Wildlife Session

Habitat Use by Bobcats in Upland Forests of Louisiana

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Abstract: Habitat use by bobcats *(Lynx rufus)* was investigated in 1978–79 in forested uplands of Louisiana by monitoring 7 radio-collared adult bobcats (3 females, 4 males). Mean male home range ($\bar{x}$ = 1,010 ha) did not differ significantly from female ranges ($\bar{x}$ = 591 ha). Distances traveled during a diel period ranged from 0.5 km to 10.2 km and averaged 3.0 km. Mean diel travel distances of males (2.8 km) were similar to those of females (3.3 km). Botanical composition of habitats within modified minimum home ranges averaged 40.1% mixed pine *(Pinus* spp.)-hardwood, 18.1% hardwood, 5.4% pine, and 36.4% nonforested. Bobcats appeared to use hardwood habitat in greater proportion to availability and avoided other habitats.

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The ban on importation of furs of endangered spotted cats in 1969 (Bean 1977) led to increased demands for the fur of the North American bobcat. Deems and Pursley (1978) reported that harvest of the bobcat in the United States rose from 10,822 in 1970–71 to 35,990 in 1975–76 as average bobcat pelt prices rose from $10 to $125. Increased demands for furs can lead to overexploitation of bobcats, but proper management can help minimize this threat.

Habitat requirements of bobcats in upland forested habitats of Louisiana are poorly documented, but such information is essential for sound management. This study reports on habitat use, ranges, and movements of bobcats in upland mixed pine-hardwood forests in Louisiana.

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Methods

Field work was centered in East Feliciana Parish on Beechgrove Plantation—3,238 ha of private land with an all-weather road system and controlled land use. The remainder of East Feliciana Parish and the southwestern portion of Amite County, Mississippi, were investigated less intensively.

The research area is characterized by loessial hills laced with a network of streams and drainageways bounded by level to nearly-level silty flood plains. Major plant communities within the area are subclimax pine, mixed pine-hardwood and hardwood forests. Shiflet (1984) provides the major species composition of the plant communities. Overstory within each forest type varies due to differences in elevation and land use. Controlled burning approximately every 3 years has reduced hardwood species, woody perennials, and density of understory vegetation while increasing annual vegetation.

Bobcats were trapped within the boundaries of Beechgrove Plantation along roads in wooded areas, trails, and sandy creek banks. Modified and unmodified No. 3 double spring steel traps with a 2-m chain and drag were used in a buried scent post configuration (Hall 1973). To reduce leg injury to the bobcats, some traps were modified by reducing the holding edge of each jaw approximately 3.2 mm and padding the exposed edge with duct tape (Shiflet 1984). Male or female bobcat urine, applied to small clumps of broomsedge *(Andropogon)*, or fresh bobcat scats were used as a scent attractant.

Ketamine hydrochloride was administered intramuscularly (2.27 mg/kg body wt.) to render the captured animals tractable. A second injection (1.13 mg/kg) was administered if the first injection was ineffective.

An age estimate (Conley and Jenkins 1969), sex, weight, shoulder height, and length of right-hind foot, body, and tail were recorded. A radio-collar transmitter (Wildlife Materials, Inc., Carbondale, Illinois) was placed around the neck of each adult bobcat prior to release at the capture site.

Locations of radio-tagged bobcats were determined daily, when possible, by plotting at least 2 intersecting aximuths taken from known reference points on aerial photographs. To reduce the size of error polygons, reference points were repeatedly tested for accuracy against known locations. Locational errors were random and should not have favored any habitat type. One diel surveillance, consisting of 12 locations recorded at 2-hour intervals, was attempted each week for each animal. Incidental observations of radio-collared bobcats were recorded and included in the analyses. Home range was delineated by the minimum area method (Dalke 1942) and the modified minimum area method (Harvey and Barbour 1965). Both methods are presented to facilitate comparisons with past studies.

Distances traveled between 2 consecutive points were calculated (Hall and Newsom 1976) and considered minimum estimates of travel distance because bobcats infrequently travel in straight lines. Differences in movement rates and travel distances between sexes by time of day were tested for significant differences by analysis of variance on rank transformed data (Conover and Iman 1981).

Habitat was delineated on aerial photographs into 4 types: hardwood forest, upland pine-mixed hardwood forest, upland pine forest, and nonforested lands. Nonforested lands included agricultural fields, pastures, roads, and home sites. Areas classified as upland pine contained 30% hardwoods. Hardwoods had a maximum of 30% pine. Areas with 30% of both hardwoods and pines were classified as upland mixed pine-hardwoods. A chi-square test was used to test for significant differences between overall availability and usage. Preference in relation to availability was determined following a technique described by Neu et al. (1974).

Results

Twelve bobcats were captured between January 1978 and April 1979. Four adult males and 1 juvenile male, but no females, were captured from January-May 1978, when urine of a captive adult male bobcat was used as an attractant. Urine of a captured adult female was used from October 1978 to April 1979, and 2 adult males, 4 adult females, and 1 juvenile female were captured. The average number of trap days per capture using the male urine was 14.9, while the corresponding average for female urine was 8.4.

Movements of 7 adult bobcats (4 males, 3 females) were monitored between January 1978 and April 1979 (Table 1). One of the radio-tagged males was shot and another was trapped and shot within 2 months of capture. A third male was shot during the hunting season following capture.

Adult male bobcats generally weighed more than adult females (Table 1). Weights ranged from 10.8 kg for the heaviest male to 6.7 kg for the lightest female.

Diel movement distances were recorded for 6 bobcats (Table 2). Mean travel distances by all bobcats was 3.0 km (range: 0.5-10.2 km). Male bobcats showed greater variation in movement in 24-hour periods, but average male (2.8 km) and

Table 1. Capture and monitoring data of 7 radio-tagged bobcats, East Feliciana Parish, Louisiana, and Amite County, Mississippi.

Bobcat Identification No.–Sex	Capture Date	Age (yrs)	Weight (kg)	Monitoring Termination	Number of Locations	Status
1–M	14 Jan 1978	2	10.8	6 Feb 1978	20	shot (6 Feb 1978)
2–F	9 Feb 1978	2	6.8	22 May 1978	173	alive (22 May 1978)
3–F	26 Feb 1978	2	6.7	7 May 1978	143	alive (19 Nov 1982)
4–F	15 May 1978	4	6.9	28 Jul 1978	24	alive (28 Jul 1978)
5–M	11 Oct 1978	2	8.8	29 Nov 1978	67	shot (29 Nov 1978)
6–M	24 Dec 1978	3	7.2	9 Apr 1979	188	shot (29 Nov 1979)
7–M	17 Feb 1979	2	6.8	25 Apr 1979	107	alive (25 Apr 1979)

Table 2. Diel movements and minimum and modified minimum area estimates of home ranges for adult radio monitored bobcats in East Feliciana Parish, Louisiana, and Amite County, Mississippi.

Bobcat Identification No.–Sex	Distance (km) $\bar{x}$	Distance (km) Range (min – max)	Diel Periods (N)	Minimum area (km^2)	Modified minimum area (km^2)
1–M	8.74	6.51–10.24	3	5.79	3.26
2–F	4.09	1.36–8.66	9	15.57	10.41
3–F	2.46	1.73–4.08	8	9.60	4.80
4–F				17.72	2.51
5–M	3.40	2.20–5.53	4	44.29	18.64
6–M	1.95	0.50–4.65	11	28.95	16.93
7–M	1.38	0.58–2.00	7	2.20	1.56

female (3.3 km) travel distances during diel periods were similar ($P > 0.05$). Average movement rate for all bobcats, including periods of rest, was 142 m/hr. The average movement rate for males (127m/hr) was less ($P < 0.05$) than the average for females (164 m/hr). Straight line travel distances during diel periods ranged from 0.04 km to 4.1 km ($\bar{x} = 0.7$ km) for both sexes. Mean straight line travel distances for males (0.7 km) were similar ($P > 0.05$) to females (0.8 km). Diurnal travel distances of all bobcats ranged from 30.2 to 51.4% ($\bar{x} = 40.5\%$) of total diel travel distance.

Modified minimum area home ranges of bobcats ranged from 156 ha to 1,864 ha (Table 2). Male home range averaged 1,010 ± 450 ha ($\bar{x} \pm$ SE) and female home range averaged 529 ± 310 ha; however, differences were not significant ($P > 0.05$).

Habitat within the home ranges of the monitored bobcats consisted of 40.1% mixed pine-hardwoods, 18.1% hardwoods, 5.4% pine and 36.4% nonforested habitat (Table 3). The average home range composition for male bobcats (38% mixed

Table 3. Habitat availability and use within home ranges of 7 adult bobcats as determined by telemetric locations in East Feliciana Parish, Louisiana, and Amite County, Mississippi.

Bobcat Identification No.–Sex	Home Range Habitat Composition (%)[a] H[c]	Pine	MPH[d]	Non-forested	Occurrence in Habitat Type[b] H	Pine	MPH	Non-forested	χ^2, 3 df
1–M	32.5	5.5	21.1	40.9	19	1	9	11	5.2
2–F	14.7	5.1	42.8	37.4	74	8	51	40	109.4*
3–F	15.7	8.4	54.1	21.8	57	27	34	25	97.4*
4–F	14.4	4.5	32.0	49.1	6	0	10	8	4.9
5–M	10.7	3.2	34.3	51.8	18	6	28	15	35.6*
6–M	25.1	1.4	24.1	49.4	88	1	60	39	72.3*
7–M	13.8	9.7	72.6	3.9	41	3	57	6	58.1*
Mean	18.1	5.4	40.1	36.3	43.3	6.6	35.6	20.6	

[a]Based on minimum area method of range determination.
[b]Based on radio-telemetry locations.
[c]Hardwood.
[d]Mixed pine-hardwood.
*Indicates a difference at the 0.05 level of significance.

Table 4. Simultaneous confidence intervals using the Bonferroni approach for utilization of vegetation types, P_i.

Bobcat Identification No.–Sex	Expected Proportion of Usage P_{io}	Actual Proportion of Usage P_i	Bonferroni Intervals for P_i
2–F	25.43	42.8	$33.4 \leq P_1 \leq 52.2$*
	8.82	4.6	$0.6 \leq P_2 \leq 8.6$*
	74.04	29.5	$20.9 \leq P_3 \leq 38.2$*
	64.70	23.1	$15.1 \leq P_4 \leq 31.1$*
4–F	3.46	25.0	$2.9 \leq P_1 \leq 47.1$
	1.08	0.0	$0 \leq P_2 \leq 0$
	22.98	42.0	$16.9 \leq P_3 \leq 67.1$
	34.71	33.0	$9.1 \leq P_4 \leq 56.9$
5–M	7.17	26.8	$13.3 \leq P_1 \leq 40.3$*
	2.14	9.0	$0.3 \leq P_2 \leq 17.7$
	22.98	41.8	$26.8 \leq P_3 \leq 56.8$*
	34.71	22.4	$9.7 \leq P_4 \leq 35.1$
6–M	47.19	46.8	$37.7 \leq P_1 \leq 55.9$
	2.63	0.5	$0 \leq P_2 \leq 1.8$*
	45.31	31.9	$23.4 \leq P_3 \leq 40.4$*
	92.81	20.7	$13.3 \leq P_4 \leq 28.1$*
7–M	14.77	38.3	$26.6 \leq P_1 \leq 50.0$*
	10.38	2.8	$0 \leq P_2 \leq 6.7$*
	77.68	53.3	$41.3 \leq P_3 \leq 65.3$*
	4.17	5.6	$0.1 \leq P_4 \leq 11.2$

*Indicates a difference at the 0.05 level of significance.

pine-hardwood, 20.5% hardwood, 5% pine, 36.5% nonforested) was similar ($\underline{P} > 0.05$) to that of females (43% mixed pine-hardwood, 14.9% hardwood, 6% pine, 36.1% nonforested).

Five bobcats used habitats not in proportion to availability (Table 3). Hardwood habitat was used by chance more than expected by 3 of the 5, while pine-mixed hardwood habitat was avoided by 4, pine habitat was avoided by 3 and nonforested habitat was avoided by 2 (Table 4).

Approximately 7% of all locations were on roads in wooded areas. The range of fix locations on roads was from 3% to 12.6% of all individual locations.

Discussion

Within 2 months after capture, 1 monitored male bobcat was shot and 1 was trapped and killed. A third monitored male was shot during the fall following capture. This 43% mortality rate for tagged bobcats suggests that there was heavy human exploitation of bobcats in forested upland habitats adjacent to the study area.

Monitoring periods were too short to determine annual home range estimates; therefore, the home range estimates presented are for the respective time periods of observation only. Home range sizes in forested upland habitat were 2 or more times larger than those reported by Hall and Newsom (1976) for bobcats in Louisiana bottomland habitats (male: $\underline{\bar{x}} = 490$ ha, female: $\underline{\bar{x}} = 102$ ha). These differences may

have been influenced by habitat differences, time of year when monitoring occurred, hunting season, and/or abundance of prey. Hall and Newsom (1976) collected data during the summer when hunting seasons are closed, but most of the monitoring for this study was during the fall and winter during hunting seasons. Hall and Newsom (1976), Young (1958), and Knight (1962) thought that abundance of prey and lack of hunting pressure were responsible for small home ranges. Yet, other studies have shown large variation in home range size for bobcats. In Minnesota, Berg (1979) reported that 6 females and 16 males had average home ranges of 3,802 and 6,200 ha, respectively, and in Idaho, Bailey (1972) reported home ranges of 1,930 ha for 8 females and 4,210 ha for 4 males. Conversely, 1 female and 3 males in South Carolina had spring home ranges of 250 ha and 390 ha (Marshall and Jenkins 1966), and 6 females and 6 males had home ranges of 150 and 300 ha in Alabama (Miller 1980).

Although not significant ($P > 0.05$), observed adult male home ranges in this study were 1.7 times larger than female, and this difference approximates the ratios reported by Buie et al. (1979) in South Carolina (1.9), Miller (1980) in Alabama (2.0), Berg (1979) in Minnesota (1.6), Zezulak (1981) in California (1.7) and Bailey (1972) in Idaho (2.3); but, Hall and Newsom (1976) in Louisiana bottomlands (4.9) and Kitchings and Story (1979) in eastern Tennessee (4.2) found home ranges for males were about 4-5 times larger than those of females. Our data showed no significant difference, but small sample size may have contributed to the lack of a difference being noted.

Total distances moved during a diel period observed in this study (male = 2.8 km, female = 3.3 km) were similar to the 4.4 km for males and 2.9 km for females observed in Louisiana bottomland hardwoods (Hall and Newsom 1976). Other studies, however, have shown greater daily travel distances. Bobcats traveled an average of 8.8 km daily in Minnesota (Rollins 1945), 5.6 km daily in Michigan (Erickson 1955), and 4.9 km daily in Massachussets (McCord 1974).

Similar average straight line travel distances during a diel monitoring period (male: $\bar{x} = 0.7$ km, female: $\bar{x} = 0.8$ km) were not observed by Hall and Newsom (1976), who found males moved an average 2.2 km and females moved an average 1.3 km during a 24-hour period. Bobcats in forested upland habitats of Louisiana apparently do not limit travel to hours of darkness because diurnal travel distances of all bobcats averaged more than 40% of the total diel travel distance.

Almost 80% of home ranges of monitored bobcats consisted of mixed pine-hardwoods (40.1%) and unforested habitats (36.4%). If the number of locations in a habitat type reflects time spent in that habitat, bobcats in Louisiana uplands heavily use hardwood habitats and avoid other habitats. Avoidance of nonforested areas by monitored bobcats may be in response to human disturbances during farming activities.

Hardwood forests on the study area are characteristically located along major drainages and tributaries, while pine and mixed pine-hardwood forests are associated with the drier uplands. Nonforested areas are intermingled with the forested areas. Tagged bobcats were observed along the edges of fields moving slowly and

stopping often. Such movement is indicative of hunting behavior in bobcats (Marshall and Jenkins 1966).

Mixed pine-hardwoods were most often chosen for resting. These areas were more hilly and may have provided better visibility. No distinct bedding sites were documented; however, 4 monitored bobcats rested within the same area more than once. Short distance movements were common in areas selected by bobcats for resting, i.e., a bobcat may remain in 1 location as long as an hour, move <50 m and then not move again for a minimum of 15 minutes. Movements within a bedding area have been previously documented by Erickson (1955).

Bobcat movements within the hardwood habitat were direct with few stops. In these instances it is believed the hardwoods were used as travel corridors. Bobcats observed on roads in wooded areas also appeared to be using them as travel corridors; but bobcats were also observed hunting along the edge of roads.

Approximately 7% of all locations were on roads in wooded areas. Less than 4% of Beechgrove Plantation consists of roads; therefore, track counts as an indication of population level of bobcats may be invalid if conducted on roads.

Size of opening appears to influence use of bobcats. Roads, which were small openings of nonforested habitat, were heavily used, while other nonforested habitat was avoided.

Conclusions

Bobcats in forested upland habitats use larger ranges than bobcats in bottomland habitats of Louisiana, but movements within the habitats were similar. Bobcats chose hardwood areas associated with drainages in the uplands and avoided the drier upland habitat types. Bobcats extensively used the small openings associated with roads in wooded areas. It is recommended that bobcat habitat managers enhance upland habitats by maintaining the hardwoods along drainages and favor small openings in forested areas.

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