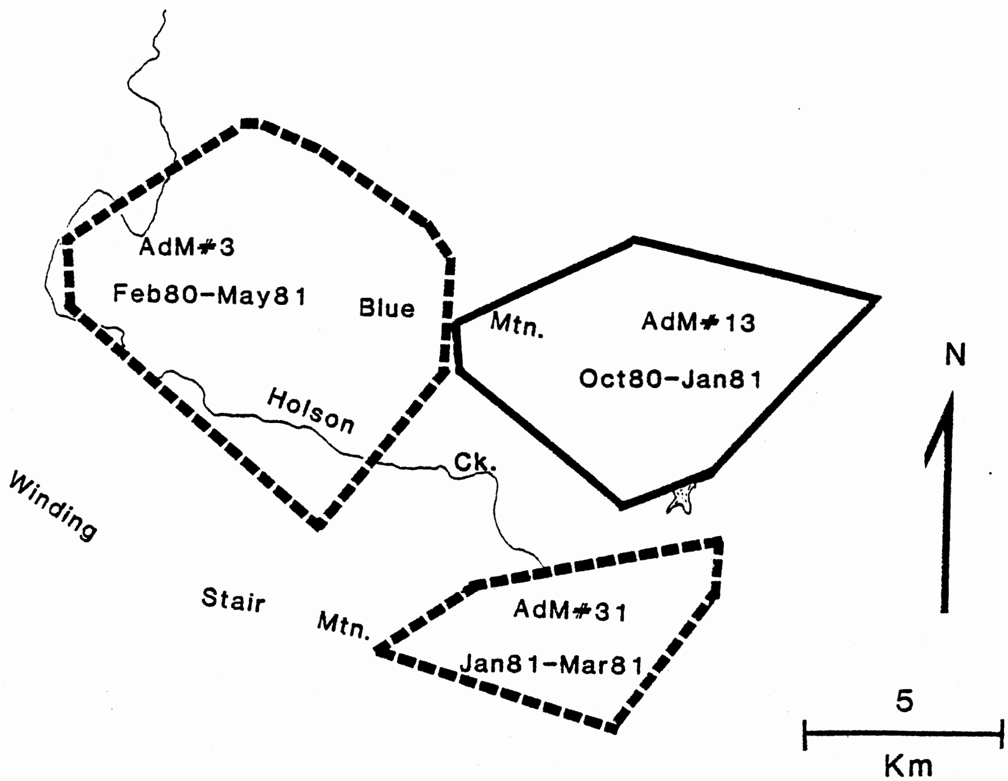

Figure 4. Non-overlapping home ranges of adult males no. 3, no. 13, and no. 31 in winter 1980-81.

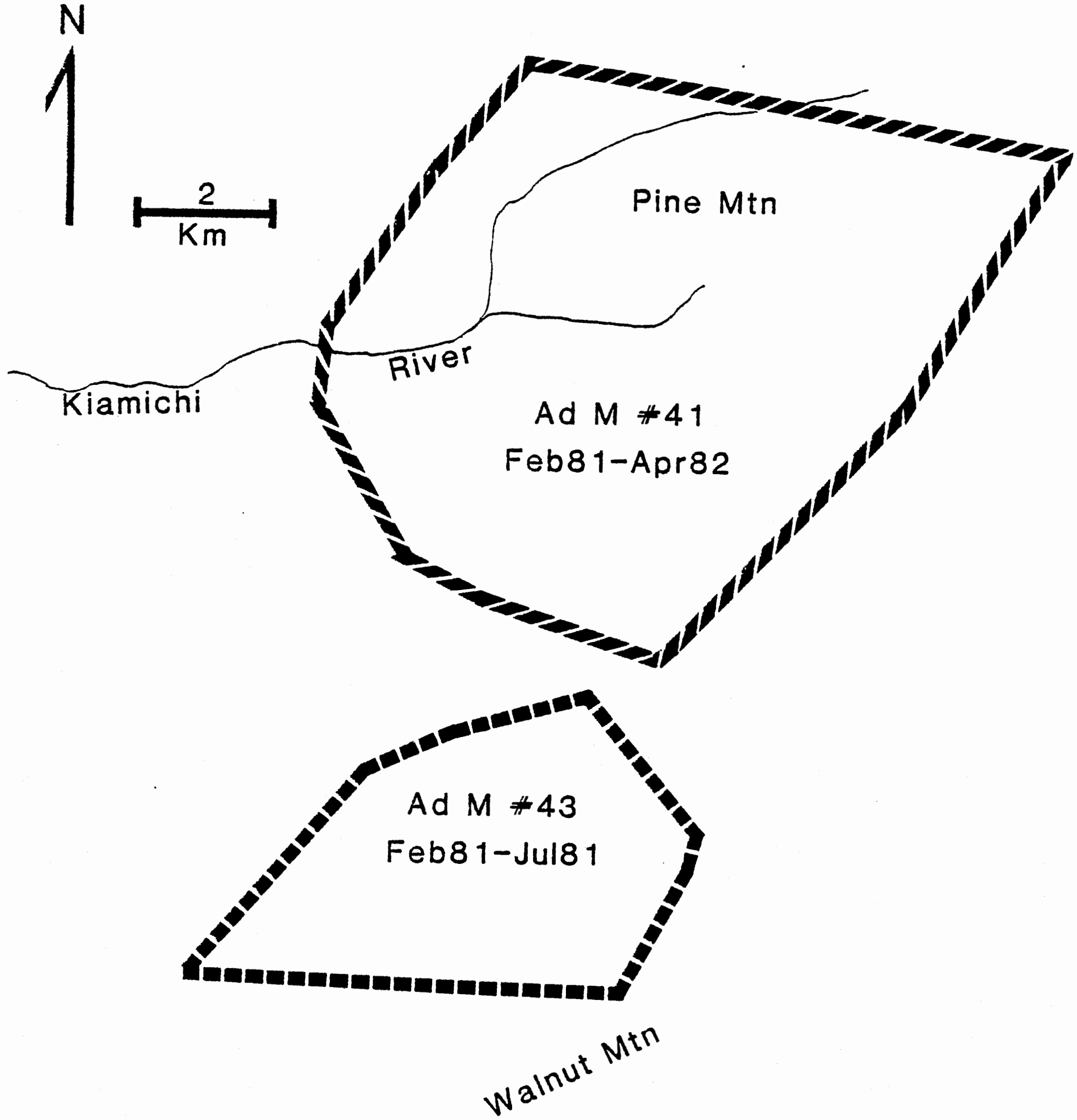

Figure 5. Non-overlapping home ranges of adult males no. 41 and no. 43 in spring and summer 1981.

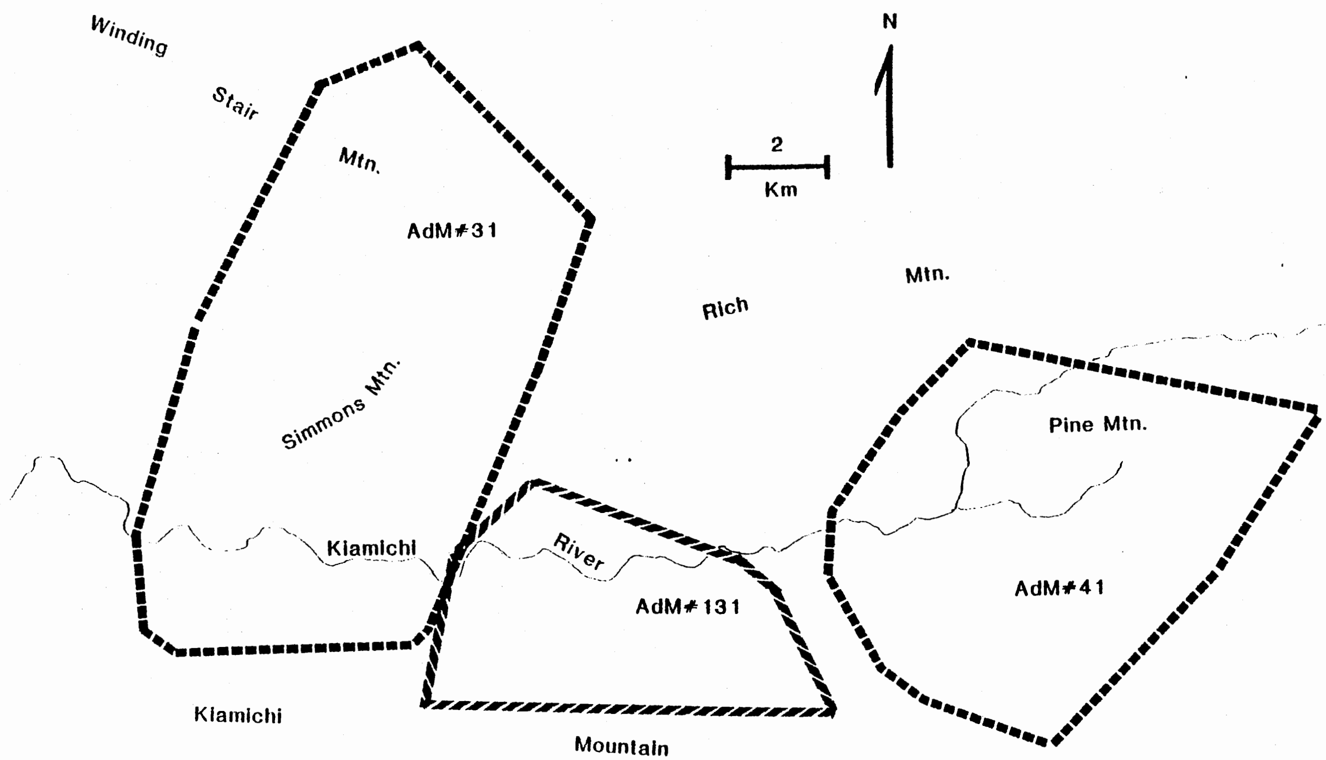

Figure 6. Home ranges of adult males no. 31, no. 41, and no. 131 in winter 1981-82.

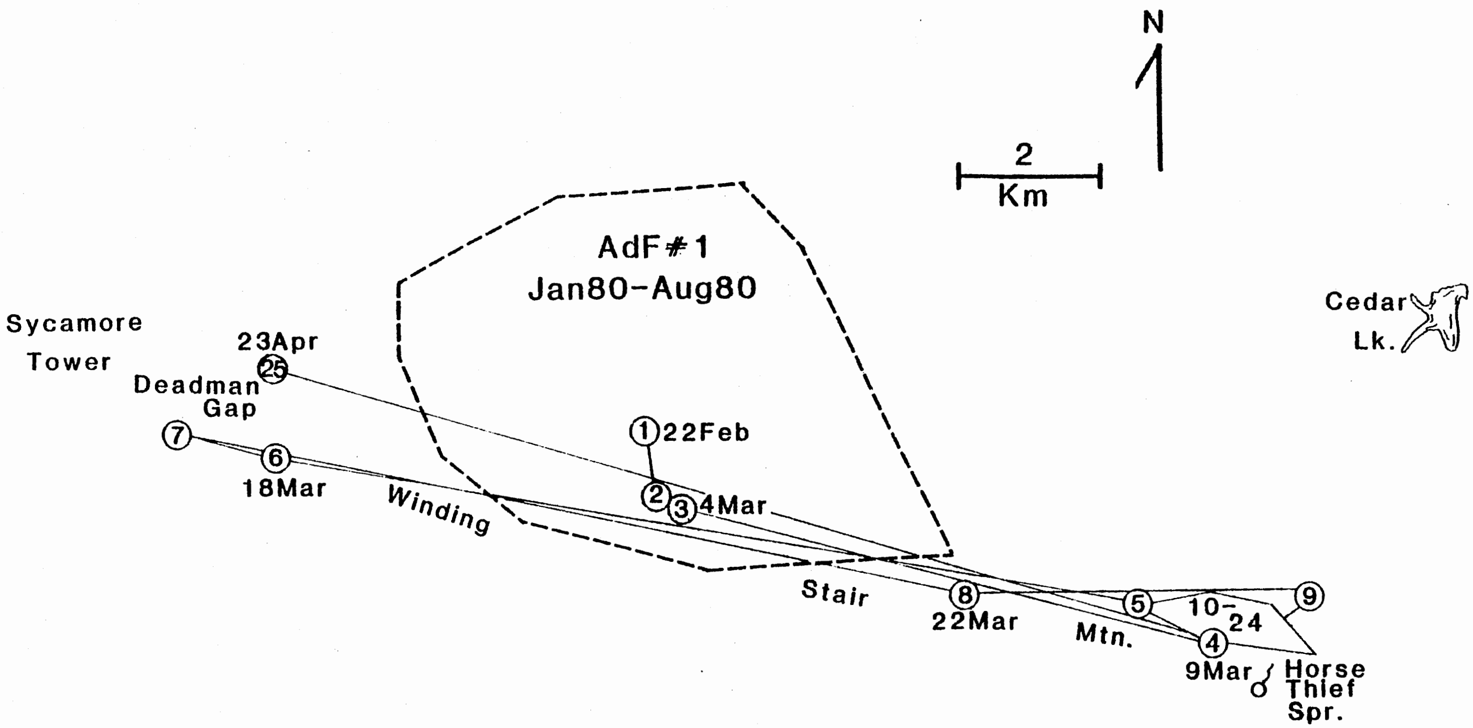

Figure 7. Dispersal and post-dispersal movements of juvenile female no. 5 during spring 1980 and home range of adult female no. 1 from January 1980 through August 1980.

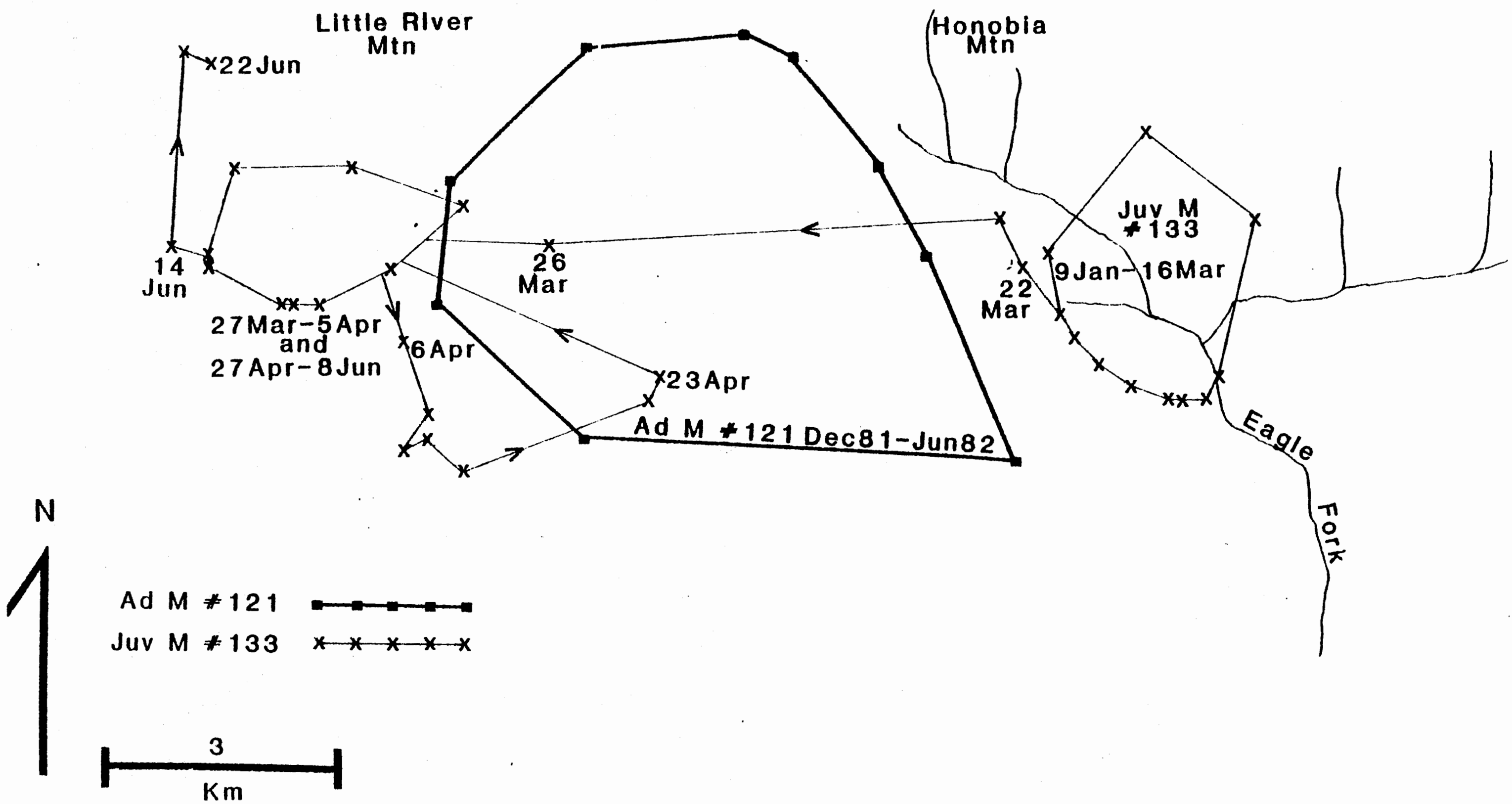

Figure 8. Pre-dispersal range and dispersal movements of juvenile male no. 133 in relation to the home range of resident adult male no. 121.

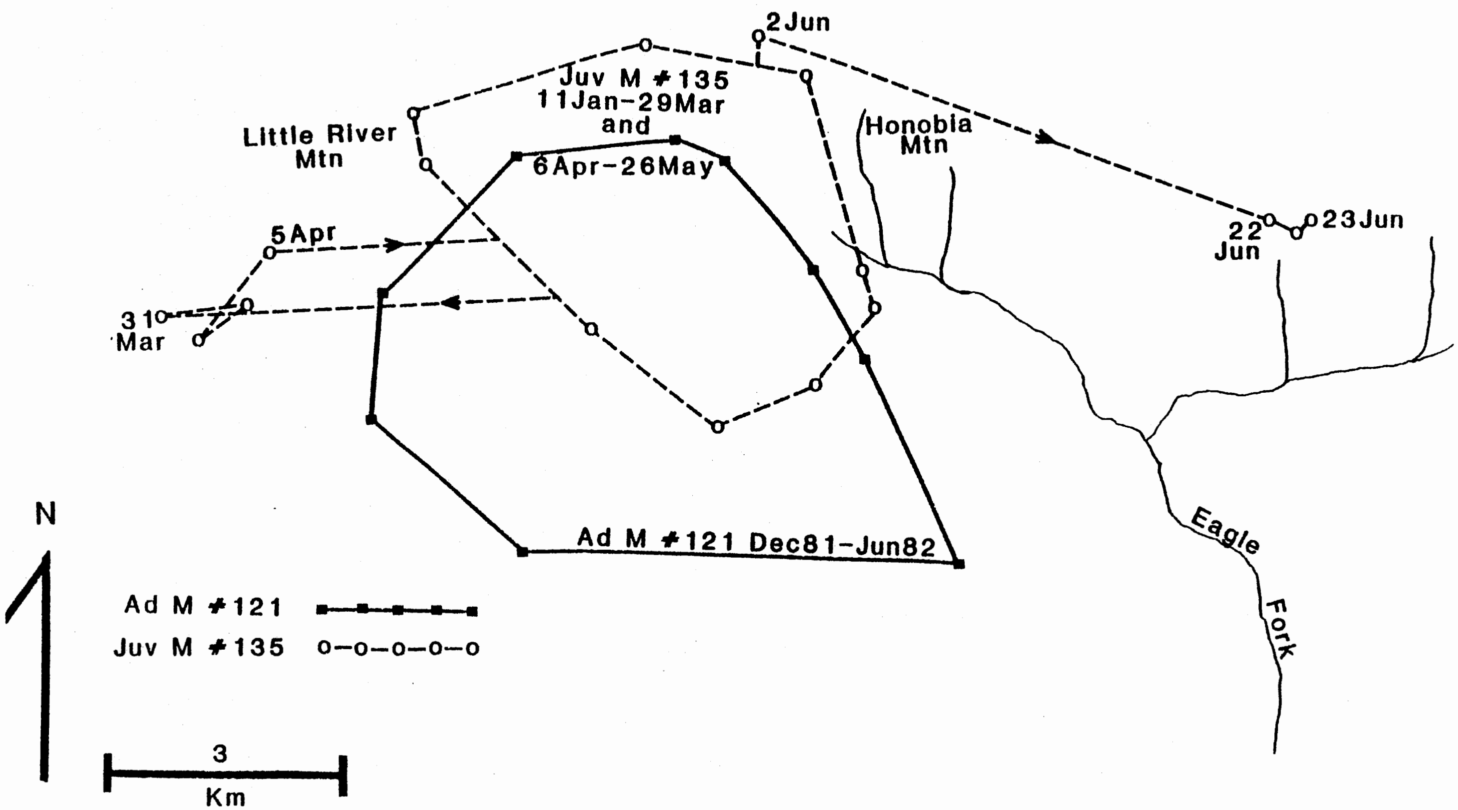

Figure 9. Pre-dispersal range and dispersal movements of juvenile male no. 135 in relation to the home range of resident adult male no. 121.

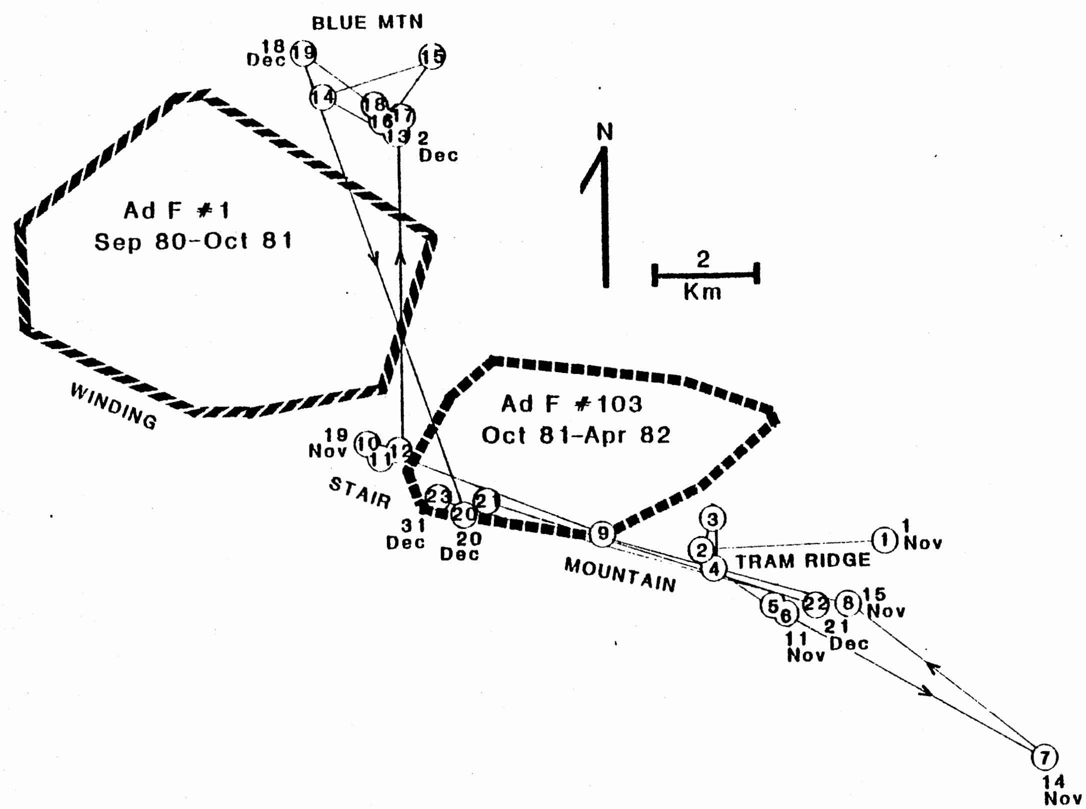

Figure 10. Movements of transient female no. 109 in relation to home ranges of resident females no. 1 and no. 103 in fall and winter 1981.

CHAPTER III

BOBCAT POPULATION DYNAMICS IN OKLAHOMA

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Abstract: Demographic parameters of the bobcat (*Lynx rufus*) population in Oklahoma were quantified in order to evaluate the status of the population. A density of 1 adult bobcat/11.0 km^2 was estimated for the Ouachita National Forest in southeastern Oklahoma. Scent-station surveys provided no evidence for different densities in different physiographic regions, but strongly indicated that bobcat populations declined from 1977 to 1981. The observed finite rate of increase (λ) over this period was 0.89. Sex and age structure and reproductive rates were determined from an examination of 553 carcasses and/or skulls. Sex ratios did not differ significantly from an expected 50:50 ratio. The age structure of the harvest was relatively young, with 25.7% juveniles, 31.5% yearlings, and 42.8% adults. Pregnancy rate of yearling females (45.7%) was significantly lower than adult pregnancy rate (92.4%). Yearling pregnancy rate was further reduced following a decline in prey abundance. Mean *in utero* litter sizes of yearlings and adults were 2.25 and 2.66 kittens/litter, respectively. Estimates of adult survival rate ranged from 0.53 to 0.66. Estimated juvenile survival rate was 0.23. Harvest was the sole source of non-study related mortality of radio-collared bobcats. Continued harvest of already low density bobcat populations may further depress the populations and result in local extirpations. A "tracking" harvest strategy is recommended.

The economic value of bobcat (Lynx rufus) pelts has increased dramatically during the last decade. The nationwide average price of bobcat pelts in the 1970-71 harvest season was $12 (Deems and Pursley 1978). In Oklahoma the average price paid for bobcat pelts increased from $12 in 1974-75 to $66 in 1980-81 (Day 1978, Okla. Dept. of Wildlife Conservation, unpubl. data). Increased value of pelts has resulted in increased harvest in Oklahoma as well as nationally. The 1974-75 estimated harvest of bobcats in Oklahoma was 1,500 compared to 2,782 in 1980-81 (Okla. Dept. of Wildlife Conservation, unpubl. data). The reported nationwide harvest in 1970-71 was 10,822 (Deems and Pursley 1978) versus 86,998 in 1980-81 (U. S. Fish and Wildlife Service, unpubl. data). In order to evaluate the impact of increased harvest pressure a better understanding of bobcat population dynamics is needed.

Crowe (1975) presented a model of an exploited bobcat population in Wyoming. He stated that his data were inadequate to determine pregnancy rates and therefore assumed a 100% pregnancy rate. Crowe did not incorporate age-related differences in reproductive rates into his model. Additionally, Crowe's estimated annual adult survival rate of 67% was likely an overestimate since his sample was drawn from what appeared to be a declining population.

The purpose of this study was to quantify demographic parameters of bobcats in Oklahoma, especially age-specific rates of reproduction and mortality, in order to evaluate the status of the bobcat population in Oklahoma. Additionally, the effects of fluctuations in food availability on age-specific reproductive parameters were examined.

This study would not have been possible without the advice and guidance of J. H. Shaw, F. Schitoskey, P. A. Vohs, J. M. Gray, and G. Bukenhofer. Field assistance provided by M. E. Stewart, M. Wagner, and L. Ashford is greatly appreciated. C. Clubb, T. Clubb, and D. Clubb assisted with trapping. W. D. Warde assisted with statistical analyses. Special thanks are due to R. T. Hatcher for providing unpublished data from the Okla. Dept. of Wildlife Conservation.

METHODS

This investigation combined a radio-telemetry study of an exploited bobcat population with a statewide collection of bobcat carcasses and skulls. The study area for the radio-telemetry phase was the Choctaw and Kiamichi Districts of the Ouachita National Forest in LeFlore County of southeastern Oklahoma (Figure 1). The study area was described in detail by Rolley (1983). Between January 1980 and November 1981 no. 2 coil-spring steel leghold traps and wire cage traps, baited with live chickens and domestic rabbits, were used to capture bobcats. Use of wire cage traps was discontinued after 481 trapnights yielded no bobcat captures. In December 1981 and January 1982 a local trapper, who used both no. 2 and no. 3 coil-spring leghold traps, was hired to assist with bobcat trapping. Trapped bobcats were immobilized with ketamine hydrochloride ($\bar{x}$=22.4 mg/kg), weighed, measured, ear-tagged, radio-collared, and released. Bobcats captured by the local trapper were immobilized, transported to the field laboratory for processing, and released near the capture location approximately 24 hr after they were trapped. Radio-collared bobcats were located using both hand held and aircraft mounted receiving equipment and standard radio tracking methods. Methods used to calculate home range size were described in Rolley (1983). Home range size and overlap were used to estimate densities. Additionally, estimates of adult survival rates were determined for radio-collared bobcats (Trent and Rongstad 1974).

Bobcat carcasses and skulls were collected from hunters, trappers, and furbuyers throughout Oklahoma. Sex was determined from external and internal genitalia. Age was determined using closure of the root apical foramen and counts of dental cementum annuli in commercially prepared sections of extracted canine teeth (Crowe 1972). Reproductive tracts were removed from female carcasses and uteri were preserved by freezing. Pregnancy rates and _in utero_ litter size were determined from placental scar counts. Nutritional condition was estimated based on carcass weight and an index of fat reserves. Renal and omental fat reserves were evaluated visually and assigned a score from 0 (none) to 3 (very abundant).

Winter food habits were estimated from stomach contents. Prey remains were identified by macroscopic examination, comparisons with known material, and hair-scale impression techniques (Korschgen 1969). Relative abundance of primary prey species on the Ouachita National Forest was estimated monthly during spring and summer 1980 through 1982. Abundance of eastern cottontail rabbits (Sylvilagus floridanus) was indexed by roadside counts. Catch/snap-trap night was used to index cricetine rodent abundance. Five to 7 snap-trap lines, 25 stations/line with 1 rat trap and 1 "museum-special" trap/station, were placed in major cover-types in the study area. Trapping continued for 3 nights each month. Time-area counts (Overton 1969) were used to monitor abundance of tree squirrels (Sciurus spp.).

The Oklahoma Dept. of Wildlife Conservation conducted scent-station surveys in 59 to 77 counties of Oklahoma from 1977 to 1981. Survey lines were designed after the scent-station surveys conducted by the U.S. Fish and Wildlife Service (Knowlton and Tzilkowski 1979). Surveys were conducted for 2 nights during August. Two indices of bobcat abundance were derived from these surveys; the percent of counties reporting bobcat visits to the survey lines, and the number of stations with bobcat visits in 2 nights divided by the number of operable station nights, hereafter referred to as the scent-station index.

The state was divided into 5 regions (Figure 1) based on distribution of habitat types (Duck and Fletcher 1943, Freeman and Shaw 1979) for analysis of scent-station surveys. Northwest and southwest regions were combined, as were northeast and southeast regions, for analysis of sex and age structure and reproductive rates.

Statistical analyses were performed using the Statistical Analysis System (Helwig and Council 1979).

RESULTS AND DISCUSSION

Density and Distribution

Rolley (1983) described home range size and overlap of 4 resident adult female and 7 resident adult male bobcats on or near the Ouachita National Forest. Mean home range size of adult females was 14.8 km^2. Home ranges of males were approximately 3 times larger and averaged 43.2 km^2. Little to no intrasexual home range overlap was observed. Assuming no intrasexual home range overlap and complete intersexual home range overlap I calculated a density of 1 adult bobcat/11.0 km^2 for the Ouachita National Forest. This is likely an overestimate of adult density since it assumes complete intersexual home range overlap and no unoccupied areas. Only one instance of intersexual home range overlap was actually observed; however, the extent of intersexual home range overlap was probably greater than that observed (Rolley 1983).

Reported densities of bobcats have varied widely and appear to be related to prey availability. High bobcat densities have typically been observed in southeastern United States. Provost et al. (1973) estimated a density of 1 bobcat/0.6 km^2 on the Savannah River Plant in South Carolina. Marshall and Jenkins (1966) felt that high prey abundance and complete protection were responsible for the small home ranges of bobcats on the Savannah River Plant. A density of 1 bobcat/ 0.8-1.3 km^2 was estimated in southern Alabama (Miller and Speake

1978). Similar densities (1/0.7-0.9 km^2) were found in southern California (Lembeck and Gould 1979).

Bobcat densities in semi-arid and arid regions have been substantially lower. Zezulak and Schwab (1979) reported densities of 1 bobcat/10 km^2 and 1/20 km^2 for their northeastern California and Mojave desert study areas, respectively. Bailey (1974) reported a density of 1/18.4 km^2 in southeastern Idaho. The large home ranges and low densities of bobcats in southeastern Oklahoma are typical of densities in xeric environments, probably due to low prey abundance.

Bobcats are distributed throughout Oklahoma. Bobcat visitations to scent-station survey lines from 1977 through 1981 were compared for the 5 regions of Oklahoma (Table 1). The percentage of counties reporting visits did not differ significantly between regions when tested by analysis of variance ($P<0.28$). Additionally, the 5 year mean scent-station index did not differ significantly between regions ($P<0.38$). The statewide 5 year mean percentage of counties reporting visits and scent-station index were 85.8% and 0.051, respectively. Roughton and Sweeny (1982) urged caution in using scent-station surveys for comparisons of populations in diverse habitats. It is worth noting, however, that the scent-station data available for Oklahoma provide no evidence of different population densities in the 5 regions of the state.

Hatcher (1979) surveyed professional wildlife personnel by mail to determine bobcat distribution and relative abundances in Oklahoma. Bobcats were sighted in all regions of the state, but sightings were more frequent in northwestern and southwestern Oklahoma. It is likely that the larger number of sightings in western Oklahoma was due to greater visibility in the more open grasslands of the west than in the more forested eastern regions and therefore may not reflect higher densities.

Rate of Increase

Scent-station surveys were used as indices of bobcat abundance and were analyzed by regression analysis (Figure 2). The percentage of counties in Oklahoma reporting bobcat visits declined significantly from 1977 to 1981 (slope=-0.028, $P<0.04$) as did the statewide mean scent-station index (slope=-0.006, $P<0.004$). Regression lines fitted to regional mean scent-station index values had negative slopes in all regions except northeastern Oklahoma (Table 2). The negative slope of the regression line in northwestern Oklahoma was significantly different from 0 ($P<0.001$). Within each region the percentage of counties reporting bobcat visits had a negative slope, but the slopes did not differ significantly from 0. Although the reliability of scent-station surveys to reflect changes in bobcat population densities has not been determined, the consistent decline in both indices strongly suggests that bobcat population densities in Oklahoma have declined from 1977 to 1981.

The observed rate of increase (r) of the Oklahoma bobcat population from 1977 to 1981, calculated using the statewide mean scent-station index values (Caughley 1977:109), was -0.113. This converts to an observed finite rate of increase (λ) of 0.89, i.e. an 11% decline/yr.

<u>Sex and Age Composition</u>

Sex could be determined for 411 carcasses and/or skulls. The sex ratio in the harvest showed a slight preponderance of females in 2 of the 3 years of the study (Table 3); however, the sex ratio did not differ significantly from an expected 50:50 ratio in any of the 3 years. Likewise, the percentage of females in the harvest did not differ significantly between years ($P<0.33$), between regions of Oklahoma ($P<0.64$), or between ages ($P<0.14$). The sex ratio of bobcats in the harvest over all 3 years was 0.87 males/female. The sex ratio of the 22 bobcats trapped on the Ouachita National Forest was 1.0 males/female.

Reported sex ratios of bobcats vary widely and include 0.4 males/female in Vermont (Foote 1945), 0.9 males/female in Idaho (Bailey 1974), 1.0 males/female in Wyoming (Crowe 1975), and 1.7 males/female in Arkansas (Fritts and Sealander 1978). Gilbert (1979) suggests that variations in sex ratios of samples from bobcat populations may reflect variation in harvest pressure. He noted that males typically have larger home ranges and greater daily movements, and therefore would be more vulnerable to harvest. Gilbert implied that lightly hunted populations would show a predominance of males in the harvest but greater harvest pressure would result in a more even sex ratio in the harvest sample. Support for greater vulnerability of males is provided by the sex and age composition of harvested bobcats reported by Crowe and Strickland (1975) and Fritts and Sealander (1978). Both found a greater proportion of males than females in the younger cohorts and a preponderance of females in older age classes.

While the relationship of harvest pressure to sex ratios needs additional clarification, it is interesting to hypothesize that the nearly even sex ratio of the harvest in Oklahoma may indicate moderate to heavy harvest pressure. This hypothesis is consistent with estimates of population trends.

Age of 549 carcasses and/or skulls collected from 3 regions of Oklahoma during winter 1979-80 through 1981-82 was determined (Table 4). Yearly and regional differences in age structure of the harvest were tested for by Chi-square analysis. Bobcats aged 6.5 years old and older were combined for this analysis. The difference in age structure between years, pooled across regions, approached statistical significance ($P<0.11$), as did the differences between regions, pooled across years ($P<0.10$). However, within years, the age structures did not differ significantly between regions. Within regions, the difference in age structure between years approached statistical significance ($P<0.11$) only in eastern Oklahoma. In 1980-81 28.8% of the bobcat carcasses and skulls collected from eastern Oklahoma were 0.5 years old. This was substantially higher than the percentage of 0.5 year olds in 1979-80 and 1981-82, 14.0 and 21.3%, respectively. The greater number of juveniles in 1980-81 was also evident in central and western Oklahoma.

In 2 of the 3 years of the study the proportion of 1.5 year old bobcats in the carcass collection exceeded the proportion of 0.5 year olds. This could result from juvenile bobcats being less vulnerable than yearlings and adults to harvest, relatively poor reproduction in 1979 and 1981, or a combination of these. Lower reproductive rates in 1981 were indicated by a lower yearling pregnancy rate in this year, as discussed below. Both Bailey (1979) and Blankenship and Swank (1979) also found that the proportion of 1.5 year old bobcats exceeded the proportion of 0.5 year olds in their samples. Bailey (1979) felt that this was due to juveniles being less vulnerable to harvest than bobcats 1.5 years old or older, and Blankenship and Swank (1979) noted that the percentage of juveniles in the harvest increased as the trapping season progressed. It appears that breakup of juvenile-adult female groups does not occur in Oklahoma until late winter or early spring (Rolley 1983) whereas the furbearer season is December and January. The low percentage of juveniles reported by Bailey (1979) may also be due to poor reproduction during the years of his collection, since the pregnancy rate of 1.5 and 2.5 year old bobcats was relatively low. Numerous other authors have reported a greater number of 0.5 year olds than 1.5 year olds in their samples (Crowe 1975, Fritts and Sealander 1978, Johnson 1979, Berg 1979).

The age distribution of bobcats harvested in Oklahoma was relatively young. The mean age of the 549 carcasses or skulls was 2.3 years old. This was similar to the mean age of a sample from an exploited population in Wyoming (2.1 yr) calculated from Crowe (1975). The mean age of bobcats in a sample from Arkansas was 3.4 yr and Fritts and Sealander (1978) hypothesized this older age distribution was due to lower harvest pressure. A young age distribution could result from either high rates of reproduction or high rates of adult mortality. An example of the effects of harvest on age structure is provided by Lembeck and Gould's (1979) study of 2 bobcat populations, one with light harvest pressure, the other with heavy trapping pressure. The age distributions differed substantially between the 2 populations. Only 57% of the harvested population was 2.5 years old or older compared to 82% of the relatively unharvested population. Since reproductive rates of bobcats in Oklahoma were not particularly high, as discussed below, the observed young age distribution likely resulted from high adult mortality rates.

Reproductive Parameters

Age-specific pregnancy rates and *in utero* litter size were determined from counts of placental scars (Table 5). Placental scars were first visible in 1.5 year old carcasses, indicating that some bobcats in Oklahoma breed during their first year. However, yearling pregnancy rate was significantly lower than adult pregnancy rate in 1980-81 and 1981-82. Overall only 45.7% of 1.5 year old carcasses had evidence of a previous pregnancy compared to 92.4% of adults. Placental scars in bobcats apparently do not persist for more than one year so the percentage of adults with placental scars reflects the annual pregnancy rate.

Yearling pregnancy rates varied between years. In 1980-81 53.3% of yearling females had placental scars but only 29.4 % did in 1981-82. This difference was not statistically significant ($P<0.17$); however, it was concomitant with a decrease in the percentage of juveniles in the harvest from 1980-81 to 1981-82. Pregnancy rates of yearlings and adults did not differ significantly between regions of Oklahoma.

The decline in yearling pregnancy rate in 1981-82 appeared to be related to reduced prey availability in 1981. Major prey species in stomachs of bobcat carcasses included cottontail rabbit, hispid cotton rat (*Sigmodon hispidus*), eastern woodrat (*Neotoma floridana*), deer mouse (*Peromyscus* spp.), and tree squirrels (Table 6). Abundance of major prey species on the Ouachita National Forest was monitored during spring and summer of 1980, 1981, and 1982 (Table 7, Figure 3). The abundance of cottontail rabbits, hispid cotton rats, deer mice, harvest mice (*Reithrodontomys* spp.), and tree squirrels all showed a marked decline from spring and summer 1980 to 1981. The abundance of all these species increased substantially from 1981 to 1982. The low prey abundance in 1981 followed a severe drought in summer 1980.

Concomitant with a decrease in prey availability from summer 1980 to summer 1981 was a decline in nutritional condition of bobcats (Table 8). Mean weight of bobcat carcasses in winter 1980-81 was significantly lower than carcass weights in 1979-80 or 1981-82 ($P < 0.003$). Likewise, there was a significant difference in the fat index between years ($P < 0.06$) with lowest mean fat index values in winter 1980-81.

The age of first breeding in other carnivore species is influenced by food availability. The percentage of 10 month old lynx (*Lynx canadensis*) that conceived varied with changes in availability of snowshoe hares (*Lepus americanus*), their principal prey (Nava 1970, Brand et al. 1976). Similarly, Gier (1968) found that the percentage of yearling coyotes (*Canis latrans*) that produced young was affected by rodent availability and winter severity. It seems likely that the relatively low pregnancy rate of yearling bobcats observed throughout this study was due to low prey abundance.

Mean *in utero* litter size of yearlings and adults did not differ significantly between years or regions of Oklahoma. Mean litter sizes of yearlings and adults, over the 3 years, were 2.25 and 2.66 kittens/litter, respectively. The difference in litter size of yearlings and adults approached statistical significance ($P<0.09$). Adult mean *in utero* litter size observed in this study was similar to that reported by other authors (Bailey 1979, Crowe 1975, Fritts and Sealander 1978, Johnson 1979).

Survival Rates

Survival rates were calculated by 2 methods. A composite life table was calculated from the age distribution of the harvest (Table 9) and a daily survival rate was calculated for radio-collared bobcats (Trent and Rongstad 1974). Although the age distribution was not stable over the duration of the study, by combining the samples obtained over 3 years into a composite life table the probability of securing a representive mean age distribution is increased. The low percentage of juveniles in the harvested sample suggests that hunting and trapping may not sample proportional to the age distribution of the population. Since harvest mortality was a major portion of total mortality, as discussed below, the harvested sample was treated as a sample of the dying. The number of bobcats at age 0 was estimated from the age distribution, mean age-specific reproductive parameters, and an assumed 50:50 sex ratio at birth. The age distribution was corrected for the observed rate of increase (-0.113) (Caughley 1977:93) and survival rates were calculated from the corrected age distribution. Annual survival rate of adult bobcats

($\geq$1.5 yr old) was 0.53. Survival rate from birth to 0.5 years was 0.45 and from 0.5 to 1.5 years of age was 0.66. The combined survival rate from birth to 1.5 years was 0.30.

Adult survival rate was also calculated from radio-collared bobcats. Four of the 22 bobcats trapped and radio-collared during this study died of capture related injuries and were not included in this analysis. The only other mortalities recorded were 3 bobcats killed by trappers and 2 killed by hunters or trappers during the 62 day furbearer season. Since all non-study related deaths occurred during the furbearer season, survival rates were calculated separately for this period (Trent and Rongstad 1974). During the 3 years of the study 747 bobcat days were recorded during December and January. Daily survival rate during the furbearer season was 0.993, for a 62 day furbearer season survival rate of 0.66. This may be an overestimate of survival. Radio contact with 2 other bobcats was lost during the furbearer season. If it is assumed that these bobcats died, then the furbearer season survival rate was 0.56. Assuming no adult mortality outside of December and January, the annual adult survival rate, as determined from radio-collared bobcats, ranged from 0.56 to 0.66. The survival rate of 0.56 was similar to the estimated survival rate of 0.53 calculated from the composite life table.

Rates of natural mortality of adult bobcats appear to be low. Crowe (1975) calculated a 3% annual natural mortality rate for adult bobcats, based on Bailey's (1974) study of a protected population. Only 2 of the 17 known deaths of radio-collared bobcats reported by Berg (1979) were not caused by humans. Hamilton (1982) noted that 31%

of the 11 known non-study related mortalities, during his 2.5 year study in southeastern Missouri, were not caused by hunting. Also 31% of the deaths were from illegal harvest during the first 2 years of the study when bobcats were protected. The lowest bimonthly survival rate (0.74) in Hamilton's study was during December and January, which coincided with the majority of the furbearer season.

It appears that variation in survival rates of juvenile bobcats is directly related to food availability. During the third year of his study, Bailey (1972) failed to capture any kittens in fall or winter despite considerable effort. This contrasted with high capture success of kittens in fall of the first 2 years. In addition, no tracks of kittens were found in the third winter. This apparent lack of recruitment coincided with a marked decline of lagomorphs on the study area. It was known that adult females produced young in all years of the study but kitten survival till winter was 0 during the rabbit decline. Similarly, Nellis et al. (1972) and Brand et al. (1976) found that survival of lynx kittens was directly related to abundance of snowshoe hares. While more information is needed on the range of juvenile survival rates of bobcats under conditions of fluctuating prey abundance it seems likely that the low rate of survival from birth to 6 months of age of bobcats in Oklahoma is due to low prey abundance.

CONCLUSIONS

Density of adult bobcats on the Ouachita National Forest (1 adult/11.0 km^2) was relatively low and densities, as indexed by scent-station surveys, were similar in the 5 regions of Oklahoma. These low densities were probably due primarily to low prey availability. The low yearling pregnancy and juvenile survival rates observed further suggest generally low prey abundance throughout the duration of this study. Additionally, further reduction in prey abundance due to climatic fluctuations appears to lower rates of reproduction and juvenile survival even more.

Rates of adult natural mortality in unexploited bobcat populations appear to be quite low. Harvest was the sole source of non-study related mortality of radio-collared bobcats. Seventeen percent of radio-collared bobcats were killed by trappers and an additional 11% were killed by hunters or trappers. Hunting and trapping clearly increase total adult mortality. Brand and Keith (1979) were unable to detect any relationship between natural and human caused mortality of lynx and concluded that harvest mortality was largely additive to natural mortality. They felt that trapping pressure was primarily determined by pelt price and only secondarily affected by lynx density. Harvest pressure on bobcats is also strongly related to pelt price (Erickson and Sampson 1978, Okla. Dept. of Wildlife Conservation, unpubl. data) and therefore is likely to be density independent.

While it seems probable that reproduction and juvenile survival rates are higher in exploited populations than in protected populations the decline in bobcat densities in Oklahoma strongly suggests that these adjustments are inadequate to compensate fully for increased adult mortality caused by harvest. Continued harvest of already low density bobcat populations may further depress the populations and seriously impair the populations' ability to increase when climatic or habitat conditions improve. Brand and Keith (1979) warned that heavy trapping pressure during periods of poor recruitment could lead to local extirpations of lynx. Bailey (1981) recommended that the "tracking" harvest strategy, i.e. reduction or curtailment of harvest during periods of negative rate of increases (Caughley 1977), was appropriate for bobcat populations in Wyoming and Idaho. This appears to be the most appropriate harvest strategy for bobcat populations in Oklahoma.

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Table 1. Five year mean bobcat visitation rate to scent-station survey lines in 5 regions of Oklahoma, 1977-1981.[a]

Region	Mean Number of Counties/Yr	% Counties Reporting Visits[b]	Scent-Station Index[b,c]
Northwest	16.2	80.2	0.061
Northeast	12.8	87.5	0.052
Central	20.6	90.2	0.046
Southwest	12.2	82.0	0.047
Southeast	9.2	89.1	0.049
Mean		85.8	0.051

[a] Unpublished data from the Okla. Dept. of Wildlife Conservation.

[b] No significant difference between regions in the percent of counties reporting visits ($P<0.28$) or in the scent-station index ($P<0.38$) as tested by analysis of variance.

[c] Scent-station index is the number of stations visited divided by the number of operable station nights.

Table 2. Slope and observed significance level (OSL) of regression lines fitted to regional scent-station indices.[a]

Region	% Counties Reporting Visits		Scent-Station Index	
	Slope	OSL	Slope	OSL
Northwest	-0.040	0.213	-0.018	0.002
Northeast	-0.013	0.674	0.001	0.821
Central	-0.011	0.597	-0.003	0.354
Southwest	-0.058	0.112	-0.004	0.494
Southeast	-0.024	0.494	-0.004	0.427

[a]Unpublished data from the Okla. Dept. of Wildlife Conservation

Table 3. Sex structure of bobcats collected from hunters, trappers, and furbuyers in Oklahoma during winters 1979-80 to 1981-82.

Year	Males		Females	
	Number	Percent	Number	Percent
1979-80	34	41	50	59
1980-81	73	46	87	54
1981-82	84	50	83	50
Totals	191	46	220	54

Table 4. Age structure of bobcats collected from hunters, trappers, and furbuyers in 3 regions of Oklahoma during winters 1979-80 through 1981-82. Age was determined by closure of the canine apical root foramen and counts of dental cementum annuli. Values are the percentage of sample that was the indicated age.

Age	East			Central			West			Total
	1979-80	1980-81	1981-82	1979-80	1980-81	1981-82	1979-80	1980-81	1981-82	
0.5	14.0	28.8	21.3	25.0	41.2	20.9	25.0	26.3	25.4	25.7
1.5	30.2	28.8	44.0	31.3	22.1	30.2	34.4	26.3	32.2	31.5
2.5	11.6	10.0	16.0	18.8	19.1	25.6	12.5	13.1	25.4	17.5
3.5	11.6	11.3	6.7	12.5	8.8	11.6	12.5	18.4	8.5	10.4
4.5	7.0	6.3	5.3	8.3	4.4	4.7	6.3	10.5	3.4	6.0
5.5	11.6	3.8	5.3	6.7	1.5		3.1	2.6		3.5
≥6.5	14.0	11.3	1.3		2.9	7.0	6.3	2.6	5.1	5.5
Number of Bobcats	43	80	75	48	68	43	32	38	59	549

Table 5. Pregnancy rate and *in utero* litter size of yearling and adult female bobcats collected from hunters, trappers, and furbuyers in Oklahoma during winters 1979-80 through 1981-82. Sample size is in parentheses.

Reproductive Parameter	1979-80[a]	1980-81	1981-82	All Years
Pregnancy Rate[b]				
Yearling		53.3%(15)	29.4%(17)	45.7%(35)
		*	**	**
Adult		85.0%(20)	95.2%(42)	92.4%(66)
Mean $\pm$ 95% CI *in utero* litter size[c]				
Yearling	2.00 $\pm$0.00(3)	2.13 $\pm$0.83(8)	2.60 $\pm$0.68(5)	2.25 $\pm$0.41(16)
Adult	2.50 $\pm$0.92(4)	2.53 $\pm$0.48(17)	2.73 $\pm$0.26(40)	2.66 $\pm$0.21(61)

[a] Sample size in 1979-80 was too small to determine pregnancy rate.

[b] Percent of females with placental scars.

[c] Number of placental scars per pregnant female.

* $P<0.05$, ** $P<0.001$, Chi-square test.

Table 6. Winter food habits of bobcats in Oklahoma, 1979-80 through 1981-82. Food habits determined by frequency of occurrence of prey species in stomachs of carcasses collected from hunters, trappers, and furbuyers.

Prey Item	Frequency of Occurrence	Percentage of Total Prey Remains
Cottontail rabbit (*Sylvilagus* spp.)	107	32.5
Blacktail jackrabbit (*Lepus californicus*)	1	0.3
Hispid cotton rat (*Sigmodon hispidus*)	101	30.7
Eastern woodrat (*Neotoma floridana*)	20	6.0
Deer mouse (*Peromyscus* spp.)	10	3.0
Pocket mouse (*Perognathus* spp.)	3	0.9
Harvest mouse (*Reithrodontomys* spp.)	7	2.1
House mouse (*Mus musculus*)	1	0.3
Vole (*Microtus* spp.)	8	2.4
Pocket gopher (*Geomys* spp.)	4	1.2
Fox squirrel (*Sciurus niger*)	11	3.3
Gray Squirrel (*S. carolinensis*)	9	2.7
Unidentified squirrel (*Sciurus* spp.)	3	0.9
Eastern chipmunk (*Tamias striatus*)	2	0.6
Unidentified rodent	3	0.9
Shorttail shrew (*Blarina brevicauda*)	1	0.3
Opossum (*Didelphis virginiana*)	4	1.2
Beaver (*Castor canadensis*)	1	0.3

Table 6. continued.

Prey Item	Frequency of Occurrence	Percentage of Total Prey Remains
Gray fox (*Urocyon cinereoargenteus*)	1	0.3
White-tail deer (*Odocoileus virginianus*)	1	0.3
Unidentified mammal	1	0.3
Meadowlark (*Sturnella* spp.)	2	0.6
Bobwhite quail (*Colinus virginianus*)	1	0.3
Mallard (*Anas platyrhynchos*)	1	0.3
Domestic turkey	1	0.3
Domestic chicken	1	0.3
Dark-eyed junco (*Junco hyemalis*)	1	0.3
Cardinal (*Richmondena cardinalis*)	1	0.3
Wild turkey (*Meleagris gallopavo*)	1	0.3
Unidentified bird	16	4.8
Total Number of Prey Remains		329

Table 7. Genera of small mammals captured/1000 trapnights on the Ouachita National Forest during May-September 1980, April-September 1981, and April-June 1982.

Genera	Year		
	1980	1981	1982
Sigmodon	7.2	2.0	13.7
Neotoma	1.2	1.6	1.5
Peromyscus	51.6	5.8	32.6
Reithrodontomys	9.1	0.4	17.8
Trapnights	4050	4500	2700

Table 8. Mean weight and fat index of bobcats collected in Oklahoma during winters 1979-80 through 1981-82. Sample size is in parentheses.

Year	Mean Weight (kg)[a]	Mean Fat Index[b]
1979-80	5.95(54)	1.99(57)
1980-81	5.28(84)	1.56(93)
1891-82	6.18(99)	1.68(103)

[a] Carcass weights were significantly different between years (analysis of variance, $P<0.003$).

[b] Distributions of fat index were significantly different between years (Chi-square test, $P<0.06$).

Table 9. Composite life table for the Oklahoma bobcat population. Bobcats were collected from trappers, hunters, and furbuyers throughout Oklahoma during winters 1979-80 through 1981-82. Harvested bobcats were assumed to be a sample of the dying and were entered in the d_x column. Life table was corrected for the observed rate of increase ($\bar{r}$ = -0.1133).

Age x	d_x	l_x (A)	Correction Factor e^{rx} (B)	Corrected l_x (AxB)	Corrected d_x	S_x
0.0			1.00	1162[a]	643	0.4466
0.5	141	549	0.94495	519	175	0.6629
1.5	173	408	0.84377	344	167	0.5146
2.5	96	235	0.75343	177	83	0.5316
3.5	57	139	0.67276	94	44	0.5319
4.5	33	83	0.60073	50	24	0.5200
5.5	19	49	0.53641	26	12	0.5385
6.5	10	30	0.47898	14	6	0.5715
7.5	7	20	0.42769	8	3	0.6250
8.5	1	13	0.38190	5	1	0.8000
9.5	4	12	0.34101	4	2	0.5000
10.5	2	8	0.30450	2	0	1.0000
11.5	3	6	0.27192	2	1	0.5000
$\geq$12.5	3	3	0.24280	1	1	0.0000

[a] Number of aged 0.0 bobcats were determined from corrected population age stucture, observed age-specific reproductive parameters and an assumed 50:50 sex ratio.

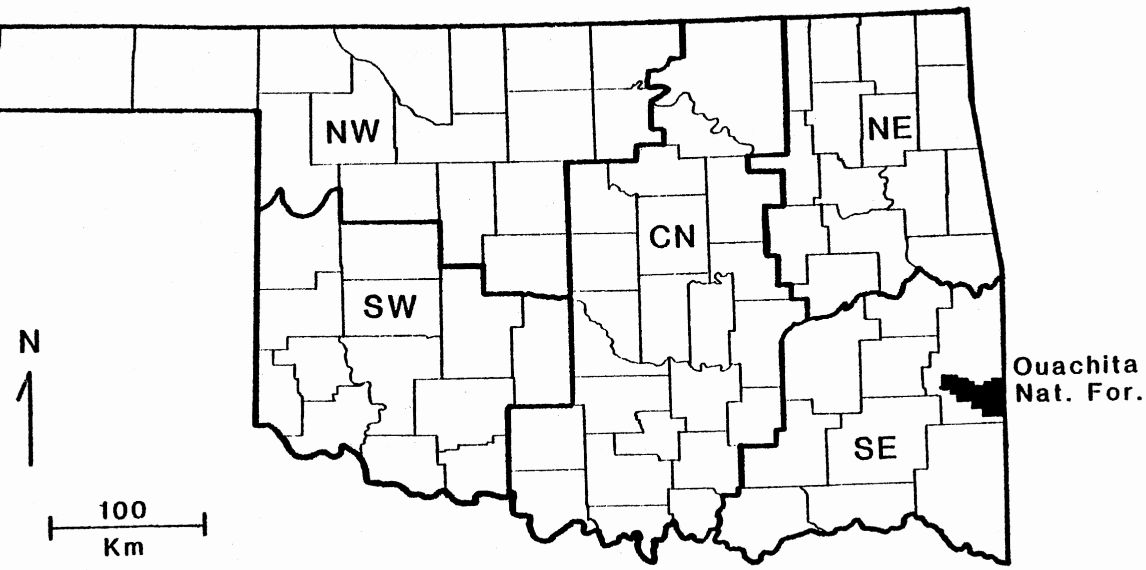

Figure 1. Location of radio-telemetry study area and boundaries of physiographic regions of Oklahoma.

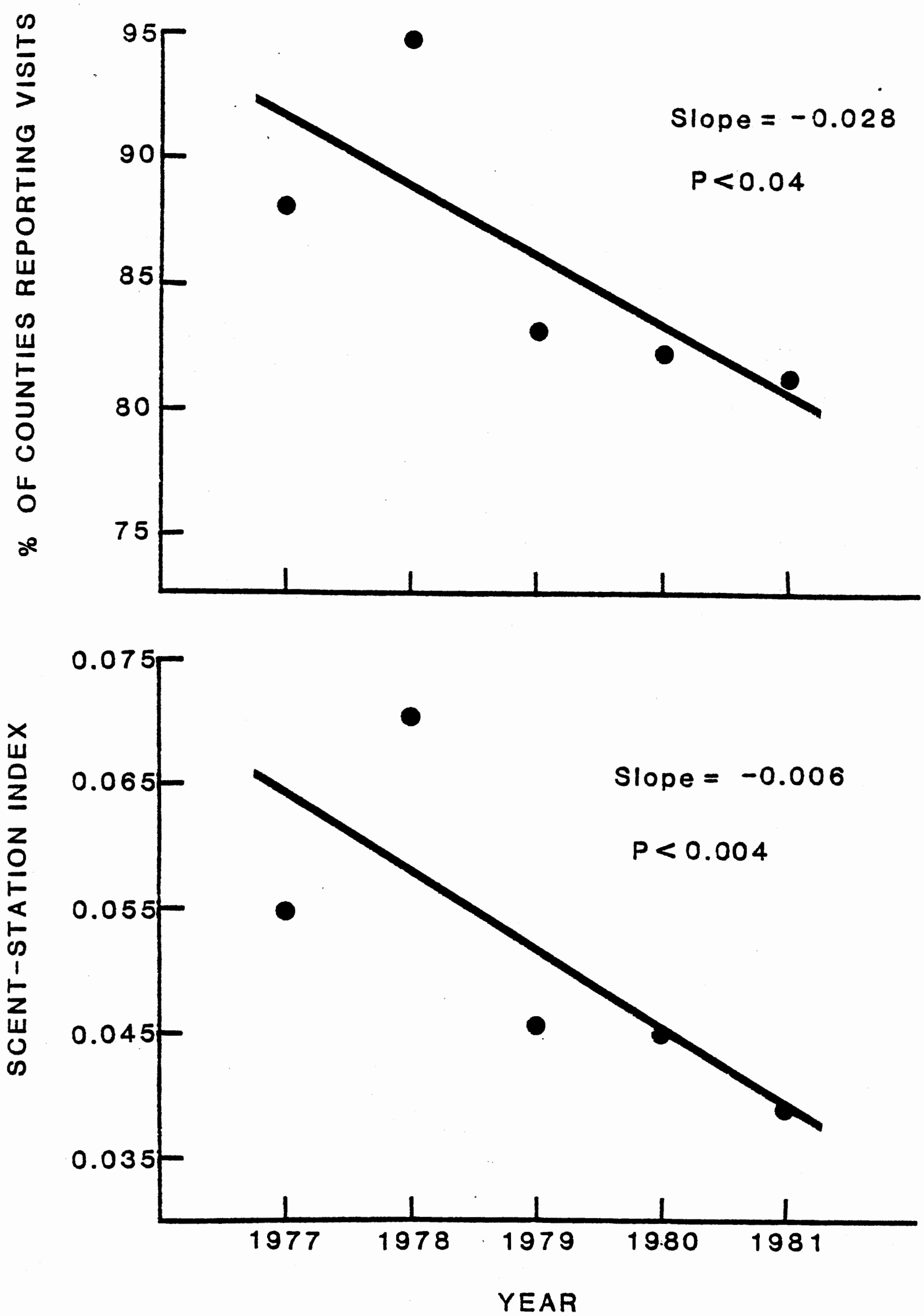

Figure 2. Indices of bobcat abundance derived from scent-station surveys conducted by the Okla. Dept. of Wildlife Conservation from 1977 to 1981. The scent-station index (below) was the number of stations with bobcat visits in 2 nights divided by the number of operable station nights.

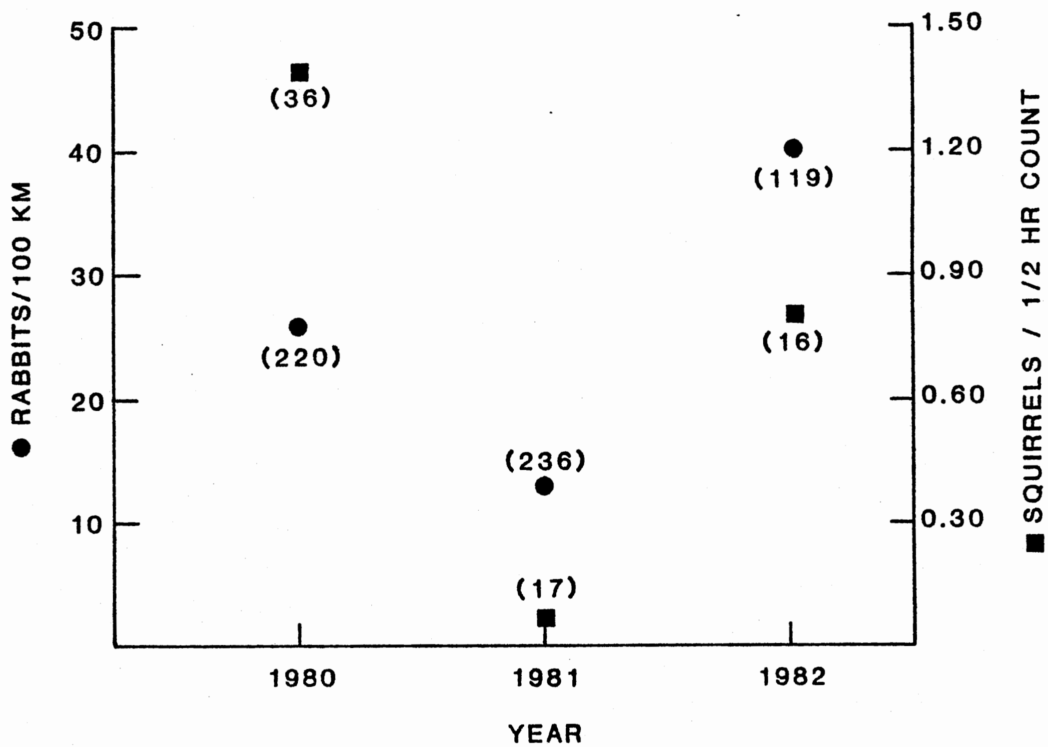

Figure 3. Abundance of cottontail rabbits and tree squirrels on the Ouachita National Forest in spring and summer 1980 through 1982. Rabbit abundance was monitored by road-side rabbit counts and time-area counts provided estimates of squirrel abundance. Number of 1/2 hr time-area counts and km of road driven are in parentheses.

CHAPTER IV

BOBCAT HABITAT USE AND ACTIVITY PATTERNS IN SOUTHEASTERN OKLAHOMA

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Abstract: Habitat use and activity patterns of bobcats (*Lynx rufus*) in southeastern Oklahoma were studied from January 1980 through June 1982 using radio telemetry. A total of 1268 locations were obtained on 9 male and 6 female bobcats. Habitat use and availability were determined using Landsat digital data. Diel activity was indexed by the rate of movement between 522 locations obtained at hourly intervals. Bobcat home ranges tended to be located away from pastures and agricultural land. Habitat use by 6 bobcats was significantly different from availability of habitats within their home ranges, with grassy and brushy areas as well as deciduous forest preferred and pine woods avoided. Habitat use differed between sexes, as did the diel pattern of habitat use. Use of grassy and brushy areas was highest during late afternoon and night. Lagomorph and cricetine rodent abundance was higher in clear-cuts than in other habitats. The activity pattern of both sexes was largely bimodal in all seasons with peak activity during crepuscular hours. Differences between sexes in diet and patterns of diel and seasonal habitat use suggest partial niche segregation between sexes.

Increased harvest pressure on bobcat (*Lynx rufus*) populations during the last decade has resulted in the need for a better understanding of the ecology of this species. The vast majority of recent research on bobcats has focused on home range characteristics and population density (Bailey 1974, Berg 1979, Lembeck and Gould 1979, Miller and Speake 1978, Rolley 1983a, Rolley 1983b, Zezulak and Schwab 1979). A better understanding of bobcat habitat requirements is needed in order to interpret the variation in home range size and population density observed in other studies. Additionally, information on diel activity patterns is required to interpret daily patterns of habitat use.

As part of a broader study of bobcat ecology in Oklahoma, habitat use and diel activity patterns of bobcats in southeastern Oklahoma were investigated from January 1980 through June 1982. In addition, we examined the relationship between habitat use and relative abundance of major prey species in different habitats.

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STUDY AREA

The 2015 km^2 study area was centered on the Choctow and Kiamichi Districts of the Ouachita National Forest, LeFlore County in southeastern Oklahoma (Figure 1). The study area extended onto privately owned forested land, south of the Kiamichi Mountains. The region is characterized by rugged low mountains and narrow valleys at elevations from 150 m to 810 m. The primary vegetation type is oak-pine forest. Dominant tree species on north slopes include white oak (*Quercus alba*), red oak (*Q. rubra*), mockernut hickory (*Carya tomentosa*), and black hickory (*C. texana*). South slopes are dominated by short-leaf pine (*Pinus echinata*), blackjack oak (*Q. marilandica*), and post oak (*Q. stellata*).

Extensive portions of the Poteau and Kiamichi River valleys have been cleared for pastures and agriculture. Timber management practices on the Ouachita National Forest include limiting the size of clear-cuts to 32-40 ha. The privately owned forested land is characterized by larger clear-cuts of 200-240 ha.

Average annual rainfall on the study area is 112-127 cm (U. S. Forest Servive, unpublished data). The mean July temperature is 28.2 C and the mean January temperature is 5.0 C.

METHODS

Bobcats were trapped from January 1980 through January 1982 in no. 2 and no. 3 coil spring leg-hold traps, immobilized with ketamine hydrochloride, weighed, measured, ear tagged, radio collared, and released. Rolley (1983a) describes trapping methods in more detail.

Radio-collared bobcats were located with hand-held receiving equipment using standard triangulation methods and by the method described by Mech (1974) using aircraft-mounted receiving equipment. Locations were first plotted on U. S. Geological Survey 1:24.000 topographic maps and later transformed into grid coordinates, with grid squares of 2.6 ha. We estimated the accuracy of locations to be within 2.6 ha. Bobcats were located approximately twice a week during daylight hours. In addition, bobcats were located at hourly intervals. While not randomized, hourly locations were obtained during all hours of the day and night. The duration of hourly tracking periods was typically 10-12 hours but varied from 3 to 96 hours. All times were recorded as central standard time and then combined into 12 2-hour time periods (00-02, 02-04,..., 22-00).

Activity was measured as the rate of movement between hourly locations and was also subjectively rated based on changes in signal strength during locations and assigned a score from 0 (inactive) to 2 (very active). Home range size and boundaries were calculated using the minimum-perimeter polygon method (Mohr 1947) as described by Rolley (1983b).

A digital habitat map was generated from Landsat data scaled to coincide with the 2.6 ha grid coordinate system. The date of the

Landsat data was 26 September 1979. Six cover types were identified: pine forest, deciduous forest, mixed pine-deciduous forest, grass fields, brush, and open water. Open water was not considered to be available habitat for bobcats and was deleted from habitat analyses. Deciduous forest included both upland and lowland sites. Grass fields included agricultural fields and clear-cuts less than 3 to 5 years old. Brush largely consisted of older clear-cuts but also included some pastures. Habitat use was determined by matching the grid coordinates of bobcat locations with the habitat map. Habitat use was compared to availability using Chi-square goodness of fit tests. Preference and avoidance of particular cover types were determined using Z tests.

Food habits were estimated from stomach contents of bobcat carcasses collected from trappers, hunters, and fur buyers. Relative abundance of major prey species in the dominant cover types of the Ouachita National Forest was estimated monthly during spring and summer 1980, 1981, and 1982 . Abundance of eastern cottontail rabbits (*Sylvilagus floridanus*) was estimated by roadside counts along a 38.4 km route. The cover type that rabbits were sighted in was recorded. The availability of cover types along the 38.4 km route was estimated by recording the cover type at 0.16 km intervals along the route. Catch/snap-trap night was used to estimate the relative abundance of cricetine rodents. Snap-trap lines, 25 stations/line with 1 rat trap and 1 "museum-special" trap/station, were placed in 5 cover types: ungrazed clear-cuts, grazed clear-cuts, pine forests, deciduous forests, and creek bottoms. Trapping continued for 3 consecutive nights each month. Thirty-minute time-area counts (Overton 1969) were used to monitor abundance of tree squirrels (*Sciurus* spp.). Time-area counts were conducted in pine forests, deciduous forests, and mixed pine-deciduous forests in 1980, 1981, and 1982 and in creek bottoms in 1982.

Statistical analyses were performed using the Statistical Analysis System (Helwig and Council 1979).

RESULTS AND DISCUSSION

Between January 1980 and February 1982 22 bobcats were captured and radio collared. Habitat use and activity patterns were not analyzed for 7 bobcats, each located less than 15 times before mortality or transmitter malfunction. The remaining 15 bobcats consisted of 9 males and 6 females. Rolley (1983b) describes the criteria used to classify these into social classes. The 9 males included 7 resident adults and 2 juveniles. The 6 females included 4 resident adults, 1 transient, and 1 juvenile. As described in Rolley (1983b) the 3 juveniles and 1 transient did not establish permanent home ranges during the period they were followed. However for the purpose of determining availability of habitats we used all locations of these individuals to calculate their "home range" boundaries. The 15 bobcats were located a total of 1268 times; 522 locations of 12 bobcats were obtained at hourly intervals.

Habitat Use

Johnson (1980) indicated that comparisons of habitat use to availability of habitats within an animal's home range could be misleading since the animal had already exhibited selection in establishment of its home range. Therefore we examined habitat preference on 2 levels, locations of home ranges within the study area and use of habitats within home ranges of radio-collared bobcats. To determine if bobcats exhibited selection in the location of their home ranges we compared the percentage of locations in each cover type to the availability of cover types on the entire study area (Table 1). For this analysis both sexes were combined, as were all seasons and times of day. The observed use of cover types differed significantly from their availability on the study area ($P<0.001$), with pine forests preferred and brush avoided.

Approximately 45% of the area classified as brush or grass fields occurred in 2 portions of the study area, the Poteau River valley and the Kiamichi River valley west of Simmons Mountain. These areas comprised only 17% of the study area but over 51% of the area in these regions was identified as brush or grass fields on the Landsat data. The majority of the area classified as brush or grass fields in these 2 regions actually consisted of pastures or agricultural fields. None of the home ranges of radio-tracked bobcats extended into these portions of the study area. We consider these areas to be unsuitable habitat for bobcats and therefore they were excluded from the habitat map and availability of cover types was recalculated for the remainder of the study area. The observed use of cover types was again significantly different from availability ($P<0.001$). However, brush was no longer avoided and grass fields were now significantly preferred ($P<0.001$). In addition, pine forests were no longer preferred and use of mixed pine-deciduous forests was significantly less then expected ($P=0.032$). Thus, it appears that bobcat home ranges were located away from large pastures and agricultural fields.

The observed use of cover types by each bobcat was compared to the availability of habitats within its home ranges (Table 2). Use of habitats by 6 bobcats (3 males and 3 females) was significantly different from availability ($P<0.05$). The difference between habitat use and availability for 1 additional male approached statistical significance ($P=0.053$). Although the pattern of habitat selection varied between individuals several patterns were consistent. Use of pine forests by 13 bobcats was lower than its availability within their home ranges. This difference was statistically significant ($P<0.05$) for 3 females and 1 male. Only 1 male bobcat used pine forests significantly more often than expected. Two females exhibited significant preference ($P<0.05$) for deciduous forest and one female preferred mixed pine-deciduous forests. One male significantly avoided deciduous forests and no males significantly preferred either deciduous or mixed pine-deciduous forests. Two males and 1 female were located in grass fields significantly more often than expected and 1 male significantly preferred brush. Grass fields and brush within bobcat home ranges were primarily recent and older clear-cuts; however, some small pastures were included in these cover types.

Typically bobcats have been found to prefer cover types associated with heavy undegrowth. Hall and Newsom (1978) reported that they frequently located bobcats in mid-successional seral communities. In southern Missouri bobcats preferred brushy fields and oak regeneration sites (Hamilton 1982). McCord (1974) observed that bobcats in Massachusetts selected roads, spruce (<u>Picea abies</u>) plantations, and stands of hardwoods mixed with hemlock (<u>Tsuga canadensis</u>). Spruce plantations and hemlock-hardwood stands contained the highest prey concentrations on McCord's study area.

Both McCord (1974) and Hamilton (1982) reported preferential use of cliffs or river bluffs by bobcats for shelter. Cliffs and rock outcroppings were not detectable from the Landsat data but during aerial locations several bobcats were frequently found near cliffs.

Seasonal patterns of habitat use were examined using Chi-square tests (Table 3). We defined the following seasons: winter (January-March), spring (April-June), summer (July-September), and fall (October-December). Habitat use differed between seasons for both male and female bobcats ($P=0.006$ and $P=0.007$, respectively), and use differed between sexes ($P=0.018$). However, the seasonal patterns of habitat use by males and females were not consistent ($P<0.001$). Use of pine forests by male bobcats was highest in summer and lowest in winter and spring. Males used deciduous forests more frequently than expected in fall and less than expected in summer. Use of mixed pine-deciduous forests by males was lowest in summer. Male use of grass fields was high in winter and spring and low in fall. Use of brush by males was lowest in summer.

Female bobcats also used pine forests more than expected in summer and less than expected in winter and spring. The seasonal use of grass fields by females was similar to the pattern of use by males, with greatest use in winter and spring. Seasonal use of mixed pine-deciduous forests was also similar between sexes.

The major difference between sexes in seasonal habitat use was the use of deciduous forests and brush. Female bobcats used deciduous forests more frequently than expected in spring and summer and less then expected in fall and winter. This contrasts with males, whose peak use of deciduous forests occurred in fall. Female use of deciduous forests was higher than male use when seasons were combined. Female use of brush was lowest in summer, as was male use of brush; however, use of brush by females was lower than male use was in all seasons. The greater use of deciduous forests by females and of brush by males was also indicated by the selection of habitats within individual home ranges, as discussed above.

For analysis of diel patterns of habitat use (Table 4) the 12 2-hour time periods were combined into 6 4-hour time periods (i.e. 22-02, 02-06,...,18-22). Habitats used by female bobcats differed significantly between times of day ($P<0.001$). The difference in habitat use of males between times of day only approached statistical significance ($P=0.114$); however, the diel patterns of habitat use of males and females were significantly different ($P=0.003$). Both sexes used pine forests to a greater extent at night than during the day. Conversely, both sexes used deciduous forests more during the day than at night, but use of deciduous forest by females during the morning was higher than use by males. Use of mixed pine-deciduous forest by males was highest during the morning, while peak use by females occurred during the afternoon. The highest use of brush and grass fields by males was during the afternoon and evening while females used these habitats primarily between 0200 and 0600.

Food Habits and Prey Abundance

Food habits of bobcats were estimated from stomach contents of carcasses collected from hunters, trappers, and fur buyers in southeastern Oklahoma (Table 5). Major prey species included cottontail rabbit, cotton rat (*Sigmodon hispidus*), eastern woodrat (*Neotoma floridana*), deer mouse (*Peromyscus* spp.), and tree squirrel. Food habits were significantly different between sexes (Chi-square test, $P=0.037$). Males consumed proportionally more cotton rats, tree squirrels, and large mammals while females comsumed a greater proportion of cottontail rabbits and deer mice. Fritts and Sealander (1978) also found differences in diets of male and female bobcats in Arkansas, where females consumed more rats, mice, and rabbits while males consumed more medium to large sized mammals. They hypothesized that optimum prey size may differ between sexes since adult males in their sample were larger than adult females. Likewise, skinned carcasses of adult males in Oklahoma averaged 2.0 kg (36%) heavier than adult female carcasses.

Relative abundance of prey species was estimated in major cover types on the Ouachita National Forest. The frequency of cottontail rabbit sightings in 5 cover types along the roadside census route (Figure 2) was significantly different from the availability of cover types along the route ($P<0.001$). Only 12% of the census route passed through clear-cuts but 32% of rabbits observed were in this habitat. Cottontail rabbits were observed less frequently than expected in pine forest, deciduous forest, and mixed pine-deciduous forest.

The total number of cricetine rodents captured (Table 6) was significantly different between cover types ($P<0.001$) as was capture success for both cotton rats ($P<0.001$) and harvest mice (Reithrodontomys spp.) ($P<0.001$). The difference in number of deer mice captured between cover types approached statistical significance ($P=0.056$). Woodrat capture success was low in all habitats.

To estimate relative abundance of tree squirrels in 4 cover types we conducted 68 30-minute time area counts. The number of time-area counts in pine forests, deciduous forests, mixed pine-deciduous forests, and creek bottoms were 21, 21, 19, and 7, respectively. The mean number of gray squirrels (Sciurus carolinensis) (0.63) and fox squirrels (S. niger) (0.15) observed per count did not differ significantly between cover types ($P=0.427$ and $P=0.811$, respectively).

Activity Patterns

The rate of movement (km/hr) between 522 hourly locations was used as an index of activity. We examined the effects of sex, season, and time of day on rate of movement. Due to the small sample size during fall and winter these 2 seasons were combined. Time of day was divided into 12 2-hour time periods. The rate of movement was significantly different ($P<0.001$) between individuals, within sex-season-time period blocks (Table 7). A multiple regression of sex and home range size of resident adults accounted for 76% of the variation between individuals in rate of movement ($R^2=0.76$, $P=0.013$).

Due to unequal sampling effort 74% of the 522 hourly locations were obtained from 2 individuals. In order to reduce the influence of these 2 individuals we calculated the mean rate of movement for each individual within each season-time period block. A total of 128 means were thus obtained (Table 7) and used in an analysis of variance to test the effects of time period, sex, and season on rate of movement.

The mean rate of movement did not differ significantly between time periods ($P=0.389$). However, the mean rate of movement for both males and females exhibited a bimodal pattern (Figure 3) with peak activity between 0800-1000 and 1400-1800. Low levels of activity occurred in early afternoon and between midnight and 0600. Similar activity patterns have been reported by Buie et al. (1979), Hall and Newsom (1978), Hamilton (1982), and Marshall and Jenkins (1966). Although the diel activity pattern did not differ significantly between sexes ($P=0.989$) the higher mean rate of movement of males during the afternoon may be related to their greater use of grass fields and brush during this time period.

Diel activity patterns did not differ significantly between seasons (Figure 4, $P=0.844$). However, mean rate of movement was significantly different between seasons ($P=0.023$). This was largely due to the difference between sexes in their seasonal activity pattern (Figure 5, $P=0.027$). Male activity was lower than female activity in fall and winter but male activity exceeded female activity in spring and summer. Greater activity by females during fall and winter may be due to greater energy demands related to rearing of kittens. The lower activity of females during spring and summer is probably due to their remaining near the natal den during the day in these seasons.

Mean rate of movement was significantly different between the 3 classes of subjective activity scores ($P<0.001$), with type 0 having the lowest movement rate (0.20 km/hr) and type 2 the highest movement rate (0.61 km/hr). The percentage of locations within each time period that received each activity score is shown in Figure 6. This suggests that the morning activity peak may result from a preponderance of medium speed activities (type 1) while the evening activity peak may be associated with the peak in high speed activities (type 2). Marshall and Jenkins (1966) observed that hunting bobcats frequently stop, sit, and watch. McCord (1974) and Hamilton (1982) reached similar conclusions from tracking bobcats in snow. Therefore hunting would likely be associated with a relatively slow rate of linear movement.

Mean rate of movement did not differ significantly between cover types (P=0.965). However the rate of movement was highest in mixed pine-deciduous forest and pine forest, lowest in deciduous forest, and intermediate in grass fields and brush (Table 8). The high rate of movement through pine and mixed pine-deciduous is suggestive of rapid movement through these cover types by bobcats on route to habitats used for hunting or bedding.

CONCLUSIONS

Home ranges of bobcats were located within the forested portion of the study area, generally away from pastures and agricultural fields. Within bobcat home ranges, use of habitats differed from availability. Both sexes tended to avoid stands of mature pine. Females more commonly preferred deciduous or mixed pine-deciduous forests while males preferred grass fields and brush. In addition to the differential use of habitats, seasonal and diel patterns of habitat use and diet all differed between sexes. We believe that the observed differences in diet and habitat use strongly suggest partial niche segregation between sexes of bobcats. Bailey (1981) hypothesized that differential resource use may result from inter-sexual competition.

The selection of grass fields and brush, primarily recent and older clear-cuts, by males is probably related to prey availability. Abundance of both cottontail rabbits and cricetine rodents was highest in clear-cuts. The late afternoon and evening activity peak of males coincided with the higher use of grass fields and brush during this time. Activity peaks of both cottontail rabbits and cotton rats are largely crepuscular (Jones 1959, Lord 1964, Calhoun 1945). The relatively high amount of diurnal activity by both sexes may reflect the importance of tree squirrel in the diet. Additional research is needed on the relationship of indices of activity and actual behaviors before habitat use and requirements of bobcats can be fully understood.

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Table 1. Percent use of 5 cover types by bobcats on or near the Ouachita National Forest based on 1268 locations. Availability of cover types was determined for the entire study area and with the Poteau and Kiamichi River valleys excluded.

Cover type	Observed Use (%)	Availability (%)	
		Entire Study Area	Poteau and Kiamichi River valleys excluded
Pine forest	58.0	54.2 ++[a]	57.4
Deciduous forest	9.3	8.4	9.7
Mixed pine-deciduous forest	17.9	18.4	20.3 -
Grass field	7.6	7.7	5.0 ++
Brush	7.1	11.3 --	7.5
Chi-square		24.8 **	21.3 **

[a]Significant preference (++ = P<0.01) or avoidaence (- = P<0.05, -- = P<0.01) based on Z test.

** P<0.001

Table 2. Percent use of cover types by 15 bobcats and the availability within their home ranges on or near the Ouachita National Forest. Significant preference or avoidance (P<0.05) of particular cover types is indicated by + and - signs.

Animal Number	Pine		Deciduous		Mixed Pine-Deciduous		Grass Fields		Brush		Number of Locations	Chi-square
	Use	Avail.	Use	Avail.	Use	Avail.	Use	Avail.	Use	Avail.		
Females												
01	54.5 -	78.6	15.2 +	3.2	15.1	12.4	2.3	2.5	3.1	3.3	352	163.5 ***
05	64.0	56.3	8.0	10.4	24.0	31.5	4.0	0.7	0.0	1.1	25	5.2
103	67.6	69.2	4.1	2.7	27.0	22.5	1.4	3.4	0.0	2.0	74	3.6
109	39.1 -	68.7	17.4 +	6.2	39.1 +	16.4	0.0	2.9	4.3	1.9	23	16.8 ***
123	41.1 -	53.3	0.0	1.8	11.6	15.6	32.6 +	18.6	14.7	10.6	95	22.8 ***
Males												
03	74.4 +	66.4	1.5 -	5.3	13.3	15.6	5.6	5.1	5.1	7.5	195	9.4 *
13	57.9	75.4	5.2	2.1	10.5	12.5	21.1 +	4.6	5.3	5.3	19	12.8 ***
31	54.4	56.4	12.2	10.8	23.3	25.2	4.4	3.3	5.6	4.2	90	1.1
41	52.8	59.5	15.3	9.5	20.8	25.9	2.8	2.2	8.3 +	2.9	72	11.4 **
43	23.1	24.2	50.0	40.4	23.1	27.0	3.8	5.4	0.0	3.0	26	1.7
121	44.6	48.6	4.1	6.0	24.3	23.5	1.3	5.3	25.7	16.5	74	6.7
131	76.7	66.7	0.0	7.4	15.0	18.8	3.3	2.5	5.0	4.7	60	5.9
133	41.1	55.1	5.3	4.9	14.7	21.7	31.6 +	7.1	7.4	11.2	95	80.8 ***
135	36.5	44.1	15.4	13.1	25.0	27.7	1.9	4.3	21.2	10.7	52	6.9

* P=0.053, ** P<0.05, *** P<0.01

Table 3. Percentage of locations in 5 cover types, by season, for male and female bobcats in southeastern Oklahoma.

Cover type	Male					Female				
	Jan.-Mar.	Apr.-Jun.	Jul.-Sep.	Oct.-Dec.	Total	Jan.-Mar.	Apr.-Jun.	Jul.-Sep.	Oct.-Dec.	Total
Pine	50.5	50.6	67.6	55.4	56.5	54.5	55.6	67.0	59.3	59.8
Deciduous	8.8	8.6	5.9	10.8	8.0	4.5	14.3	12.3	7.4	10.8
Mixed Pine-Deciduous	17.6	20.1	16.0	21.6	18.2	21.4	18.5	12.8	22.2	17.6
Grass Fields	12.5	9.8	5.0	1.4	8.2	13.4	7.4	4.4	3.7	7.0
Brush	10.6	10.9	5.5	10.8	9.1	6.2	4.2	3.5	7.4	4.8
Number of Locations	216	174	219	74	683	112	189	203	81	585

Table 4. Diel patterns of habitat use by male and female bobcats in southeastern Oklahoma. Values are the percentage of locations in each 4-hour time period in each cover type.

Cover type	Time Periods						Total
	2200-0200	0200-0600	0600-1000	1000-1400	1400-1800	1800-2200	
Males							
Pine	63.8	71.9	52.6	57.9	49.7	64.1	56.5
Deciduous	5.2	3.1	11.6	8.1	9.0	5.1	8.0
Mixed Pine-Deciduous	15.5	18.8	24.4	19.2	19.0	7.7	18.2
Grass Fields	8.6	0.0	6.3	5.7	10.9	12.8	8.2
Brush	6.9	6.2	5.3	9.1	11.4	10.3	9.1
Number of Locations	58	32	95	209	211	78	683
Females							
Pine	72.8	63.3	58.4	58.4	49.7	70.9	59.8
Deciduous	1.7	2.0	18.0	11.5	14.7	6.3	10.8
Mixed Pine-Deciduous	18.6	6.1	12.4	19.9	24.5	12.7	17.6
Grass Fields	5.1	16.3	5.6	5.4	5.6	10.1	7.0
Brush	1.7	12.2	5.6	4.8	5.6	0.0	4.8
Number of Locations	59	49	89	166	143	79	585

Table 5. Stomach contents of male and female bobcat carcasses from southeastern Oklahoma during winters 1979-80 through 1981-82.

Prey Item	Percentage of Total Prey Remains	
	Male	Female
Rabbits (*Sylvilagus* spp.)	31.4	42.4
Cotton rat (*Sigmodon hispidus*)	24.3	19.5
Woodrat (*Neotoma floridana*)	7.1	6.1
Deer Mouse (*Peromyscus* spp.)	0.0	6.1
Tree Squirrel (*Sciurus* spp.)	14.3	4.9
Other Small Mammals[a]	10.0	9.7
Large Mammals[b]	5.7	0.0
Birds	7.1	11.0
Total Number of Prey Remains	70	82

[a]Includes harvest mouse (*Reithrodontomys* spp.), vole (*Microtus* spp.), eastern chipmunk (*Tamis striatus*), pocket gopher (*Geomys* spp.), shorttail shrew (*Blarina brevicauda*), and unidentified rodents.

[b]Includes opossum (*Didelphis virginiana*) and grey fox (*Urocyon cinereoargenteus*).

Table 6. Genera of cricetine rodents captured/1000 trapnights in 5 cover types on the Ouachita National Forest during spring and summer 1980 through 1982.

Cover type	Number of Trapnights	Genera				Total[a**]
		Peromyscus*	Reithrodontomys**	Sigmodon**	Neotoma	
Ungrazed Clear-cut	2250	48.9	20.9	22.2	0.4	92.4
Grazed Clear-cut	1950	19.5	13.3	7.7	2.6	43.1
Deciduous Forest	2400	17.5	0.0	0.0	1.3	18.8
Pine Forest	2250	27.1	0.0	0.4	1.8	29.3
Creek Bottom	1950	29.2	0.5	0.5	1.0	31.2

[a] Includes Sylvilagus and Blarina.

* P=0.056, ** P<0.001.

Table 7. Mean rate of movement of female and male bobcats and home range size of resident adult bobcats in southeastern Oklahoma.

Animal Number	Number of Hourly Locations	Number of Time period-Season Blocks	Mean (SE) Rate of Movement (km/hr)	Home Range Size (km^2)
Females				
01	255	24	0.44 (0.02)	25.3
05	12	6	0.37 (0.10)	a
103	11	7	0.44 (0.12)	13.5
123	24	15	0.28 (0.04)	10.0
Totals and Means	302	52	0.38	16.3
Males				
03	133	22	0.61 (0.05)	64.3
31	16	9	0.48 (0.11)	72.1
41	15	8	0.36 (0.06)	49.5
43	11	7	0.14 (0.05)	17.1
121	7	7	0.14 (0.02)	29.4
131	12	6	0.14 (0.05)	26.0
133	22	13	0.31 (0.04)	a
135	4	4	0.25 (0.12)	a
Totals and Means	220	76	0.31	43.1

[a] Home range size was not computed for juvenile and transient bobcats.

Table 8. Mean rate of movement of bobcats in 5 cover types in southeastern Oklahoma. Rate of movement was calculated from 522 hourly locations.

Cover type	Number of Locations	Rate of Movement (km/hr)
Pine Forest	343	0.46
Deciduous Forest	47	0.35
Mixed Pine-Deciduous	77	0.47
Grass Fields	35	0.40
Brush	20	0.45

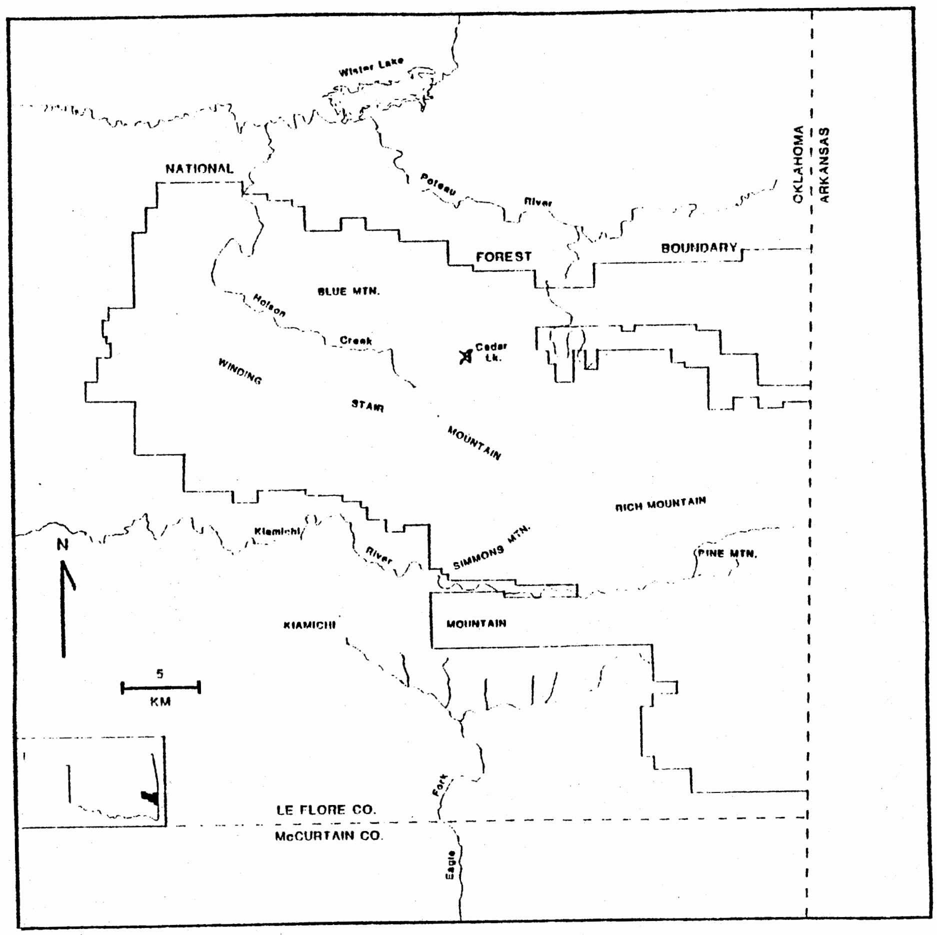

Figure 1. Location of study area and the Ouachita National Forest in southeastern Oklahoma.

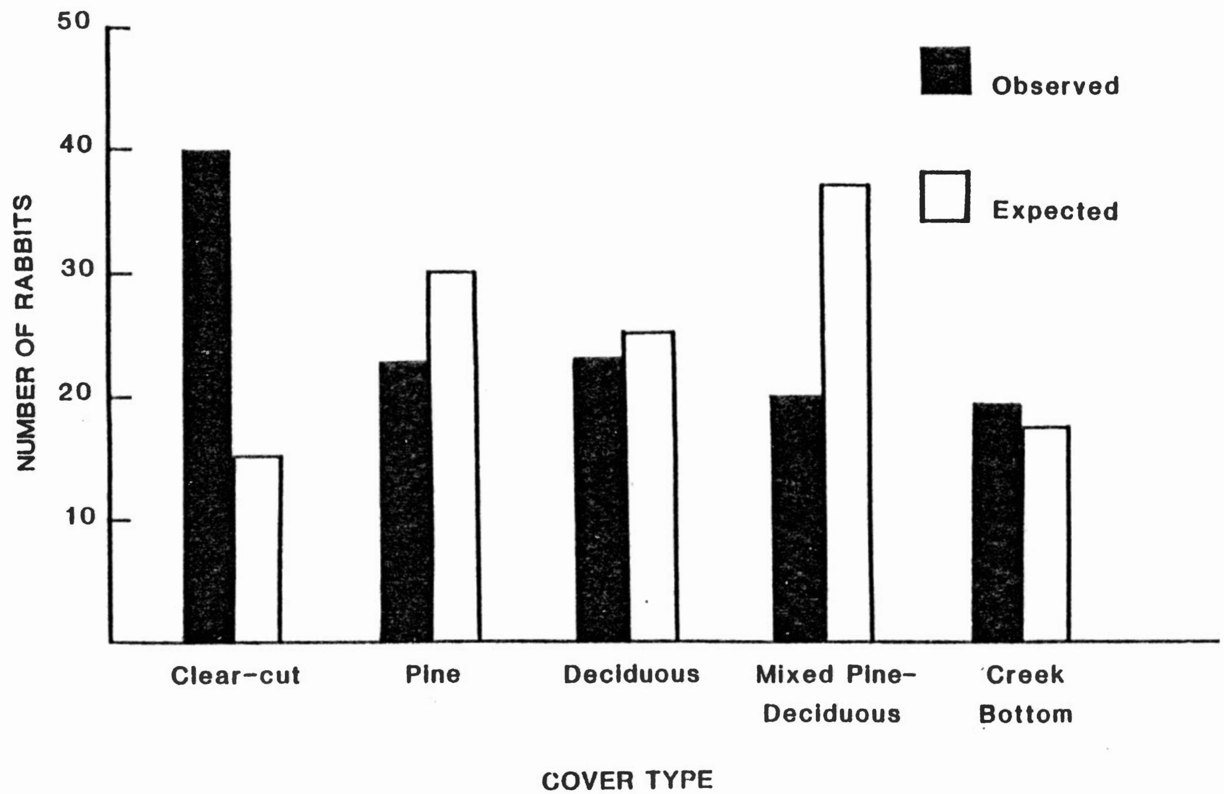

Figure 2. Number of cottontail rabbits observed and expected in 5 cover types during 15 38.4 km roadside counts. Expected frequency determined from the percentage of the census route in each cover type.

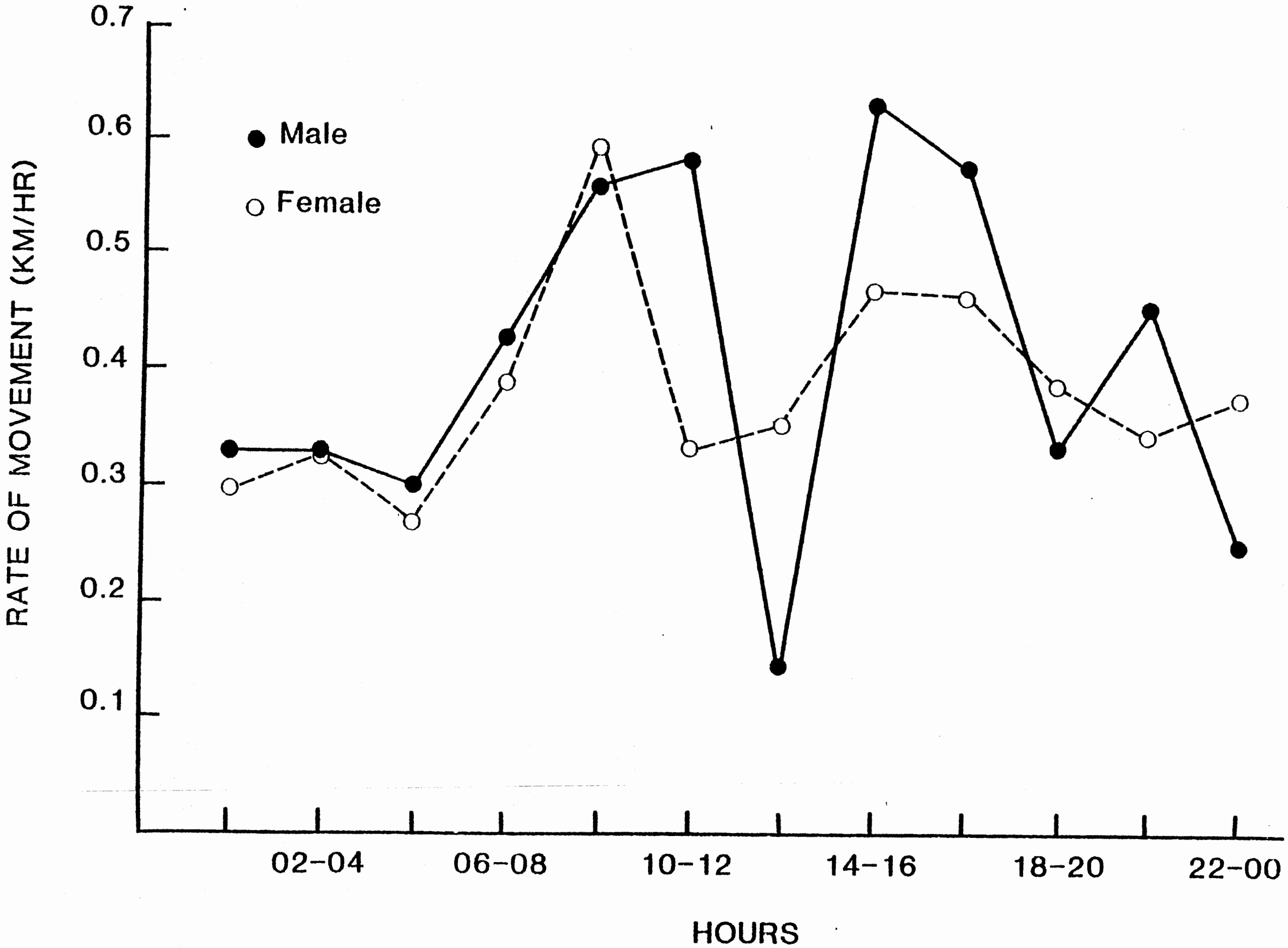

Figure 3. Mean rate of movement (km/hr) of male and female bobcats during 12 2-hr time periods.

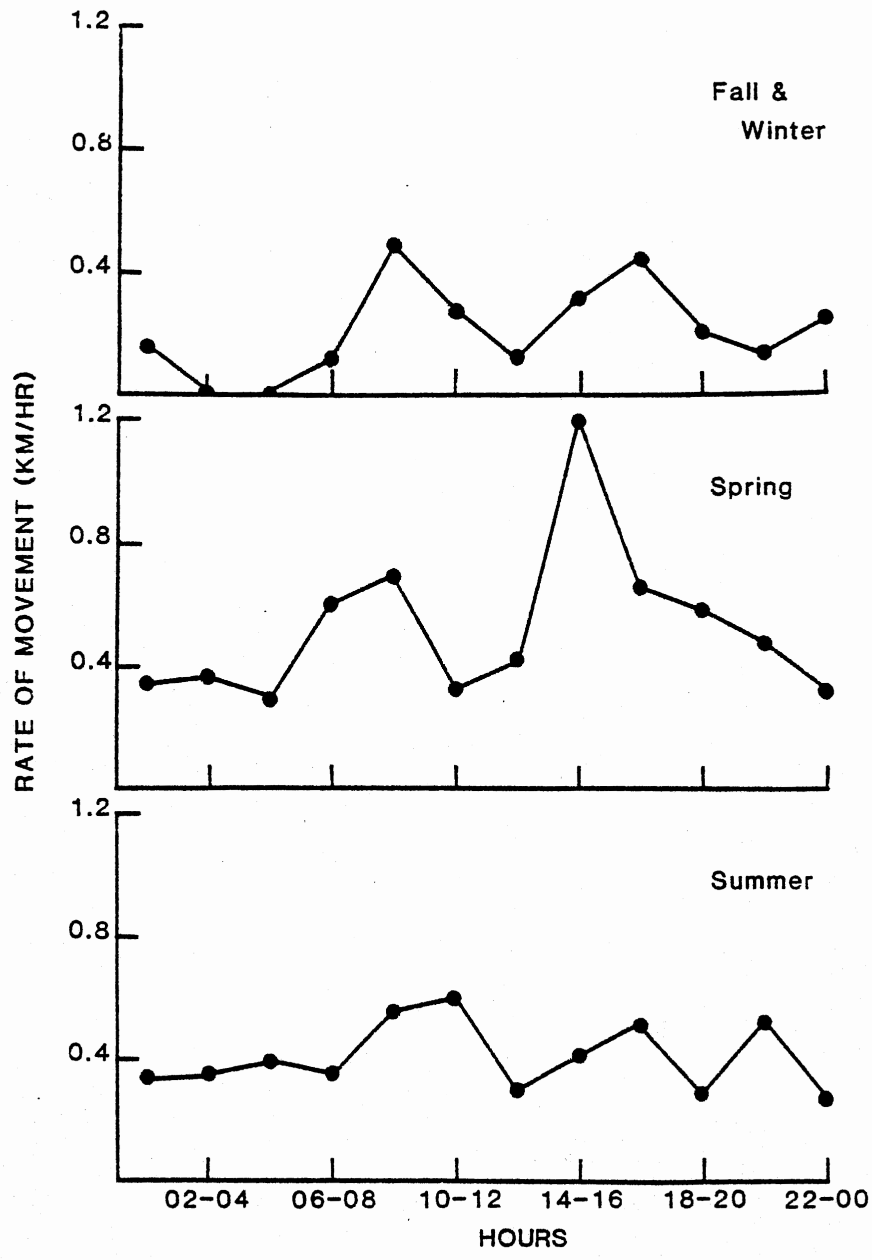

Figure 4. Diel activity patterns of bobcats during fall and winter, spring, and summer. Activity determined by rate of movement between hourly locations.

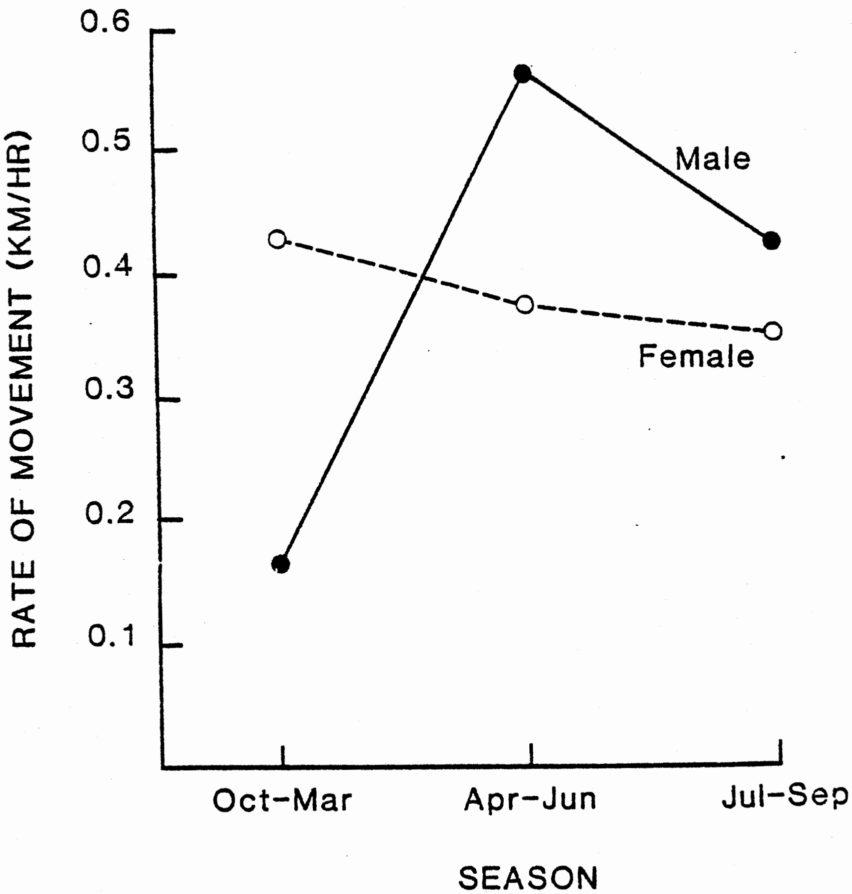

Figure 5. Mean rate of movement (km/hr) of male and female bobcats during fall and winter, spring, and summer.

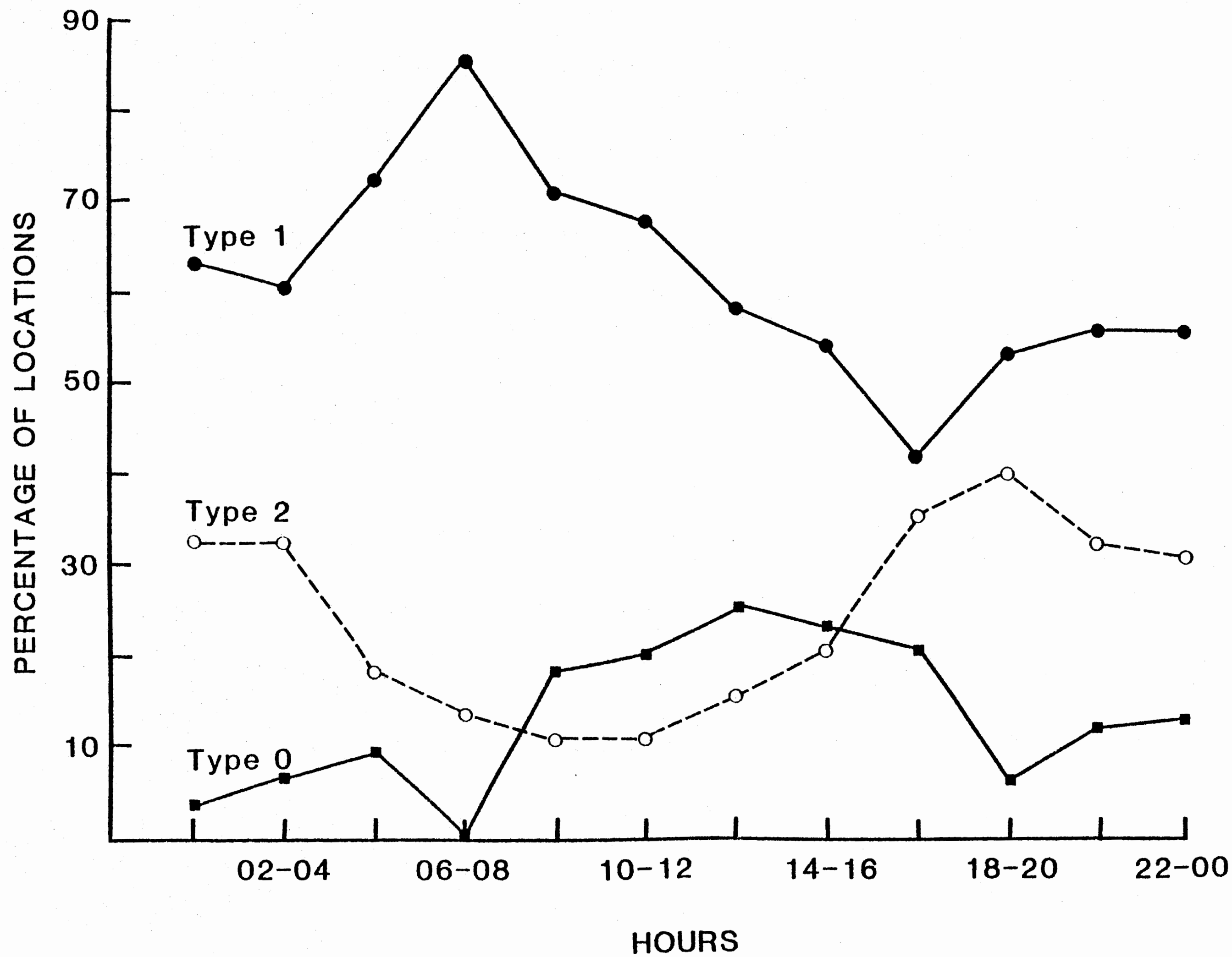

Figure 6. Percentage of locations assigned to 3 activity classes during 12 2-hr time periods.

VITA 2

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