Diel Activity Patterns of Adult Bobcats in Central Mississippi

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Abstract: We monitored 13 (6 female, 7 male) adult bobcats (*Lynx rufus*) using radiotelemetry and examined seasonal activity patterns using 9,217 observations from August 1989 – August 1990. Female bobcats were active 49% and males were active 60% of the diel period. Mean percentage activity during winter of males ($\bar{x}$ = 71%,SE = 4.0%) was greater ($P < 0.01$) than that of females ($\bar{x}$ + 44%, SE + 5%). Bobcats exhibited greatest activity during crepuscular and nocturnal periods. We detected a less defined bimodal crepuscular activity than previous studies. High diurnal activity makes bobcats susceptible to incidental harvest during sport hunting seasons. We recommend managers consider influence of activity on harvest patterns when designing harvest limits on bobcat populations.

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Generally, bobcats are considered to be nocturnal, but peaks in activity often occur around sunrise and sunset (Hall and Newsome 1976, Buie et al. 1979), characterizing them as crepuscular (Marshall and Jenkins 1966, Hall 1973, Zezulak 1981, McCord and Cordoza 1982, Edwards 1996). Zezulak and Schwab (1980) reported that bobcats were active approximately 12 hours of the diel period, mostly during crepuscular and nocturnal periods. Shiflet (1984) and Buie (1980) reported that bobcats displayed bimodal daily activity patterns with greatest activity coinciding with peaks in lagomorph activity (Anderson 1987).

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Previous studies addressing bobcat activity have calculated average distance traveled between consecutive locations during the diel period (Anderson 1987) with distance moved per unit time to index or reflect activity. Reynolds and Laundre (1990) reported that estimates of movement and daily distance traveled for coyotes (*Canis latrans*) and pronghorn (*Antilocarpa americana*) were sensitive to time interval between consecutive locations. Although activity information obtained in movement studies is beneficial, biases inherent in these analyses, including stalking periods and potentially circular movement patterns, would tend to underestimate activity. Additions of motion-sensitive switches on radio-transmitters allow bobcat activity patterns to be more accurately quantified (Shiflet 1984). Our objectives were to 1) determine sex-specific seasonal activity patterns; and 2) examine differences in activity patterns throughout the diel period for a bobcat population in central Mississippi during 1989–1990.

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Methods

Study Area

This research was conducted on the 14,410-ha Tallahala Wildlife Management Area (TWMA), situated within the Bienville National Forest in sections of Jasper, Newton, Scott, and Smith counties, Mississippi. TWMA contained 30% mature bottomland hardwood forests, 37% mature pine (*Pinus* spp.) forests, 17% mixed pine-hardwood forests and 11% 1-to 15-year-old loblolly pine (*P. taeda*) plantations. Topography on TWMA was greatly to moderately rolling and climate was mild with a mean annual temperature of 20 C and mean annual precipitation of 152 cm.

Bobcat capture

Bobcats were captured from 10 January to 15 August 1989–1990 using No. 3 and 1.5 Victor soft-catch foot-hold traps (Woodstream Corp. Lititz, Pa.). Captured bobcats were netted and anesthetized using an intramuscular injection of Ketamine hydrochloride (Ketaset Vet. Prod., Fort Dodge Lab., Inc., Fort Dodge, Iowa) at 15 mg/kg of estimated body mass. Each bobcat was weighed, standard body measurements taken, and each was given a unique identifying metal ear tag. Adult bobcats were fitted with 175–225 g motion and mortality-sensitive radio transmitters (Wildl. Mat., Inc., Carbondale, Ill.). Neither juveniles nor adult males around the periphery of TWMA were fitted with radio transmitters. Anesthetized bobcats were placed in portable pet kennels and kept for 24 hours to monitor recovery, then released at the capture site the following morning.

Radio-telemetry

Telemetry was conducted from 15 August 1989–15 August 1990 from fixed telemetry stations using a 3-element Yagi antenna and TRX-100s receiver (Wildl. Mat., Carbondale, Ill.). Bobcats were monitored for activity over the complete diel period. Each diel period was divided into 4 6-hour sampling periods: morning (0600–1200), midday (1200–1800), evening (1800–2400), and night (2400–0600). During each monitoring session, activity was monitored for 1 minute every 10 minutes during the 6 hours. Activity data were recorded as (1) active for intensity or activity change (i.e., change in motion switch or signal intensity) and (0) for inactivity. The monitoring schedule was 6 hours "on" followed by 12 hours "off," which measured 1 diel period for a bobcat every 3 days. Seasons were delineated by calendar year: winter (21 Dec–19 Mar), spring (20 Mar–20 Jun), summer (21 June–21 Sep), and fall (22 Sep–20 Dec).

Data Analysis

For analysis, the diel period was divided into 12 2-hour time intervals and subsequently grouped into 4 categories: morning, midday, evening, and night. Percentage activity was determined and compared between sexes across seasons and time periods. A 3-way analysis of variance (ANOVA) with all possible 2-way interactions was used to examine differences in mean percentage activity between sexes, across seasons, and time intervals. Linear contrasts were used to test differences in activity among the 4 time categories and to create 2 other categories: crepuscular and all. All was based on individual contrasts and allowed us to combine morning and evening into crepuscular periods and examine potential differences in activity in 1 period relative to all other periods. Assumptions for homogeneity of variance and normality were tested using Hartley's F-max (Steele and Torrie 1980) and Shapiro-Wilks tests (Zar 1984), respectively.

Results

We monitored 13 adult bobcats (6 female, 7 male) from August 1989 to August 1990, with 9,217 locations recorded to determine activity patterns. A 3-way ANOVA with all possible 2-way interactions indicated a significant interaction between sex and season ($P < 0.001$) and between season and time ($P = 0.001$). Therefore, we examined sex and time by season.

We detected no interaction between sex and time ($P = 0.63$) during winter. Therefore, we examined sex and time as main effects and found no difference regarding percentage activity across time intervals ($\bar{x} = 58\%$, SE = 4%) ($P = 0.35$). Mean percentage activity for males ($\bar{x} = 71\%$, SE = 4%) exceeded ($P < 0.001$) that of females ($\bar{x} = 44\%$, SE = 5%) (Fig. 1).

We detected no significant interaction between sex and time ($P = 0.88$) nor did differences between sexes occur ($P = 0.50$) during the spring. However, activity differed across time ($P = 0.04$). Bobcats were more active during crepuscular periods

($\bar{x}$ = 74%, SE = 3%) than night ($\bar{x}$ = 53%, SE = 4%) (P = 0.01) and compared with all ($\bar{x}$ = 62%, SE = 3%) (P = 0.05). Midday activity ($\bar{x}$ = 68%, SE = 3%) was not significantly different from night ($\bar{x}$ = 53%, SE = 5%) (P = 0.09).

We detected no significant interaction between sex and time (P = 0.81) during summer, but activity differed over time (P = 0.01). Bobcats were more active during crepuscular periods ($\bar{x}$ = 61%, SE = 4%) than during the midday ($\bar{x}$ = 46%, SE = 4%) (P = 0.03). Activity was not significantly higher during crepuscular than night and midday combined ($\bar{x}$ = 50%, SE = 3%) (P = 0.09). Although males ($\bar{x}$ = 57%, SE = 3%) were more active than females ($\bar{x}$ = 48%, SE = 3%), differences were not significant (P = 0.08).

We detected no significant interaction between sex and time (P = 0.36), nor did activity differ across time (P = 0.33) or between sexes (P = 0.90) during the fall. Bobcats were active approximately 50% of the time during fall and displayed greatest activity during evening ($\bar{x}$ = 61%, SE = 5%).

When activity data were pooled across season and time, mean percentage activity was 49% and 60% for females and males, respectively.

Discussion

Previous studies examining bobcat activity have used distance moved per unit time to examine activity patterns. However, if bobcats had been stalking prey or traveling in a circular fashion, activity patterns could have been underestimated. In our study, activity was indexed with motion switches and intensity changes rather than measured by movement. Thus, although previous studies reported similar results regarding periods of peak activity, researchers should be cautious if using movement rates to index activity patterns. Although similarities exist between results of our study and previous studies, we did not observe bimodal patterns in activity for bobcats on TWMA and bobcats were likely to be active approximately 50% of the diurnal period.

We realize that indexing activity using motion switches and intensity changes may create biases in observed activity rates. Factors including animal orientation and environmental conditions may influence signal reception and hence, introduce biases into estimating activity. Thus, although use of movement rates may underestimate activity, our method of indexing activity may overestimate observed activity.

Both male and female bobcats were more active during crepuscular periods in spring and summer, consistent with other studies (Marshall and Jenkins 1966, Zezulak 1981, Shiflet 1984). Crepuscular peaks in activity may coincide with peaks in lagomorph activity, a primary prey item of bobcats on TWMA and throughout the southeast (Anderson 1987, Miller and Speake 1978, Fritts and Sealander 1978, Edwards 1996). In northern areas of their range, bobcats may have greater diurnal movements that coincide with warmer temperature periods in winter (Buie et al. 1979). However, we detected no differences in activity between diurnal and nocturnal periods during winter, likely due to mild climactic conditions on TWMA.

Males were considerably more active during winter than females. Males have larger home ranges than females annually and seasonally (Buie et al. 1979, Conner et

al. 1992). Bobcats breed during winter (Stys and Leopold 1993), so male activity may increase during breeding to increase probability of mating. Conversely, low female activity during breeding may be a function of energy conservation during periods of lower prey availability or a strategy to increase mating probabilities (Conner 1991, Sandell 1989).

Because parturition in female bobcats on TWMA predominately occurs during spring and summer, we hypothesized that female activity would be lower than male activity due to responsibilities involved in caring for young. However, we detected no significant differences between activity patterns of males and females with both sexes displaying strong crepuscular patterns. Although not significant, lower observed activity by females during summer may be a function of female bobcats caring for young. Similarities in temporal activity existed between sexes during summer, with both males and females considerably more active during crepuscular than midday periods. This similarity between sexes is likely attributable to extreme summer heat on TWMA. Conversely, we suggest that mild fall climate on TWMA contributed to the lack of differences in activity between sexes during fall. Bobcats do not need to shift diurnal activity patterns to avoid daily temperature extremes during fall as is common in northern areas of the bobcat's range (Anderson 1987).

Management Implications

Commercial trapping has declined in Mississippi (Lipe 1997) and corresponding harvest of bobcats has declined throughout the southeast (Linscombe 1993). However, high diurnal activity makes bobcats susceptible to incidental harvest by deer hunters (Chamberlain, unpubl. data). Thus, managers must consider this potential harvest and influence of activity patterns on harvest susceptibility when implementing harvest limits on bobcat populations. Because bobcats are active during diurnal periods, incidental harvest of bobcats may be a useful method to index bobcat populations. However, relationships between activity patterns and bobcat density could bias utility of using incidental harvest information. Research examining density dependent relationships on activity is lacking and certainly warranted.

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