

Space Use, Movements and Habitat Selection of Adult Bobcats (*Lynx rufus*) in Central Mississippi

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ABSTRACT.—Many factors influence bobcat (*Lynx rufus*) space use, movements and habitat selection, including prey distribution and density, season, breeding behaviors and intraspecific relationships. Knowledge of ranging behaviors and habitat selection is required to understand population dynamics and ecology of bobcats within temperate ecosystems. We radio-monitored 58 adult bobcats from 1989–1997 in central Mississippi. Males maintained larger home ranges and core areas than females, but sizes of these areas did not vary seasonally. Male bobcats moved at greater rates than females and bobcats moved at greatest rates during nocturnal periods. Movement rates were greatest during winter. Habitat selection at three spatial scales differed between genders and across seasons within gender. Our findings suggest that ≤ 8 y-old pine (*Pinus* spp.) habitats are important to bobcats, particularly females, as these habitats were selected by females at all spatial scales. However, our data also indicate that mature (>30 y) pine habitats are important to bobcats on our study area.

INTRODUCTION

Reliable estimates of space use are essential to understand a species' behavioral ecology (Bekoff and Mech, 1984). Selected areas of concentrated use within home ranges are often denoted as core areas (Kaufman, 1962), implying that these selected areas are of greater significance to the animal. Bobcat home range sizes vary throughout the species' geographic distribution (McCord and Cardoza, 1982) and most previous studies have reported males to maintain larger home ranges than females (Hall and Newsom, 1976; Fuller *et al.*, 1985; Rucker *et al.*, 1989; Lovallo and Anderson, 1996). Additionally, bobcat home ranges may vary seasonally as males expand movements during breeding (Anderson, 1987) and females confine activities around den sites during young-rearing (Knick, 1990; Conner *et al.*, 1992). However, information detailing seasonal gender-specific core area sizes is lacking and, although home range sizes have been intensively examined in northern latitudes, studies in southern areas of the species' range have generally suffered from limited ($n < 20$) numbers of individuals and short duration (2–3 y).

Similar to home range, bobcat habitat selection often varies seasonally and by gender (Fuller *et al.*, 1985; Rolley and Warde, 1985; Anderson, 1987). Previous studies have suggested that differential habitat use is largely a reflection of varying prey abundance among habitats (Bailey, 1979; Boyle and Fendley, 1987; Knick, 1990). Knowledge of habitat selection is necessary to thoroughly understand dynamics of bobcat populations and general habitat use patterns of bobcats have been described (Hall and Newsom, 1976; Rolley and Warde, 1985; Lovallo and Anderson, 1996). Although the scale at which animals select habitats is unknown, few studies have attempted to address this inherent problem by

examining bobcat habitat selection at multiple spatial scales, particularly within their southern range.

Bobcat movement rates likely reflect seasonal prey abundance and breeding behaviors (Kitchings and Story, 1978). Generally, movements differ between genders, with males moving farther and at greater rates (faster) than females (Bailey, 1974). Being polygynous breeders, males would be expected to increase movements during breeding periods to increase mating opportunities (Sandell, 1989). Although several studies have addressed bobcat movement patterns (Marshall and Jenkins, 1966; Rucker *et al.*, 1989), none have examined gender-specific movement rates across the entire diel period.

Our objectives were to estimate gender-specific seasonal space use (home range and core use areas), estimate gender- and season-specific movement rates across the diel period and quantify gender-specific seasonal habitat selection at multiple spatial scales. Because female home range size is thought to be regulated by habitat quality (Anderson, 1987) whereas male home ranges are considered to be influenced by breeding opportunities (Anderson, 1987; Sandell, 1989), we predicted that male home ranges, core use areas and movement rates would be greater than for females. Furthermore, because of male breeding behaviors and female parental care responsibilities, we predicted that space use and movement rates would differ across seasons and within portions of the diel period. Prey selection by bobcats may differ by gender (Fritts and Sealander, 1978) and subsequent habitat selection in other environs may differ by gender and season (Fuller *et al.*, 1985; Rolley and Warde, 1985). Therefore, we predicted that habitat selection on our study area would differ for males and females, and across seasons.

STUDY AREA

This study was conducted on the 14,410-ha Tallahala Wildlife Management Area (TWMA), a 4900-ha area owned by the Timber Company (TC) adjacent to TWMA, and surrounding private lands in sections of Jasper, Newton, Scott and Smith counties, Mississippi. The TWMA contained 30% mature bottomland hardwood forests, 37% mature pine (*Pinus* spp.) forests, 17% mixed pine-hardwood forests, 11% in 1–15-y-old loblolly pine (*P. taeda*) plantations and 5% in agricultural areas. A tornado bisected TWMA in 1992, altering approximately 1000-ha of mature pine and hardwood forests; most (90%) of the damaged area was replanted to loblolly pine. The TC was managed primarily for wood fiber production with 90% of the area composed of 1–35-y-old loblolly pine plantations, and the remaining 10% in Streamside Management Zones (SMZs) along creek drainages. Private lands were comprised mostly of mixed pine-hardwood and short-rotation pine forests. Topography was gently to moderately rolling, with 0–20% slope. Climate was mild, with a mean annual temperature of 20 C and mean annual precipitation of 152 cm (Chamberlain *et al.*, 1999). The TWMA hereafter refers to TWMA, TC, and private lands surrounding both areas.

METHODS

Bobcat captures.—We captured bobcats with Nos. 3 and 1.5 Victor soft-catch foot-hold traps (Woodstream, Lititz, Pennsylvania) from 10 January to 15 August 1989 and from 4 January to 5 March annually from 1990 through 1997. Captured bobcats were netted and anesthetized with Ketamine hydrochloride (Ketaset Veterinary Products, Fort Dodge Laboratories Inc, Fort Dodge, Iowa) at 15 mg/kg of estimated body mass. Each bobcat was weighed and aged using body size (Crowe, 1975), teat condition of females and scrotum size of males. We fitted adult bobcats with a 175–225-g mortality-sensitive radiotransmitter (Advanced Telemetry Systems, Isanti, Minnesota). Juvenile bobcats were not fitted with

radiotransmitters because of concerns with indeterminate growth of bobcats. Drugged bobcats were placed in portable pet kennels and monitored to facilitate recovery. Following recovery, we released bobcats at the capture site. We conducted research under Mississippi State University Institutional Animal Care and Use Committee Protocol 93-032 and its associated amendments.

Telemetry.—We located bobcats using triangulation (White and Garrott, 1990) from specified points throughout the study. In most (>80%) instances, distance from observer to bobcat was ≤ 1.0 km. We used two telemetry techniques to monitor bobcats: systematic point and sequential locations. We obtained systematic point locations by recording two locations weekly for each bobcat. We conducted sequential telemetry (focal runs) throughout the diel period on a 3 to 6-h basis with a location recorded on each bobcat every hour for the entire period. Azimuths for a single radio location were recorded within a 15 min interval to reduce error due to bobcat movement; however, most (87%) consecutive azimuths were recorded within 6 min. Triangulation angles were maintained between 45 and 135° to reduce error (Kitchings and Story, 1979). Telemetry accuracy for a single bearing averaged $\pm 5.9^\circ$ across the study. Therefore, a circle circumscribing each bobcat location 1 km from each telemetry station would have an approximate area of 3.4 ha. Because the smallest habitat patch on the study area was ≥ 5 ha and most locations were recorded within 1 km of each bobcat, we assumed telemetry accuracy was sufficient for our analyses.

We used all locations (sequential and point) taken on each bobcat to estimate home range and core area sizes. Although point locations only serve to indicate a study animal's trajectory through space (Aebischer *et al.*, 1993), we realize that habitat selection at the location level may be influenced by autocorrelation of telemetry locations. Thus, we selected point locations separated by ≥ 2 h to examine habitat selection at the location level (3rd order selection described in following sections; Chamberlain and Leopold, 2000). We assumed that bobcats could traverse their estimated home range within a 2 h period, as multiple bobcats were documented as doing so during our study.

Analysis.—Bobcat locations were entered into a database and converted to Universal Transverse Mercator coordinates using program TELEBASE (Wynn *et al.*, 1990). We divided each year into biological seasons: breeding (1 Feb.–31 May), kitten-rearing (1 June–30 Sept.) and winter (1 Oct.–31 Jan.). Seasonal home range (95%) and core area (50%) contour intervals were estimated using an adaptive kernel estimator in program CALHOME (Kie *et al.*, 1994). We used a 2-way analysis of variance (ANOVA) blocked by year to examine differences in home range and core area size between sexes across seasons. We blocked by year for all analyses because many bobcats were monitored >1 year and because sample sizes were less during the early portions of the study (Chamberlain *et al.*, 1999). Home range and core area sizes were estimated for bobcats that had at least 30 locations/season and were sampled for at least 75% of a given season.

We developed a Geographic Information System (GIS) (ARC/INFO; Environmental Systems Research Institute, Redlands, California) with color infrared aerial photographs and 1:24,000 U.S. Geological Survey 7.5-min quadrangles. The U.S. Forest Service records from Bienville National Forest and stand data from TC were used to classify stands into habitat types based on forest type (*i.e.*, hardwood, pine) and stand age. We used year-specific stand maps and data to create annual habitat coverages ($n = 9$). We used aerial photographs, ground surveys and landowner consultations to quantify habitat type on private lands within and surrounding TWMA.

Home range and core area contour, and individual bobcat locations by season were converted to ARC/INFO (ESRI, Redlands, California, USA) coverages and intersected with year-specific habitat maps of TWMA. Habitat attributes for each seasonal contour interval

(home range and core area) and group of point locations were exported to a database. Habitats were delineated as: mature (≥ 30 y) hardwood, mixed pine-hardwood, pine (≤ 8 y, 9–15 y, 16–29 y and ≥ 30 y) and other habitats (agricultural areas and Conservation Reserve Program lands ≤ 2 y). Pine habitats were partitioned into the four age classes to reflect structural differences readily apparent among these habitats, such as initial canopy closure at approximately 9 y and early successional characteristics present during the first eight years of stand establishment. Mature pine hereafter refers to 30+ y-old pine stands.

We assessed habitat selection at three spatial scales, based somewhat on spatial scales suggested by Johnson (1980). First, we compared habitat composition of the home range to habitat composition of the study area. We then compared habitat composition of core use areas to habitat composition of the home range. Finally, we compared habitat associated with bobcat locations to habitat composition of the home range. Study area habitat availability was determined using a buffer system around roads used to trap bobcats throughout the study. For each year we identified the largest seasonal home range and subsequently measured the major axis. We then used the major axis to buffer the road system; hence, buffer width and study area availability varied annually. Buffer width was one axis length on each side of roads used for trapping (Chamberlain and Leopold, 2000). We then estimated annual study area habitat availability by summing the area for each habitat and dividing it by the total study area. Seasonal home range and core area availability for each bobcat were estimated using similar methodology. Used habitat was determined by summing the total number of locations within each habitat type and dividing by the total number of points within the home range.

We used compositional analysis (Aebischer *et al.*, 1993) to determine gender- and season-specific habitat selection. We used a hierarchical model testing approach to examine habitat selection between genders across each spatial scale, then across seasons within each gender. We tested differences of log-ratio habitat use and availability percentages with a multivariate analysis of variance (MANOVA). If significant differences were detected between habitat selection and availability, a ranking matrix of *t*-tests was constructed to examine habitat preferences (*i.e.*, positive or negative; Aebischer *et al.*, 1993).

We estimated movement rates (m/h) by dividing the straight-line distance between consecutive locations by the time interval. Only locations separated by < 1.25 h were used to ensure that distances between locations were associated with actual distances moved (Reynolds and Laundré, 1990). We examined movement patterns seasonally throughout the diel period (nocturnal, diurnal and crepuscular). Because day length varies seasonally, we defined diel segments as diurnal (0800–1559), crepuscular (0400–0759 and 1600–1999) and nocturnal (2000–0359) during breeding and winter; and diurnal (0700–1859), crepuscular (1900–2059 and 0400–0659) and nocturnal (2100–0359 h) during kitten-rearing periods.

We considered the seasonal movement rate within each portion of the diel period for each bobcat as the experimental unit. We used a 3-way ANOVA blocked by year to examine possible interactions between combinations of independent variables (gender, season, period). We used least significant difference multiple comparisons to test differences in main effects if 2-factor interactions were not present. For home range, core area and movement analyses, we tested homogeneity of variance using a Levene's test (Milliken and Johnson, 1992) and normality using the Shapiro–Wilk test (Steel and Torrie, 1980). We used a natural logarithm transformation for home range and core area sizes to meet assumptions of normality.

RESULTS

We monitored 58 [20 male (M), 38 female (F)] adult bobcats from 1 January 1989 to 31 December 1997 and recorded 24,585 locations to determine home range, core use areas

TABLE 1.—Mean seasonal adaptive kernel home ranges (ha; 95%) and core areas (ha; 50%) and associated standard errors (SE) for 58 adult male and female bobcats on Tallahala Wildlife Management Area, the Timber Company, and surrounding private lands, Mississippi, 1989–1997

Sex	Season	n ¹	Home range	SE	Core area	SE
Male	Breeding ²	35	1769	182	308	40
	Kitten-rearing ²	28	1528	188	295	41
	Winter ²	23	1877	265	295	40
Female	Breeding	68	863	68	148	13
	Kitten-rearing	62	870	80	146	16
	Winter	42	855	136	136	14

¹ Number of home ranges and core areas estimated within specified season

² Breeding: 1 February–31 May; Kitten-rearing: 1 June–30 September; Winter: 1 October–31 January

and seasonal habitat selection. We estimated 258 (85 M, 173 F) home ranges and core areas during breeding ($n = 103$), kitten-rearing ($n = 90$) and winter ($n = 65$). Home range size differed between genders ($F_{1,244} = 90.01$, $P < 0.001$) with males (1719 ± 119 ha; $\bar{x} \pm SE$) maintaining larger home ranges than females (863 ± 51 ha), but did not differ across seasons for either sex ($F_{2,244} = 1.14$, $P = 0.321$; Table 1). Similarly, core area size differed between genders ($F_{1,244} = 61.83$, $P < 0.001$), with males (300 ± 23 ha) maintaining larger core areas than females (144 ± 8.3 ha), but did not differ across seasons ($F_{2,244} = 0.30$, $P = 0.738$).

Differences in log-ratios of use and availability differed between genders at all three spatial scales ($F_{6,251} = 10.51$ – 15.80 , $P < 0.001$) indicating that males and females selected and used habitats differently. Female bobcats selected ≤ 8 y-old pine stands at all three spatial scales, whereas males selected 9–15 y-old and mature pine habitats (Table 2).

For males, differences in log-ratios of use and availability differed among seasons ($F_{6,77} = 7.90$ – 9.00 , $P < 0.001$) at all three spatial scales. For males, the composition of habitats within home ranges differed from availability of habitats across the study area, mature pine habitats being selected during all seasons (Table 3). The composition of habitats within core areas differed from the composition of habitats within home ranges with males most frequently selecting mature pine and ≤ 8 y-old pine habitats during all seasons. Use of habitats within home ranges by males varied considerably by season (Table 3).

For females, differences in log-ratios of use and availability differed among seasons ($F_{6,165} = 6.54$ – 12.26 , $P < 0.001$) at all three spatial scales. The composition of habitats within home ranges differed from availability of habitats across the study area with females consistently selecting ≤ 8 y-old pine habitats when selecting home ranges and core areas (Table 4). Females also used pine habitats ≤ 8 y-old extensively within their home ranges. Conversely, other habitats were least selected at two spatial scales during breeding and kitten-rearing.

We estimated movement rates for 43 adult bobcats (19 M, 24 F) during 1989–1990 and 1993–1997 using 15,002 sequential locations. Movement rates were not affected by 2- or 3-way interactions between gender, season and/or period ($P > 0.276$). Movement rates differed between genders ($F_{1,557} = 16.24$, $P < 0.001$) and among periods ($F_{2,557} = 11.05$, $P < 0.001$) and seasons ($F_{2,557} = 4.29$, $P = 0.014$). Male bobcats moved at greater rates (376 ± 12 m/h) than females (332 ± 8 m/h) and bobcats moved at greatest rates during nocturnal (385 ± 13 m/h) periods. Additionally, bobcats moved at greater rates during winter (373 ± 14.4 m/h) compared to other seasons (Table 5).

TABLE 2.—Mean ranks (1 = lowest, 7 = highest) of habitat types across three spatial scales (habitat selection within home ranges vs. availability of habitats across study area [1st order], habitat selection in core areas vs. availability of habitats within home ranges [2nd order] and habitats used within home range vs. availability of habitats in home ranges [3rd order] based on compositional analysis for adult male and female bobcats on Tallahala Wildlife Management Area, the Timber Company and surrounding private lands, Mississippi, 1989–1997

Habitat type	1st order		2nd order		3rd order	
	M	F	M	F	M	F
Mature hardwood (≥ 30 -y old)	2	1	4	4	3	4
Mature mixed pine-hardwood (≥ 30 -y old)	3	3	3	3	6	3
Pine (≤ 8 -y old)	4	7	7	7	4	7
Pine (9–15-y old)	6	6	6	6	7	5
Pine (16–29-y old)	1	2	2	2	2	2
Mature pine (≥ 30 -y old)	7	5	5	5	5	6
Other (agricultural areas and Conservation Reserve program lands ≤ 2 y)	5	4	1	1	1	1

DISCUSSION

Bobcats are sexually dimorphic, with males generally larger than females, and they are polygynous (McCord and Cardoza, 1982). Hence, males would be expected to maintain larger home ranges and move at greater rates to acquire necessary resources and increase mating opportunities during breeding (Sandell, 1989). Likewise, uniparental care exhibited by females could result in decreased home ranges and movements during kitten-rearing periods (Bailey, 1974; Knick, 1990). Our data indicate that male bobcats maintain larger home ranges than females on TWMA, consistent with findings of other researchers (Hall and Newsom, 1976; Litvaitis *et al.*, 1986; Lovallo and Anderson, 1996). However, bobcat space use on TWMA did not vary by season, suggesting that bobcats were able to acquire requisite resources throughout the annual cycle without altering space use.

TABLE 3.—Mean ranks (1 = lowest, 7 = highest) of habitat types across three spatial scales (habitat selection within home ranges vs. availability of habitats across study area [1st order], habitat selection in core areas vs. availability of habitats within home ranges [2nd order] and habitats used within home range vs. availability of habitats in home ranges [3rd order] across three seasons based on compositional analysis for adult male bobcats on Tallahala Wildlife Management Area, the Timber Company and surrounding private lands, Mississippi, 1989–1997

Habitat type	1st order			2nd order			3rd order		
	Season			Season			Season		
	B ¹	K	W	B	K	W	B	K	W
Mature hardwood (≥ 30 -y old)	1	3	3	4	4	4	4	5	3
Mature mixed pine-hardwood (≥ 30 -y old)	3	2	1	3	3	6	3	7	5
Pine (≤ 8 -y old)	5	4	6	6	7	5	6	6	4
Pine (9–15-y old)	4	6	4	7	5	3	7	4	6
Pine (16–29-y old)	2	1	2	2	2	2	2	2	2
Mature pine (≥ 30 -y old)	7	7	7	5	6	7	5	3	7
Other (agricultural areas and Conservation Reserve program lands ≤ 2 y)	6	5	5	1	1	1	1	1	1

¹ Breeding: 1 February–31 May, Kitten-rearing: 1 June–31 September, Winter: 1 October–31 January

TABLE 4.—Mean ranks (1 = lowest, 7 = highest) of habitat types across three spatial scales (habitat selection within home ranges vs. availability of habitats across study area [1st order], habitat selection in core areas vs. availability of habitats within home ranges [2nd order] and habitats used within home range vs. availability of habitats in home ranges [3rd order] across three seasons based on compositional analysis for adult female bobcats on Tallahala Wildlife Management Area, the Timber Company and surrounding private lands, Mississippi, 1989–1997

Habitat type	1st order			2nd order			3rd order		
	Season			Season			Season		
	B ¹	K	W	B	K	W	B	K	W
Mature hardwood (≥ 30 -y old)	1	1	1	3	4	4	4	3	4
Mature mixed pine-hardwood (≥ 30 -y old)	3	2	3	4	3	3	3	6	3
Pine (≤ 8 -y old)	7	7	6	7	7	7	7	7	7
Pine (9–15-y old)	6	6	5	5	6	6	5	5	6
Pine (16–29-y old)	2	3	2	2	2	1	2	2	1
Mature pine (≥ 30 -y old)	5	5	7	6	5	5	6	4	5
Other (agricultural areas and Conservation Reserve program lands ≤ 2 y)	4	4	4	1	1	2	1	1	2

¹ Breeding: 1 February–31 May, Kitten-rearing: 1 June–31 September, Winter: 1 October–31 January

Female bobcats presumably use home ranges more intensively than males, requiring consistent food resources from a smaller space relative to males (Anderson, 1987). Male bobcats on TWMA maintained home ranges and core areas nearly twice as large as females within each season. However, male movement rates were approximately 13% greater than female movement rates. This relative gender-specific difference between space use and

TABLE 5.—Mean movement rates and associated standard errors (SE) for adult male and female bobcats across seasons and diel periods on the Tallahala Wildlife Management Area, the Timber Company and surrounding private lands, Mississippi, 1989–1990 and 1993–1997

Sex	Season ¹	Period	Movement rate (m/h)	SE
Female	Breeding	Diurnal	284.5	20.5
		Crepuscular	346.3	19.1
		Nocturnal	366.8	22.9
	Kitten-rearing	Diurnal	295.1	16.7
		Crepuscular	307.6	17.6
		Nocturnal	357.5	25.7
	Winter	Diurnal	316.7	21.0
		Crepuscular	378.7	26.2
		Nocturnal	349.2	33.0
Male	Breeding	Diurnal	324.6	29.8
		Crepuscular	365.0	34.6
		Nocturnal	453.7	34.6
	Kitten-rearing	Diurnal	337.1	23.5
		Crepuscular	324.9	29.0
		Nocturnal	358.7	30.4
	Winter	Diurnal	354.2	33.3
		Crepuscular	411.3	49.6
		Nocturnal	477.2	56.3

¹ 1 February–31 May, 1 June–30 September, 1 October–31 January

movement rates supports the notion that females use home ranges and core areas more intensively than males.

Space use did not vary seasonally, but our findings support the prediction that movement rates differ by season. Although we predicted that male movement rates would be greatest during breeding, movement rates were greatest for both genders during winter. Bailey (1979) suggested that level of human disturbance may influence bobcat space use. Bobcat movements during winter, coinciding with sport hunting seasons on TWMA, may have been influenced by disturbance from hunters. Bobcats disturbed by hunters likely move quickly to refugia, potentially influencing observed movement rates during these periods. Chamberlain *et al.* (1999) reported that female movements were related to harvest by sport hunters during winter, indicating that females with greater movements were more susceptible to being incidentally harvested. Alternatively, availability of some bobcat prey (*i.e.*, rodents) may decrease as winter progresses after peaking in fall (Odum, 1955), requiring bobcats to increase movements during winter to secure prey. Because space use remained constant across seasons, increased movement rates during winter may reflect bobcats increasing foraging to fulfill energetic requirements within confined spaces.

Lancia *et al.* (1986) reported that female bobcats increased movement rates during lactation and kitten-rearing, presumably to fulfill increased energetic demands placed on solitary female felids during these periods. Conversely, females on TWMA did not increase movement rates during kitten-rearing, but female survival during this period declined relative to other seasons (Chamberlain *et al.*, 1999). These findings suggest that decreases in survival may not result solely from females increasing movements. Lactating cheetahs (*Acinonyx jubatus*) spend considerably more time hunting, requiring nearly double their normal food intake during lactation and kitten-rearing (Caro, 1994). Chamberlain (1999) reported that female activity rates increased during kitten-rearing, and if increased activity is attributable to increased foraging or parental care efforts, activity patterns during gestation, parturition, or kitten-rearing could be related to earlier findings of Chamberlain *et al.* (1999).

Female bobcats presumably select home ranges to ensure sufficient resources for their survival and survival of their young (Bailey, 1979; Anderson, 1987; Sandell, 1989), whereas males likely establish home ranges to maximize breeding opportunities (Anderson, 1987; Sandell, 1989). One could argue that males may simply locate home ranges in areas with multiple females, making the composition of habitats within the home range potentially less important to males relative to females, particularly during breeding (Conner and Leopold, 1993). Based on our findings, we cannot discount this argument, as composition of habitats within home ranges differed for males and females. Furthermore, it is noteworthy that habitat selection for females was consistent across spatial scale, whereas males appeared to select habitats differently by scale.

Presence of early successional (≤ 8 and 9–15 y-old) pine habitats influenced habitat selection at all spatial scales for females, but these habitats were most selected by males only within core areas. On TWMA, relative abundance of small mammals and other bobcat prey is greatest in these habitats (Conner, 1991; Chamberlain, 1999; Chamberlain and Leopold, 1999), consistent with previous studies (Hall and Newsom, 1976; Litvaitis *et al.*, 1986). Plowman (1997) reported that male bobcats established core areas that overlapped female core areas, presumably to maximize mating opportunities. Therefore, similarities in habitat selection by males and females at the core area scale could be related to male breeding behaviors, and subsequent maintenance of core areas by males to ensure access to females. Additionally, Ewer (1968) suggested that core areas likely contain important features such as den sites, loafing areas or escape cover that are potentially critical (Rollins, 1945; McCord

and Cardoza, 1982). These points suggest that selection of core areas and habitats contained within these areas is a synergistic function of increasing hunting opportunities, breeding behavior and location of sites important in ecological strategies of both genders.

Differential use of habitats within home ranges by bobcats has been related to differences in habitat-specific prey abundance (Hall and Newsom, 1976; Rucker *et al.*, 1989; Knick, 1990). Seasonal differences in habitat use have been reported in South Carolina (Heller and Fendley, 1986), Oklahoma (Rolley and Warde, 1985) and Idaho (Koehler and Hornocker, 1989) and may be due to shifts in prey abundance, climate or behavior such as breeding. In northern latitudes, bobcats may shift prey selection from small mammals in summer to larger prey in winter, when availability of small mammals declines (Lovallo and Anderson, 1996). Correspondingly, habitat use patterns shift seasonally and may act as a mechanism for intersexual resource partitioning at northern latitudes (Lovallo and Anderson, 1996). Although habitat selection differed across seasons for both genders, occurrence of major prey items [*i.e.*, small mammals, lagomorphs, white-tailed deer (*Odocoileus virginianus*)] in bobcat diet on TWMA does not vary seasonally (Chamberlain and Leopold, 1999). We suggest that the availability and abundance of bobcat prey likely do not vary seasonally on TWMA to the magnitude of that observed at northern latitudes. Therefore, bobcats in southern environs may be able to successfully exploit preferred prey items throughout each season by simply altering habitat selection patterns rather than shifting prey selection.

Conner *et al.* (1992) reported that mature pine habitats were generally avoided by bobcats when selecting home ranges. However, our findings indicate that mature pine habitats were selected frequently by both genders, but particularly males. We suggest that differences in our findings and those of previous studies on TWMA resulted from changes in land-use throughout the study, differences in sample size, and duration of the research. Considerable changes in forest management [*i.e.*, management for red-cockaded woodpecker (*Picoides borealis*)] have occurred on TWMA since 1994. Mature pine stands thinned and subsequently burned contain greater herbaceous vegetation relative to other stands (Palmer *et al.*, 1996) and produce abundant bobcat prey (McMurry *et al.*, 1994; Masters *et al.*, 1998). Hence, it is not surprising that bobcats selected these habitats at more than one spatial scale.

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