SUMMER HOME RANGES AND MOVEMENTS OF BOBCATS IN BOTTOMLAND HARDWOODS OF SOUTHERN LOUISIANA

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ABSTRACT

An ecological study of the bobcat (Lynx rufus) *was conducted in bottomland hardwood habitats in Louisiana over a 2-year period to evaluate movement and activity patterns. Six bobcats, trapped in spring and summer of 1973, were equipped with radio-transmitting collars and their movements subsequently monitored with portable receiving equipment. Three adult male bobcats had an average minimum home range of 494.1 ha and 3 females limited their movements to an average of 97.1 ha. Diel movements averaged 4.4 km for males and 2.9 km for females, but straight line movement averaged only 2.2 and 1.3 km respectively. Monitored animals were crepuscular in their activities, becoming quiescent around noon and midnight. In bottomland hardwood habitat the mid successional seral stages were important in providing security and prey for bobcats.*

The current interest in movement ecology of wildlife has resulted in a tremendous expansion in knowledge of life histories and an improvement in management programs. The literature contains reports of several movement studies of northern and western bobcats (Bailey 1972, Pollack 1949 and Rollings 1945), but we found only one paper dealing with southeastern bobcats (Marshall and Jenkins 1966). Of those studies, only Marshall and Jenkins discussed bobcat movements and activities during summer months.

An ecological study of the bobcat in Louisiana was initiated in the spring of 1972. This paper reports the findings of a radio telemetry study of movements and home ranges of three male and three female bobcats during summer months in bottomland hardwood habitat and some additional information on behavior.

This study was supported by the Louisiana Cooperative Wildlife Research Unit with funds made available by the Louisiana Wild Life and Fisheries Commission. We are grateful to personnel of the Louisiana Wild Life and Fisheries Commission for use of facilities at Thistlethwaite Game Management Area throughout this study.

METHODS AND MATERIALS

Study Area

The study was conducted on land now known as Thistlethwaite Game Management Area (TGMA) consisting of 4533 ha in south central Louisiana in St. Landry Parish and leased by the Louisiana Wild Life and Fisheries Commission. The majority of the TGMA lies in the alluvial floodplain of the Mississippi River and is characterized by level clayey soils of the Sharkey series, with scattered poorly drained depressions.

The high natural fertility of the soil produces lush vegetation. Bottomland hardwoods cover about 4047 ha of the area; the remainder is in openings such as pipeline rights-of-way, pastures, shell roads, and gas well sites (Neal 1967). The primary understory plant is palmetto (*Sabal minor*); however, recently logged areas support dense growths of dewberry (*Rubus* sp.). Baccharis (*Baccharis halimifolia*), ragweed (*Ambrosia* sp.), goldenrod (*Solidago* sp.), and Macartny rose (*Rosa bracteata*) are the dominant species along the roadsides and on the gas well sites.

The TGMA produces natural gas, timber, and wildlife. Sohio Oil Company has about 25 gas-well sites scattered through the area and maintains all-weather shell roads. In the early 1900's the tract was logged, after which it remained untouched until 1971 when a 405 ha yearly selective cutting schedule was initiated. Numerous species of wildlife occur on the area. Deer were stocked on TGMA in 1961 and 1962 and have been hunted since 1965. Other potential prey species for bobcats, e.g., small mammals and birds, were all considered to be abundant. This abundance of prey and the protected status of bobcats on the management area created an ideal situation for this study.

Capture and Handling

Bobcats were captured with No. 3 double spring steel traps baited with female bobcat urine, and two large live traps baited with live white chickens and placed near bobcat sign. Preliminary trapping of bobcats with the No. 3 steel trap demonstrated that checking traps twice daily eliminated the problem of injury to the foot.

A large, heavy rope net was thrown over bobcats caught in steel traps; when the animals became entangled they were anesthetized by an intramuscular injection of ketamine hydrochloride at the average rate of 15.43 mg/kg of body weight. Bobcats captured in live traps were similarly anesthetized. Captured animals were weighed, measured, ear-tagged, and given an intramuscular injection (0.75cc) of a broad-spectrum antibiotic. Five of the bobcats were released within 24 hours of capture; one was held for 2 days to allow a series of photographs to be completed.

Bobcats equipped with radio transmitters ranging in frequency from 150.855 to 151.060 MHZ were located with portable receivers and hand-held directional antennae by driving roads and pipelines and stopping frequently to check for a signal. When a signal was received, directional bearings to the nearest degree were taken with a compass from reference points on an area map. Error polygons were plotted on the area map to determine the accuracy of a fix in several instances where the bearings intersected at a distant, sharply, acute angle (Heezen and Tester 1967). A leeway of ±5.0° was used to allow for reading error and signal distortion (Heezen and Tester 1967). Very few fixes were made at distances greater than 0.40 km; therefore we assumed bobcats could always be fixed within an area no greater than 4.04 ha. However, this represents the poorest conditions; most fixes were probably accurate to within 0.40 ha.

Attempts were made to monitor the movements of all bobcats at least 4 days per week. Two 24-hour (diel) surveillances were made on each bobcat in which locations were taken at 2-hour intervals. In addition to diel tracking, several readings were taken on each bobcat at other times throughout the day and night. These readings were rotated when possible, i.e., if a bobcat was located at 1200, 1800, 2400, and 0600 one day, efforts were made to locate the animal the following day at 1400, 2000, 0200 and 0800, to get more representative activity patterns than could be obtained by haphazard fixes.

All radio locations were plotted on aerial photographs scaled 20.3 cm to 1.60 km. Distances moved were measured with a ruler; home ranges were calculated with a compensating polar planimeter.

Data Analysis

We used the modified minimum area method developed by Harvey and Barbour (1965) to circumscribe home range boundaries. What appeared to be exploratory sallies were connected to the home range area by a straight line, and calculated to be a lane 15 m wide. In so doing, large areas from which there were no fixes were eliminated. Certain portions of each home range, except one, received intense usage and for comparison to total home range, these core areas, similar to those described by Kaufman (1962), were subjectively delineated.

The study of animal movement requires defining and measuring certain parameters. Those used in this study were:

(1) Maximum straight-line distance—the straight line distance between the two most extreme locations in a diel period.

(2) Minimum total distance—the sum of the distances between sequential locations in a diel period, considered minimum due to the 2-hour sampling interval.

(3) Rate of movement—the hourly rate of linear movement for that time period equal to half of the measured distance between sequential fixes, taken at 2-hour intervals.
(4) Activity period—the highs and lows of activity in a diel period.

A nested analysis of variance was performed on movement data to evaluate within sex, animal, hour, and day variation (Snedecor and Cochran 1967).

Hunting a Radio-Tagged Bobcat

To determine the effect of extreme harrassment on home range fidelity, two attempts were made by two experienced bobcat hunters to pursue a radio-instrumented animal with a pack of hounds. The hunting evaluation involved the use of six to nine well-disciplined hounds, two mounted riders and a road crew to monitor the bobcat's movements with the radio receiver. The bobcat was radio-tracked for several hours before the hunt; at the scheduled time two hounds were led in the direction of the animal with the aid of the telemetry equipment. When these dogs started trailing, the remainder of the pack was released. The course of the bobcat's evasive action was mapped by following the chase on horseback and by monitoring movements with the radio receiver.

RESULTS

Instrumented Bobcats

Bobcat 27-15. This large adult male was captured at a urine scent post set at an oil well site. In a period of 68 days he was radio-located 131 times in an area of 742.6 ha. Logging activities in the extreme southeast portion of this animal's range did not seem to interfere with his movements. On the contrary, he often moved into the logging area in late evening and traveled along the newly opened woods roads. Shell roads, pipeline, and dense woods were all favored hunting areas; frequently he was radio-located in a stationary position on the edge of the large east-west pipeline. Radio signal strength gradually diminished to the point where it became impossible to monitor after 68 days.

Bobcat 28-111. This adult male bobcat was captured at a scent post set at a cattleguard. He was located 97 times in 34 days and his movements became quite predictable. During the daytime he would often rest in an area of heavy undergrowth in the vicinity of an active well site, and in the evening he would hunt along the shell road and pipeline that ran through his range. Radio-contact was lost abruptly and never regained. An adult female (33-07) was later trapped and monitored in his range and proved to have a core area overlapping that of 28-111. Since core areas rarely overlap, even between bobcats of the opposite sex (Bailey 1972), we hypothesized that 28-111 had shifted his range. Evidence supporting this came 121 days later when a local farmer killed this cat 8.4 km northwest of the periphery of the animal's former range.

Bobcat 29-17. This 2-year-old male bobcat was trapped at a urine scent post set at the intersection of two shell roads. He was monitored for 29 days during which time he was radio-located 97 times and sighted once. Erratic movements resulted in a two-parted home range, atypical of other bobcats. A core area could not be defined. While trying to determine the nature of his daytime rest cover, we found him lying dead within 4.5 m of a shell road. An advanced state of decomposition prevented determination of the cause of death, however a small puncture in the top of the skull suggested external forces were responsible.

Bobcat 31-03. The first female to be used in the telemetry study was caught at the intersection of two shell roads in a urine scent post set. Her age was recorded as 1.5 years. In 44 days this bobcat was radio-located 94 times. Movements of 31-03 were somewhat restricted during the two diel tracking periods: in fact she was never recorded as having moved more than 0.53 km in a 2-hour interval (Table 1). Her hunting efforts were confined primarily to the numerous shell roads running through her range. Signal strength became weaker and contact with this animal was eventually lost.

Bobcat 32-04. A live trap baited with a live white chicken captured this adult female at an active oil well site. In 23 days she was radio-located 51 times and sighted on four occasions. The southeast quadrant of this animal's range was logged the previous year (1972) and provided her with a great deal of security in the downed treetops and heavy undergrowth;

Table 1. Distances moved (km) per 2-hour time interval by six bobcats during diel tracking periods on Thistlethwaite Game Management Area, Louisiana.

Bobcat number	Tracking period	Time interval (hours) 1100 1300	1300 1500	1500 1700	1700 1900	1900 2100	2100 2300	2300 0100	0100 0300	0300 0500	0500 0700	0700 0900	0900 1100	Total
27- 15	1	0.00	0.17	0.75	0.80	1.46	1.46	0.00	0.00	1.30	0.30	0.49	0.00	6.77
	2	0.00	1.23	2.41	1.25	0.00	0.00	0.09	0.00	1.06	0.49	0.00	0.00	6.56
28-111	1	0.00	0.00	0.72	0.30	1.07	0.14	0.54	0.00	0.65	0.80	0.00	0.00	4.26
	2	0.00	0.00	0.49	1.20	0.57	0.54	0.00	0.00	0.35	0.00	0.20	0.00	3.39
29- 17	1	0.00	0.70	0.30	0.30	0.30	0.20	0.00	0.00	0.00	1.01	0.85	0.00	3.70
	2	0.00	0.00	0.45	0.43	0.22	0.14	0.20	0.00	0.20	0.09	0.00	0.00	1.77
31- 03	1	0.00	0.00	0.09	0.14	0.00	0.00	0.00	0.09	0.04	0.20	0.00	0.00	0.59
	2	0.00	0.00	0.49	0.37	0.53	0.25	0.00	0.25	0.20	0.22	0.09	0.25	2.70
32- 04	1	0.00	0.00	0.25	0.49	0.00	0.00	0.17	0.00	0.20	0.49	0.45	0.20	2.30
	2	0.00	0.35	0.25	0.00	0.90	0.35	1.01	0.00	1.07	0.04	0.54	0.00	4.55
33- 07	1	0.00	0.00	0.12	0.35	0.12	0.04	0.00	0.00	0.94	0.78	0.00	0.45	3.20
	2	0.00	0.00	0.80	0.30	0.75	0.04	1.01	0.00	0.24	0.45	0.61	0.00	4.23
Average		0.00	0.20	0.59	0.49	0.49	0.27	0.28	0.03	0.53	0.41	0.17	0.08	3.66

Bobcat 33-07. This adult female was taken in a live trap baited with a live white chicken at the intersection of a shell road and a pipeline. She was radio-located 65 times and sighted once in a period of 38 days. This bobcat had a larger range than the other two females and tended to make more extensive movements within her range. She often spent the late afternoon and evening around the shell road that transected her range, moved to the pipeline after dark, and returned to the road at dawn. Radio tracking was concluded when she was caught and killed by a pack of cathounds.

Hunting a Radio-Tagged Bobcat

Since 33-07 was the only bobcat being regularly monitored at the conclusion of the telemetry study, she was used in an attempt to evaluate the effects of disturbance on bobcat movements. One hunt was made at dawn and lasted 1.5 hours; the second one made at dusk lasted 1.7 hours. This female showed a strong home range fidelity during both chases; her evasive movements were limited mainly to areas of dense understory and swamp in the central part of her range.

Home Range

Six bobcats on the TGMA had an average summer home range of 295.8 ha in bottomland hardwood habitat (Table 2). Five ranges included a core area of high usage with several areas of favored resting cover. Home ranges were of varying sizes and irregular shapes (Fig. 1). Data in Table 3 indicate the relationship between core area size and home range.

The minimum summer home range of three male bobcats in bottomland hardwood habitat varied from 340 to 726 ha with an average of 494 ha (5.2 km^2). Three females in an identical environment had an average summer home range of 97 ha (0.98 km^2), ranging from 85.4 to 120.5 ha. The general shape of the female home range, as determined by the length-width quotient, tended to be slightly (20 percent) more linear than male ranges. These more linear ranges were centered around the shell roads.

Movements

Movements by radio instrumented bobcats were monitored at 2-hour intervals for diel periods (Table 1). The average minimum total distance moved was 4.4 km for three male bobcats and 2.9 km for three female bobcats while the maximum straight-line distance averaged 2.2 and 1.35 km respectively (Table 4). Rate of movement for diel tracking periods was a function of the distance moved and coincided with time of peak activity. Males exhibited the greatest rate of movement, averaging 369 to 434 meters per hour (mph) between 1500 and 1900 (Fig. 2). Females traveled at an average rate of about 192 mph between 1900 and 2100 and 192 to 224 mph between 0300 and 0700 (Fig. 2). Telemetered bobcats were most active in the evening from 4 hours before average sunset until 2 hours after sunset; morning activity was greatest from 2 hours before average sunrise until 4 hours after sunrise (Fig. 3). Frequency of activity by males and females is presented by time interval in Table 5.

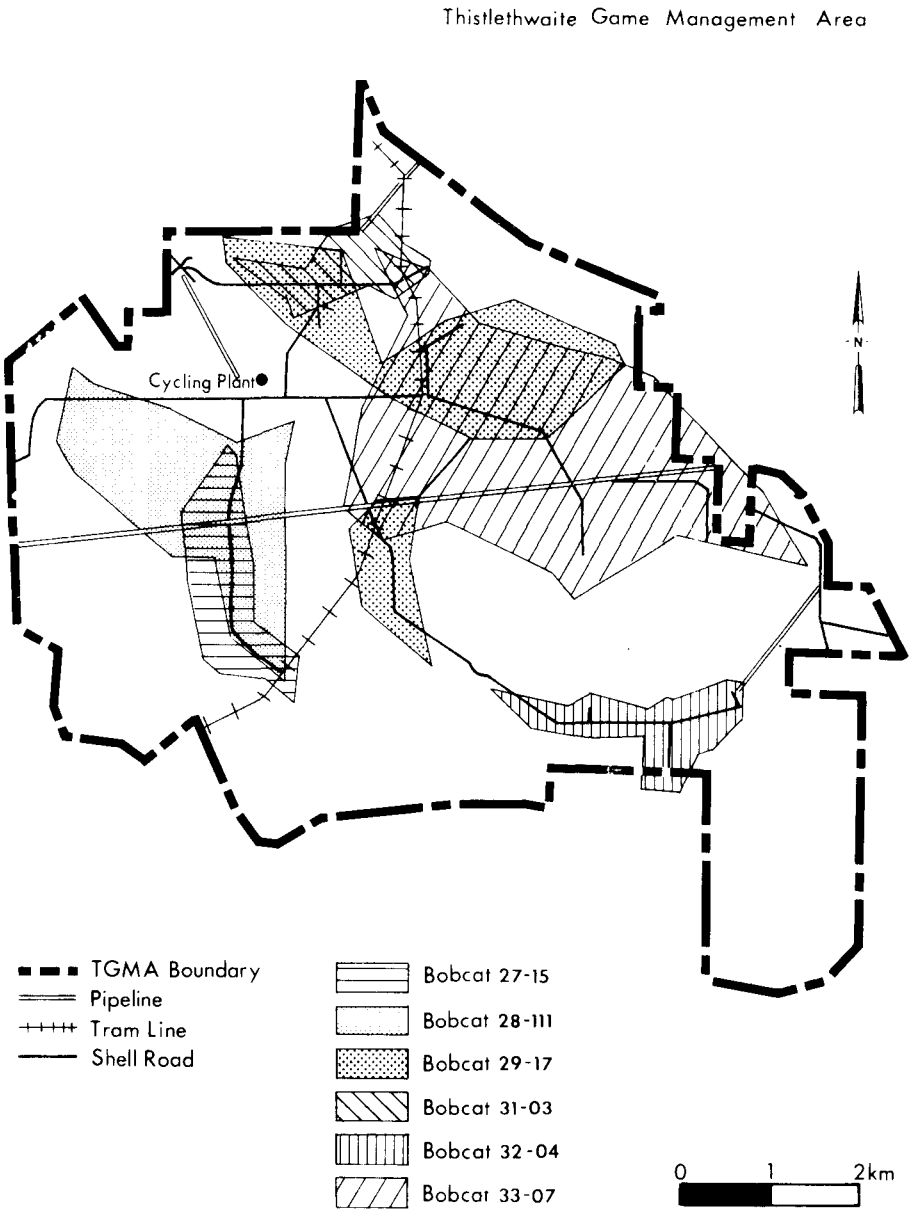

Figure 1. Modified minimum summer home ranges of six bobcats on the Thistlethwaite Game Management Area, Louisiana.

Table 2. Modified minimum summer home range data of six bobcats on Thistlethwaite Game Management Area in Louisiana as determined by radio-tracking.

Bobcat number	Tracking interval	period days	Number of fixes	Modified minimum home range (ha)	(km²)	Range major axis (km)	Range minor axis (km)	Range length-width quotient[1]
27-15	5/30-8/5	68	131	726.4	7.27	6.34	2.41	5.55
28-111	6/1-7/4	34	97	339.9	3.39	3.83	1.91	4.33
29-17	6/24-7/22	29	97	416.0	4.16	ND	ND	ND
31-03	7/10-8/22	44	94	85.39	0.85	2.10	0.65	5.24
32-04	7/17-8/8	23	51	85.39	0.85	2.71	0.94	8.45
33-07	7/25-8/31	38	65	120.59	1.21	2.43	0.75	4.87
Male average		44	108	494.1	4.94	5.08	2.17	4.94
Female average		35	70	97.1	0.98	2.41	0.78	6.19

[1]The quotient of the range major axis divided by the range average width; average width was determined by dividing the range area (area units) by the range major axis (linear units) (Kurz and Marchinton 1972).

Table 3. Characteristics of five core areas in bobcat ranges on the Thistlethwaite Game Management Area, Louisiana.

Bobcat number	Total fixes	Core area fixes	Percent of total fixes	Home range area (ha)	Core area (ha)	Percent of home range
27-15	131	79	60	726.4	216.9	30
28-111	97	71	73	339.9	72.4	21
31-03	94	51	54	85.3	10.1	12
32-04	51	35	69	85.3	28.7	34
33-07	65	34	52	120.5	13.3	11

DISCUSSION

Home Range

Home range sizes delineated in this study were considerably smaller than those reported elsewhere. This difference may reflect seasonal differences due to time of year the different studies were conducted. In Minnesota during the winter, Rollings (1945) stated that bobcats probably remain in an area of 26 to 39 km². Pollack (1949) worked with bobcats in the northeastern United States and estimated the home range to be between 3.8 and 14.2 km². Bailey (1972) radio-tracked 17 bobcats in Idaho and found that the home range of adult females varied from 9.0 to 57.0 km² and that for males, 54.0 to 175.0 km². These large ranges in Idaho were in an area of rocky, volcanic strata, characterized by a climax vegetation of sagebrush and grass.

Marshall and Jenkins (1966) reported spring and summer maximum home ranges of 4625, 887 and 252 ha ($\bar{x}$ = 3.5 km²) for three bobcats instrumented on the Savannah River Project (SRP) in South Carolina. They recognized that these were smaller ranges than had been found by other workers and suggested that abundance of prey and prohibition of hunting on the SRP (Kight 1962) may have been responsible for the small range size. Young (1958) also suggested that available prey and hunting pressure were the two most important factors in determining the home range of the bobcat.

Table 4. Summer movement parameters of bobcats in diel periods as determined by radio-tracking on Thistlethwaite Game Management Area, Louisiana.

Bobcat number	*Sex*	*Tracking dates (1973)*	*Minimum total distance traveled (km)*	*Maximum straight line distance (km)*
27-15	M	6/4-6/5	6.77	3.66
		7/2-7/3	6.56	3.66
28-111	M	6/17-6/18	4.26	2.05
		6/24-6/25	3.39	1.77
29-17	M	6/26-6/27	3.70	1.56
		7/1-7/2	1.77	0.65
31-03	F	7/22-7/23	0.59	0.35
		8/21-8/22	2.70	0.85
32-04		7/22-7/23	2.30	1.46
		7/29-7/30	4.55	2.36
33-07	F	8/13-8/14	3.20	0.94
		8/19-8/20	4.23	2.10
Male average			4.40	2.22
Female average			2.90	1.35

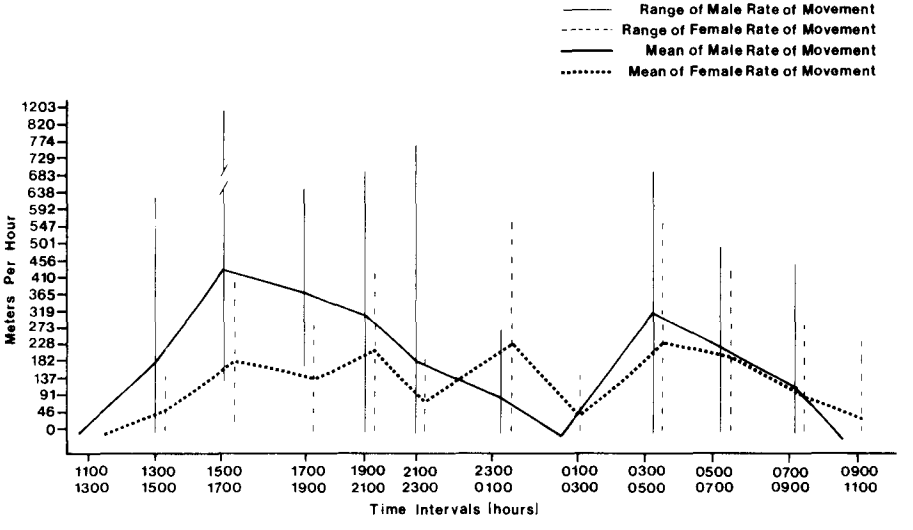

Figure 2. Rates of movement for male and female bobcats during the summer on Thistlethwaite Game Management Area, Louisiana.

Similar conditions of abundant prey and no hunting pressure existed on the Thistlethwaite study area and were probably responsible for the comparatively smaller home ranges (♂ $\bar{x}$ = 4.9 km², ♀ $\bar{x}$ = 0.9 km²).

Movements

Minimum total distance. Data from diel tracking periods (Table 1) indicate that males averaged 1.5 km more in total distance moved (4.4 km) than females (2.9 km). In addition, sequential radio-locations independent of diel tracking suggested a greater amount of

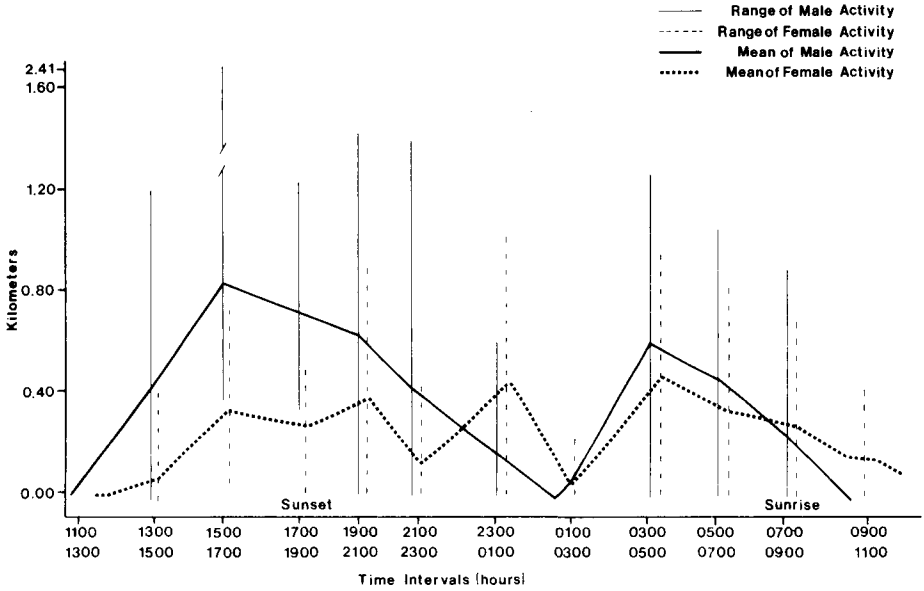

Figure 3. Summer movements of male and female bobcats in diel periods on Thistlethwaite Game Management Area, Louisiana.

Table 5. Frequency of activity of bobcats during the summer on Thistlethwaite Game Management Area, Louisiana.

Time interval	Animals active			
	Male observations (n=6)		Female observations (n=6)	
	Percent	Number	Percent	Number
1100-1300	0	0	0	0
1300-1500	50	3	17	1
1500-1700	100	6	100	6
1700-1900	100	6	83	5
1900-2100	83	5	67	4
2100-2300	83	5	67	4
2300-0100	50	3	67	4
0100-0300	0	0	33	2
0300-0500	83	5	100	6
0500-0700	83	5	100	6
0700-0900	50	3	67	4
0900-1100	0	0	50	3

movement by male bobcats ($P<0.01$); males varied from 1.7 to 6.7 km of movement per diel period whereas females varied from 0.59 to 4.5 km. The work by Marshall and Jenkins (1966) also suggested that males move greater distances than females in their day to day travels. They reported that an adult female tracked for 18 diel periods on the SRP averaged 2.6 km total movement, while an adult male in the same area averaged 4.7 km in three diel tracking-periods.

Maximum straight-line distance. Data indicated that the average straight-line distance of male movement was 2.2 km, but only 1.3 km for females (Table 4). If, by increased

sampling, it could be shown that males move significantly more than females, it follows that their straight-line distance would also be significantly greater.

Rate of movement. Male bobcats made more extensive movements through their range than did females, thus, their rate of movement was considerably greater (Fig. 2). This does not necessarily mean that males traveled at a greater rate of speed than females but it does suggest that male bobcats probably travel farther and pause less frequently in their hunting activities. This explanation concurs with Bailey's (1972) findings that males frequently moved between 1.6 and 4.8 km while females moved most often between 0.4 and 0.8 km.

Activity periods. Distances moved by 2-hour intervals, within diel periods, were plotted separately for males and females (Fig. 3). There was a significant difference ($P<0.05$) between 2-hour intervals of activity but no significant difference between times of male and female movement.

Male bobcats began their daily summer activity between 1300 and 1500. This activity peaked between 1500 and 1900 when 100 percent of the males were moving, then tapered off to a period of inactivity from 0100 to 0300 during which there was no recorded male movement. Another flurry of activity occurred between 0300 and 0500 and decreased to zero by 0900. There was no movement detected for instrumented male bobcats from 0900 to 1300.

Female bobcats tracked in this study did not show the clear-cut activity patterns that males did. In the evening females were most active from 1500 to 2100. Morning activity peaked between 0300 and 0700 when 100 percent activity was recorded. The only recorded period of total inactivity for all females was 1100 to 1300.

Periods of greatest activity were centered around sunrise and especially sunset. Visual observations suggested that prey species such as rabbits and rodents were also active at this time and therefore were more readily available to hungry bobcats. In the South where food is plentiful and disturbance by man and dogs is limited, the bobcat is probably a crepuscular animal.

Habitat Use

In bottomland hardwood habitat, the mid-successional seral stages of saplings, vines, and briars, that are characteristic of cut-over areas, are important to bobcats. These were the areas in which the majority of radio fixes were obtained on the radio instrumented animals. Such areas provide security and rest for bobcats and a maximum supply of small prey species.

Daytime Cover

Numerous attempts to observe radio-located bobcats in their daytime rest areas were unsuccessful. These attempts were never made during diel tracking to avoid the possibility of abnormal movement. Typically a bobcat was followed in late morning until it became stationary for two or three hours, and was assumed to have chosen its daytime bed. Heavy palmetto ground-cover precluded a silent approach, and in all cases the animals were disturbed and abandoned their beds when we approached to within 30 to 40 m. The height of the palmetto prevented even a glimpse of a fleeing bobcat.

Sites that appeared to be favored at daytime cover were generally characterized by a thick understory and were usually adjacent to a road or well site. Monitored bobcats did not always return to the same daytime rest site. In general, areas of heavy undergrowth were favorite rest areas. Young (1958) stated that in the South bobcats might be driven out of wooded areas by bulldozing and burning thickets. Conversations with several cathunters further supported the importance of these thick areas. These men reported that their hounds often jumped bedded bobcats from dense briar thickets and in overgrown timber cuts.

Hunting Habits

Bobcats on TGMA appeared to favor the numerous roads, pipelines, well sites, and fallow fields for their hunting activities. These openings usually supported a heavy growth of briars, vines, and grasses that harbored high prey populations. Often radio-

instrumented bobcats would leave their rest areas in late afternoon and move slowly along a road, pipeline, or field edge. This was interpreted as hunting activity.

Visual observations provided more insight to the hunting habits of bobcats. Sixteen separate observations of hunting were made at Thistlethwaite from 31 April to 14 August 1973. Eleven of these occurred between 1500 and 2000 with a mean of 1722. Four morning sightings were made between 0530 and 0730 with a mean of 0603. Only one sighting was made in midday (1240) when a cat bounded across the road in front of the vehicle.

In the majority of the above instances, the bobcats were observed from the vehicle with the aid of binoculars as they walked slowly along a shell road. Constantly on the alert for sound or movement, a bobcat would often stop and sit in the road, peering intently into the roadside vegetation. Sometimes this position would be held for 5 to 10 minutes before the animal moved. If the object of investigation seemed to be a potential food item, a sitting bobcat would assume a crouched position, often followed by a pounce into the roadside cover. Though several of these attempts were observed, none were seen to be successful.

An interesting confrontation between two large feral hogs and an adult bobcat was observed by the senior author. The bobcat was meandering along a shell road when the two hogs approached the road edge. Apparently a mutual fear or respect caused the bobcat to hasten to cover at the opposite roadside and the hogs to pause and cross the road only after the bobcat had vanished. Within seconds of the hogs' disappearance the bobcat reappeared in the road and nonchalantly continued its travels.

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