SEASONAL HABITAT USE AND ABUNDANCE OF LOGGERHEAD SHRIKES IN SOUTH CAROLINA

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Abstract: Loss of winter habitat has been implicated in the widespread declines of loggerhead shrike (*Lanius ludovicianus*) populations; however, our understanding of what represents winter habitat for this species is poor. Thus, we investigated whether shrikes in South Carolina used similar habitats throughout the year. We found that during the breeding season shrikes inhabited areas dominated by short, grassy vegetation, whereas, outside of the breeding season, they decreased ($P = 0.047$) their use of grassy habitats and increased ($P = 0.005$) their use of cropland. Declines in shrike populations in the southeastern United States as well as the entire nation, respectively, were correlated ($r = 0.83$, $n = 15$, $P < 0.001$; $r = 0.34$, $n = 113$, $P < 0.001$) with a loss of pastureland suggesting that this habitat may be limiting. Our data suggest that management for resident shrikes in the southeastern United States should include a patchwork of short grassy habitats and sparsely vegetated bare areas at the scale of individual shrike territories.

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Loggerhead shrike populations have declined during the last 20 years (Geissler and Noon 1981, Morrison 1981, Robbins et al. 1986), possibly because of inadequate reproduction (Porter et al. 1975, Kridelbaugh 1983, Tyler 1992), pesticide poisoning (Busbee 1977, Anderson and Duzan 1978, Morrison 1979), and habitat loss (Brooks and Temple 1990, Gawlik and Bildstein 1990, Tyler 1992). Recently, however, several studies have suggested that reproductive success, at least when measured on a per pair basis at fledging, is not limiting shrike populations (Brooks and Temple 1990, Gawlik and Bildstein 1990, cf. Scott and Morrison 1990). Similarly, although it has been reported that DDT (Anderson and Duzan 1978) and dieldrin (Busbee 1977) can affect shrikes negatively, the species has continued to decline even though these chemicals have been banned in the United States since the early 1970's. Therefore, most recent efforts at explaining shrike declines have focused on habitat loss.

Loss of breeding habitat has been implicated in the population declines of some passerines (Terborgh 1989); however, studies of loggerhead shrikes breeding in the Midwest do not indicate that breeding habitat is a limiting factor (Graber et al. 1973, Brooks and Temple 1990). Thus, Brooks and Temple (1990) suggested that the loss of wintering habitat may have resulted in reduced winter survivorship of the species. Unfortunately, most information on habitat use by shrikes comes from studies of migrant populations during the breeding season, and our

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current understanding of what represents wintering habitat for the species is poor.

We wanted to determine if shrikes exhibited seasonal changes in habitat use via collection of habitat use and abundance data on loggerhead shrikes throughout South Carolina. We used independent data sets to correlate previous trends in land use with shrike abundance, thus enabling us to evaluate the relationship between a dominant habitat model variable and declines in shrike populations in the Southeast and elsewhere in the United States. Herein, we define habitat as a spatially contiguous and primarily homogenous vegetation type that is physiognomically distinctive from other such types (Partridge 1978, Hutto 1985).

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STUDY AREA AND METHODS

From October 1985 to July 1987, we conducted 36 road surveys approximately every 2 weeks along a 277-km route that extended from York County in northcentral South Carolina to Georgetown County in coastal northeastern South Carolina (Gawlik 1988). We conducted each survey from a vehicle traveling at approximately 40 km/hour with a single observer. Surveys, which were completed in 1–2 days, were not initiated during periods of precipitation. To reduce directional and time biases, we initiated and concluded each survey 56 km (one-fifth of the route) from the starting and ending point of the preceding survey. After 5 surveys, the starting and ending point occurred at an end of the route, at which time we reversed the direction of the next survey, and repeated the cycle. We recorded only those birds sighted within 100 m of the survey road. Shrikes that were flying when first sighted were included in the abundance analysis but excluded from habitat analyses.

Habitats in the agriculture-dominated landscape occurred in discrete patches that allowed us to visually estimate habitat composition. In addition, unlike vegetation height, availability of the habitat categories we recorded did not change seasonally. For example, pastureland and lawns in South Carolina are semipermanent (i.e., they are not regularly tilled), and cropland is cultivated annually.

Each time a bird was sighted, we visually estimated the percentage of each habitat type within 100 m and directly below each bird. Habitat categories included cropland (i.e., regularly cultivated fields that contained crops or were plowed in preparation for planting), disturbed grasses (i.e., residential lawns, hay fields, and grazed pastures that were mowed or grazed regularly), undisturbed grasses, wooded, and other. We also recorded perching substrate and the perch location relative to habitat features (i.e., fields, forests, residences, or roads). If a bird was perched along a roadside and adjacent to a field, we recorded its location as roadside. Distance from the bird to the center of the survey road was determined using a measuring wheel. Perch height was measured with a clinometer. As a measure of habitat structure we took visual obstruction measurements of the vegetation below perched birds using a Range Pole (Robel et al. 1970) of dimensions $100 \times 5 \times 5$ cm.

We determined seasonal habitat use by shrikes by analyzing discrete habitat variables (i.e., perch substrate, perch-site vegetation, and perch location) with a Chi-square test of independence (Conover 1980:158). Continuous habitat variables were examined with a 1-way analysis of variance and Fisher's least significant-difference pairwise comparisons for unbalanced data using SAS GLM procedures (SAS Inst. Inc. 1988). The critical level for all statistical tests was 0.05. In close accordance with standard solar-determined seasons, we considered winter to be January, February, and March; spring to be April, May, and June; summer to be July, August, and September; and autumn to be October, November, and December. In northcentral South Carolina the majority of shrike breeding activity occurs during spring as we have defined it (Gawlik and Bildstein 1990). We tested for changes in seasonal abundance of shrikes on our study

Table 1. Perch substrate and vegetation heights below loggerhead shrikes seen along a 277-km route in South Carolina, 1985–87.

	Spring			Summer			Autumn			Winter		
	%	$\bar{x}$	n	%	$\bar{x}$	n	%	$\bar{x}$	n	%	$\bar{x}$	n
Perch substrate[a]												
Utility line	88		50	94		53	88		73	69		61
Tree and shrub	2		50	0		53	7		73	21		61
Other	10		50	6		53	5		73	10		61
Vegetation height (cm)[b]		0.7AB	50		1.3BC	48		1.6C	73		0.4A	61

[a] Perch substrate is dependent on season ($P = 0.001$); Chi-square test of independence.
[b] Row means with the same letter do not differ ($P > 0.05$); ANOVA.

area using a factorial analysis of variance performed with the SAS GLM procedure (SAS Inst. Inc. 1988). The full model contained a year, season, and interaction term.

We obtained annual indices of shrike abundance from Breeding Bird Surveys analyzed by the U.S. Fish and Wildlife Service Migratory Bird and Habitat Research Laboratory, Laurel, Maryland. Each index value represented the abundance of shrikes in a state relative to other states and other years (S. Droege, U.S. Fish and Wildl. Serv., pers. commun.). Indices were calculated for 38 states that had adequate Breeding Bird Survey coverage and in which shrikes were sighted regularly. Indices of shrike abundance then were correlated with the percentage of nonwooded pastureland in each of the 38 states using Pearson correlation coefficients (SAS Inst. Inc. 1988). Acreages of nonwooded pastureland were available for 1978, 1982, and 1987 from the 1987 Census of Agriculture (Anonymous 1989). Separate analyses were conducted with all states pooled and with only those states in the southeastern coastal region (i.e., Va., N.C., S.C., Ga., and Fla.).

RESULTS

We observed 254 shrikes during the course of 36 surveys. The number of shrikes counted per survey ($\bar{x} = 7.06$, SD = 2.83) did not differ ($F = 1.71$, 7 df, $P = 0.15$) among seasons or between years.

Of the 238 shrikes included in the habitat analyses, 47% were perched in fields, 43% were along roadsides, 9% were in residential lawns, and 1% were in other locations. Neither the location of shrikes, their perching height ($\bar{x} = 6.29$ m, SD = 1.92), nor their distance from the road ($\bar{x} = 34.11$ m, SD = 24.34) differed among seasons (all χ^2 and F-tests, $P > 0.05$). Perching substrate, however, was dependent on season ($\chi^2 = 24.1$, 6 df, $P = 0.001$) (Table 1). Most shrikes were observed on utility wires throughout the year; however, these birds increased their use of trees and shrubs during the winter.

Cropland and disturbed grasses made up the largest percentage of habitat within 100 m of the shrikes we sighted. Disturbed grasses, cropland, and wooded vegetation differed among seasons (Fig. 1A), as did the height of vegetation (all F-tests, $P < 0.05$) (Table 1). Disturbed grasses were used more ($P < 0.05$) during the spring than in the autumn and winter. In contrast, cropland was used more ($P < 0.05$) during the autumn than other seasons. Trees and shrubs were used more ($P < 0.05$) during the winter than autumn. The vegetation height below birds was greater ($P < 0.05$) during the summer and autumn than in the spring and winter. Undisturbed grasses and other habitats did not differ among seasons (all F-tests, $P > 0.05$; Fig. 1A). Shrikes perched most commonly above undisturbed grasses; however, the vegetation types below birds differed among seasons ($\chi^2 = 28.34$, 12 df, $P = 0.005$; Fig. 1B).

Indices of shrike abundance were correlated with percent of pastureland nationwide ($r = 0.34$, $n = 113$, $P < 0.001$), and particularly in the southeastern coastal states ($r = 0.83$, $n = 15$, $P < 0.001$).

DISCUSSION

Because the number of shrikes seen per survey was similar between years and the number of shrikes was relatively constant each season, we believe shrike populations in our area did not receive a large influx of wintering migrants, or breeding birds left the area in proportion to arriving wintering migrants. Observations of 15 banded adult shrikes in York County, South Carolina, revealed that at least some males remained on breeding territories throughout the

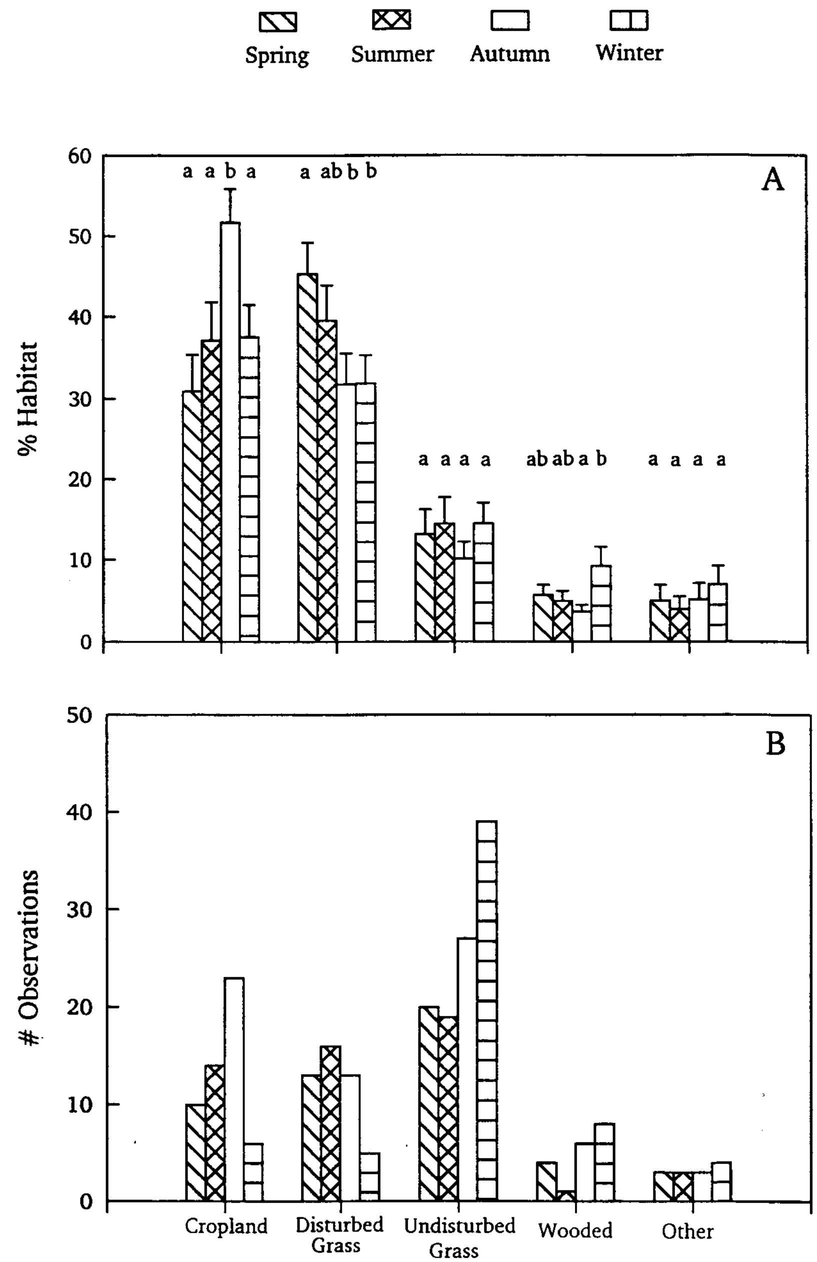

Fig. 1. Percent habitat types within 100 m of (A), and frequency of habitat types below (B), loggerhead shrikes observed along a 277-km survey route in South Carolina, 1985–87. Bars sharing a common letter within habitat types did not differ ($P > 0.05$) seasonally; ANOVA.

year (D. E. Gawlik, pers. observ.). Collectively, this evidence supports the notion that loggerhead shrikes are permanent residents throughout South Carolina east of the mountains (Wayne 1910, Miller 1931).

The importance of short grassy habitats (e.g., grazed pasture) to nesting shrikes is well documented (Kridelbaugh 1982, Brandl et al. 1986, Luukkonen 1987, Gawlik and Bildstein 1990), and shrikes nesting in these habitats are known to have higher productivity than shrikes nesting in other habitats (Luukkonen 1987, Gawlik and Bildstein 1990). Nesting shrikes supposedly avoid rowcrops (Kridelbaugh 1982), and Brooks and

Temple (1990) suggested that the conversion of pastureland to cropland in the South would have a more severe impact on wintering shrikes than on resident birds. Bohall-Wood (1987) reported no differences in habitat use by shrikes in Florida between winter and summer; however, changes in habitat use between the breeding and nonbreeding seasons may not have been detected because the breeding season of shrikes in Florida overlapped the winter and summer periods defined by the author. Our study demonstrated that in South Carolina, shrikes used disturbed grassy habitats mainly during spring, which corresponded to the breeding season. Conversely, most shrikes occupied areas of cropland in autumn. Although the cause for the decline in use of grassy habitats outside of the breeding season was unclear, a similar trend was exhibited by Eurasian kestrels (*Falco tinnunculus*) (Shrubb 1982) and Swainson's hawks (*Buteo swainsoni*) (Bechard 1982). Both authors attributed that seasonal shift in habitat use to changes in food availability.

In South Carolina, most cropland is in the middle to latter stages of growth during the shrike breeding season and is harvested during the post-fledging period. Thus, this schedule provides large open areas with sparse vegetation just as young shrikes are beginning to forage independently. Mills (1979) suggested that both shrikes and kestrels should avoid areas of tall dense vegetation. Kestrels, which forage on prey species similar to those of shrikes (e.g., Collopy and Koplin 1983, Scott and Morrison 1990, Gawlik et al. 1991), are reported to have decreased hunting success with increased vegetation height (Smallwood 1987, Toland 1987). Our observations support the notion that shrikes avoid areas of tall, dense vegetation.

Nationally, both pastureland acreage and shrike numbers have declined since 1978. In the southeastern United States especially, the extent of declines in short grassy vegetation is correlated closely with the extent of declines in shrike populations, suggesting that grassy habitats may be more limiting than cropland.

MANAGEMENT IMPLICATIONS

Seasonal shifts in habitat use exhibited by our shrikes suggest that suitable habitat for this resident population consists of a patchwork of short disturbed grasslands and sparsely vegetated cropland at the scale of individual shrike territories (0.2 ha to 14.6 ha; Yosef and Grubb 1992). One way to achieve this habitat mixture is to intersperse small monocultures of rowcrops and pastureland such that patchiness results from among-field diversity, similar to what we observed in South Carolina. Alternately, larger blocks of pastureland could be managed to provide sparse bare areas and short grasslands within fields, creating within-field diversity. Habitat interspersion under either scenario could be achieved through common grassland management techniques such as grazing, burning, plowing, and mowing.

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