Habitat Use of Bobcats at Two Spatial Scales in Southwestern Georgia

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Abstract: Habitat needs of wildlife are important for science-based wildlife management. Further, these needs may differ based upon the ecosystem in which the species lives. Bobcat habitat use within the longleaf pine *(Pinus palustris)* forest ecosystem has received little attention. Therefore, we monitored 21 bobcats *(Lynx rufus)* (8 M, 13 F) during 2001–2002 in southwestern Georgia to determine habitat use at two different spatial scales: (1) habitat associated with each animal's locations relative to habitat composition of its home range and (2) habitat composition of each bobcat's home range relative to habitat composition of the study area. Seasonal habitat selection did not differ between sexes. At the smaller spatial scale, bobcats preferred (i.e., use $\geq$ availability) food plots within their home range during fall, winter, and spring, though they preferred hardwood areas within their home range during summer. At the larger spatial scale, there was a greater proportion of mixed pine/hardwood habitat within bobcat home ranges than was available on the study site. On our study area, this habitat may serve to connect hunting areas and refugia. Prey rich areas are important to bobcats, but areas that provide refugia (e.g., hardwoods) are also important.

Key Words: bobcat, Georgia, habitat use, home range

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An understanding of wildlife habitat needs is critical for managing any species. Further, habitat use may vary based on the ecosystem of interest. In the southeastern United States, bobcat *(Lynx rufus)* habitat use has been studied in a variety of forested ecosystems (Heller and Fendley 1982, Zwank et al. 1985, Conner and Leopold 1996), but studies of bobcat habitat use are lacking within the longleaf pine *(Pinus palustris)*-dominated forest matrix. In general, differential habitat use by bobcats is explained by differential prey abundance, with bobcats preferring prey rich areas (Buie 1980, Boyle and Fendley 1987, Conner and Leopold 1996). The longleaf pine forest, when managed using prescribed fire, is characterized by an open canopy and relatively dense herbaceous understory (Landers and Mueller 1986). Small mammals, the primary prey of bobcats (Beasom and Moore 1977, Miller and Speake 1978, Maehr and Brady 1986), are often most abundant in areas with dense herba-

ceous ground cover with interspersed shrubs and vines (Golley et al. 1965). Because bobcat habitat use within longleaf pine-dominated ecosystems has received little attention, we initiated a study of bobcat habitat use within a longleaf pine-dominated study area.

Study Area

The study took place on Ichauway, the 11,700-ha outdoor conservation and research facility of the Joseph W. Jones Ecological Research Center, located in Baker County, Georgia. Longleaf pine woodlands dominated the landscape. Slash pine *(Pinus elliottii)* flatwoods, natural loblolly pine *(P. taeda)* stands, mixed pine hardwoods, and agricultural fields were distributed through the area. Old field grasses (e.g., *Andropogon* spp.) and wiregrass *(Aristida beyrichiana)* dominated the understory (Goebel et al. 1997). However, more than 1,000 vascular plant species existed on the property (Drew et al. 1998). Ichauway contained 724 km of primary, secondary, and tertiary roads as well as 980 km of firebreaks.

Prescribed fire was the most prevalent land management practice on Ichauway. Ichauway employed dormant and growing season burns on a 2-year rotation, burning approximately 4,000–6,000 ha annually. Approximately half of Ichauway was managed for Northern bobwhite *(Colinus virginianus),* and part of this management consisted of discing agriculture fields to increase native foods and cover (Landers and Mueller 1986). Food plots consisting of grain sorghum (*Sorghum* vulgare), Egyptian wheat (*Sorghum* spp.), brown top millet *(Brachiaria ramose),* cowpea (*Vigna* spp.), corn *(Zea mays),* and winter wheat *(Triticum aestivum)* were also maintained as part of the wildlife management program.

Methods

Bobcat Capture and Monitoring

We trapped bobcats using No. 3 Victor Soft Catch traps (Woodstream Corp., Lititz, Pennsylvania). Trapping began in December 2000 and continued through August 2002. We checked traps daily and restrained captured bobcats with a large net and wooden pole, which we used to pin the animal. With the animal restrained, we injected ketamine hydrochloride (10 mg/kg body weight) intramuscularly (Seal and Kreeger 1987). We attached a radio-collar (Advanced Telemetry Systems, Isanti, Minnesota) on all adult bobcats (Crowe 1975) and tattooed a unique number in the ears of all bobcats. We monitored bobcats in an approved holding cage for 24 hours to ensure recovery and then released them at the capture site. All trapping and handling procedures were approved by the University of Georgia Institutional Animal Care and Use Committee (IACUC No. A990159).

We initiated radio-tracking seven days after bobcat release, but intensive monitoring began on 24 September 2001 and ended on 20 September 2002. We used a hand-held, three-element yagi (Sirtak, New Zealand) and a hand-held receiver

(Wildlife Materials, Carbondale, Illinois) to locate bobcats using triangulation from known reference points. We obtained locations twice a day, three times a week with ≥8 hours between locations to ensure independence between locations (White and Garrott 1990). We sampled equally throughout the diel period.

Data Analysis

We estimated 95% adaptive kernel home ranges (Worton 1989) using the program HOMERANGER (Hovey 1997). We used the geographic information system developed for Ichauway within Arc/Info (Environmental Systems Research Institute, Inc., Redlands, California) to determine the habitat composition of home ranges (HR) and the habitat type associated with each bobcat telemetry location. For our analyses, we partitioned habitat across the study area into eight categories: food plots (20% of study area), shrub/scrub (i.e., shrub dominated habitats; 1%), hardwood (12%), pine regeneration (4%), mature pine (33%), mixed pine-hardwood (28%), ephemeral wetland (1%), and other (1%; e.g., human development).

We assessed habitat selection at two spatial scales (modified from Johnson 1980) using compositional analysis (Aesbischer et al. 1993). We also determined if habitat selection differed between sexes using the multivariate analysis of variance (MANOVA) component of compositional analysis. We compared habitat composition of the study area, comparable to Johnson's (1980) second order of habitat selection. We also compared the habitat associated with bobcat locations to habitat composition of HR, comparable to Johnson's (1980) third order. We used calendar seasons to assess seasonal habitat selection. We also preformed a composite analysis of habitat selection for all animals that were tracked for at least six months. Results were considered significant if $P \leq 0.05$.

Results

The number of bobcats tracked seasonally varied from 13 (5 M, 8 F) to 21 (6 M, 15 F). We tracked 21 (8 M, 13 F) bobcats for ≥6 months.

Habitat Selection within the Study Area

Seasonal habitat selection did not differ ($P > 0.05$) between males and females. Bobcats did not show a preference (i.e., use > availability) for habitat ($P > 0.05$) during fall and winter (Table 1). Habitat composition of home ranges differed ($F_{7,13} = 6.81$, $P = 0.002$) from habitat composition of the study area during spring. Bobcats most preferred (i.e., used most relative to availability) mixed pine-hardwood, mature pine, hardwood, food plot, and wetland areas and least preferred (i.e., used least relative to availability) shrub/scrub, pine regeneration, and other during spring. Habitat composition of home ranges differed ($F_{7,14} = 4.44$, $P = 0.009$) from habitat composition of the study site during summer. Bobcats most preferred mixed pine/hardwood, food plot, mature pine, and hardwood areas and least preferred other and pine regeneration during summer.

For composite data, male and female bobcats selected ($F_{7,13} = 0.69$, $P = 0.683$)

Table 1. Habitat composition within bobcat home ranges relative to habitat composition of the study area (A) and habitat use relative to habitat composition of bobcat home ranges (B) on Ichauway, Georgia, 2001–2002.

Season	Level	N^a	Order of preference[b]							
Fall	A	13	ns[c]	ns	ns	ns	ns	ns	ns	ns
	B		F_a[d]	H_a	MP_a	P/H_a	PR_{ab}	W_{bc}	O_c	S/S_c
Winter	A	16	ns	ns	ns	ns	ns	ns	ns	ns
	B		F_a	MP_b	H_b	P/H_b	W_b	S/S_{bc}	PR_{bc}	O_c
Spring	A	20	P/H_a	MP_a	H_a	F_a	W_a	S/S_b	PR_b	O_b
	B		F_a	MP_a	P/H_a	H_{ab}	S/S_{bc}	W_{bc}	PR_c	O_c
Summer	A	21	P/H_a	F_a	MP_a	H_{ab}	W_b	S/S_b	O_{bc}	PR_c
	B		H_a	MP_a	P/H_{ab}	F_{ab}	PR_{bc}	O_c	W_c	S/S_c
Annual	A	21	MP_a	H_a	P/H_a	F_a	W_{ab}	S/S_b	O_b	PR_b
	B		F_a	H_a	MP_a	P/H_b	PR_{bc}	S/S_{bc}	W_c	O_c

a. N = number of animals in analysis, sexes pooled.

b. Most preferred to least preferred.

c. ns = non significant, F = food plot, S/S = shrub/scrub, H = hardwood, PR = pine regeneration, MP = mature pine, P/H = mixed pine/hardwood, W = wetlands, O = other.

d. Within each season and level, habitats with the same subscripts are similar ($P > 0.05$).

similar habitats. Habitat composition of home ranges differed ($F_{7,14} = 4.45$, $P = 0.009$) from habitat composition of the study site. Bobcats most preferred mature pine, hardwood, mixed pine/hardwood, and food plot areas and least preferred wetlands, shrub/scrub, other, and pine regeneration (Table 1).

Habitat Selection within Home Ranges

Seasonal habitat selection was similar ($P \geq 0.50$) between sexes. However, bobcats used habitat disproportionately ($P \leq 0.05$) relative to habitat composition of the home range during all seasons. During fall, bobcats most preferred food plots, hardwood, mature pine, mixed pine/hardwood, and pine regeneration areas and least preferred wetlands, other, shrub/scrub ($F_{6,7} = 3.61$, $P = 0.059$) (Table 1). During winter, bobcats most preferred food plots and least preferred shrub/scrub, pine regeneration, and other ($F_{6,10} = 10.38$, $P = 0.001$). During spring, bobcats most preferred food plots, mature pine, mixed pine/hardwood, and hardwood areas, and least preferred shrub/scrub, wetlands, pine regeneration, and other ($F_{6,14} = 6.02$, $P = 0.003$). During summer, bobcats most preferred hardwood, mature pine, mixed pine/hardwood, and food plots and least preferred pine regeneration, wetlands, and shrub/scrub ($F_{6,15} = 8.84$, $P = 0.003$).

For composite data, male and female bobcats selected similar ($F_{6,14} = 1.78$, $P = 0.174$) habitats. Bobcats used habitat disproportionately ($F_{6,15} = 3.60$, $P = 0.021$) relative to habitat composition of the home range. Bobcats preferred food plot, hardwood, and mature pine areas and least preferred pine regeneration, shrub/scrub, wetland, and other.

Discussion

Differential habitat selection in bobcats is most often explained by differential prey abundance, with most bobcat use in those habitats that contain abundant prey (Buie 1980, Boyle and Fendley 1987, Conner and Leopold 1996). Small mammals (e.g., cotton rats [*Sigmodon hispidus*], mice [*Peromyscus* spp.]) were the most frequently occurring prey item in bobcat scats on Ichauway (> 90% frequency of occurrence; Godbois et al. 2003). Because these small mammals are most dense in areas with dense herbaceous ground cover interspersed with shrubs and shrubby vines (Golley et al. 1965, Schnell 1968) and because edges of agriculture fields and food plots are largely made up of these habitat features, we expected bobcats to prefer food plots and agriculture fields. Within home ranges, food plots and agriculture fields were the most preferred habitat as predicted.

During spring and summer, bobcats preferred mixed pine/hardwood, mature pine, food plot, and hardwood areas. These habitats were likely used for daytime rest cover or as travel corridors (Rolley 1985, Zwank 1985), while mature pines and food plots were likely used for hunting (Golley et al. 1965, Cummings and Vessey 1994).

Bobcats used habitat differently from what was available within their home ranges during all seasons. The more preferred habitats were likely used because of prey abundance in the sites or because they provided refuge from summer heat (Zwank et al. 1985, Conner and Leopold 1996). Mature longleaf pine forests have a dense herbaceous ground cover that benefits bobcat prey (Golley et al. 1965). Hardwood and mixed pine-hardwood areas are most commonly associated with wet areas on our study site; thus, bobcat preference of these habitats during summer may have been an attempt to avoid the intense heat of summer.

Management Implications

A management objective for approximately half of Ichauway was to produce a harvestable northern bobwhite population. This management is conducive for a variety of small mammals (Taylor 1981, Cummings and Vessey 1994, Doonan and Slade 1995), and as a result, supports bobcats. Prescribed fire was essential in maintaining an open-canopied forest structure which promoted a dense herbaceous understory throughout forested upland sites (Waldrop et al. 1992). The interspersion of shrubby and herbaceous cover is important, and areas that are too shrubby may be less beneficial to bobcat prey (Kitchings and Story 1978). Prescribed burning increases herbaceous ground cover and limits the presence of shrubby cover (Landers and Mueller 1986) and thus helps maintain the suitability of upland pine stands as bobcat habitat. Prescribed fire within this forest type is vital for maintaining suitable habitat for bobcat prey (Taylor 1981). Further, the presence of food plots provides edges that also may concentrate prey (Cummings and Vessey 1994). These prey concentrations likely increase the foraging efficiency of bobcats. However, these edges may also create an ecological trap (Gates and Gysel 1978) for prey animals. Research is needed to evaluate the effects habitat management practices that concentrate prey relative to the potential for increased predation associated with these habitat features.

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