

AN ABSTRACT OF THE THESIS OF

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Title: Nesting habitat and responses to habitat edges of three grassland passerine species

Abstract approved: Elmer J. Fink

Grassland passerines breeding in tallgrass prairie may have particular nest microhabitat affinities within nest sites and have different habitat affinities at nest sites among species. In Chapter 1, I examined nest sites of three passerine species--eastern meadowlark (*Sturnella magna*), dickcissel (*Spiza americana*), and grasshopper sparrow (*Ammodramus saviarum*)--in eastcentral Kansas tallgrass prairie. I tested for nest microhabitat (0.25 m<sup>2</sup> around nests) characteristics within species and compared nest microhabitats and habitats in larger areas around nests (1- to 10-m radii) among species. Nest microhabitats of all species had less bare ground cover than larger areas around nests, while only dickcissel and grasshopper sparrow nest microhabitats had significantly greater ( $P < 0.05$ ) vegetation variable means than larger areas around their nests. Several habitat characteristics were found to be significantly different among the nest sites of the three species at both spatial scales measured. My findings support previous nest-site habitat descriptions and abundance-habitat correlations for these species.

Different habitat edge types may have differing effects on breeding grassland birds in fragmented tallgrass prairie. In Chapter 2, I compared nest predation, brood parasitism by brown-headed cowbird (*Molothrus ater*), and nest placement of the three

study species in relation to their nest distances from woodland and agricultural edges in eastcentral Kansas tallgrass prairie. Daily nest survival rates of the three species were not significantly ( $P > 0.05$ ) influenced by nest distances in relation to either edge type, and only eastern meadowlark experienced significantly ( $P < 0.05$ ) higher brood parasitism rates  $\leq 100$  m of woodland edges. Dickcissel nested farther from woodland edges than agricultural edges and grasshopper sparrow nested farther from agricultural edges relative to the nest placement of the other study species. My findings suggested possible influences of woodland edges on brood parasitism and of both edges on the nest-site selection of certain grassland passerine species within 100 m of habitat edges.

NESTING HABITAT AND RESPONSES TO HABITAT EDGES OF THREE  
GRASSLAND PASSERINE SPECIES

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A Thesis

Presented to

The Division of Biological Sciences

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In Partial Fulfillment

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Master of Science

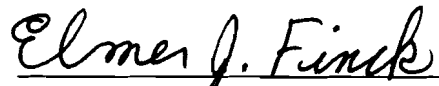
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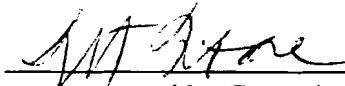
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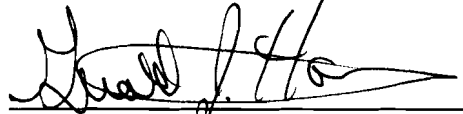
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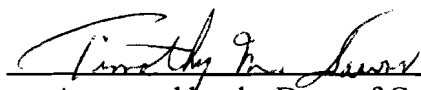
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## PREFACE

Grassland avifaunal communities of the Great Plains and Midwestern United States have recently received much attention from researchers and wildlife managers due to notable population declines of many grassland bird species. The native tallgrass prairie remaining in and near the Flint Hills region of eastern Kansas provides an excellent study area for the ecological study of grassland birds. There are many behavioral and ecological patterns and species to be investigated in the grassland bird communities of this region. The initial inspiration for the primary focus of my thesis was provided by Christopher J. Helzer, who presented findings from his M.S. research (University of Nebraska, Lincoln) at the 58th Midwest Fish and Wildlife Conference. His innovative research expanded upon earlier findings regarding the effects of habitat fragmentation on forest and grassland birds. I, in turn, attempted to expand upon some of his findings in Chapter 2 herein.

The chapters of my thesis are written in different manuscript formats suitable for submission to two separate journals; therefore, style, headings, presentation of common names of organisms, etc., are not consistent among the two chapters. Chapter 1 and Chapter 2 are written in manuscript formats suitable for publication in The Wilson Bulletin and The Journal of Wildlife Management, respectively.

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## CHAPTER 1

### NEST-SITE HABITAT AFFINITIES OF THREE PASSERINE SPECIES IN TALLGRASS PRAIRIE

ABSTRACT.--Some grassland passerine species appear to have preferred nest microhabitats and, based on nest-site and breeding territory descriptions, coexisting species in tallgrass prairie should show differences in their nest-site habitat affinities. In Chapter 1, I examined nest sites of three passerine species--Eastern Meadowlark (*Sturnella magna*), Dickcissel (*Spiza americana*), and Grasshopper Sparrow (*Ammodramus savannarum*)--breeding in eastcentral Kansas tallgrass prairie. I tested for nest microhabitat (0.25 m<sup>2</sup> around nests) characteristics within species and compared nest microhabitats and habitats in larger areas around nests (1- to 10-m radii) among species. Nest microhabitats of all species had less bare ground cover than larger areas around nests, while only Dickcissel and Grasshopper Sparrow nest microhabitats had significantly greater ( $P < 0.05$ ) vegetation variable means than larger areas around nests. Several habitat characteristics were found to be significantly different among the nest sites of the three species at both spatial scales measured. Eastern Meadowlark appears to have a relative affinity for greater standing dead grass cover and height, Dickcissel for greater live forb and woody vegetation cover and height, and Grasshopper Sparrow for lower live grass height and greater bare ground cover. These findings support previous nest-site habitat descriptions and abundance-habitat correlations for these species.

## INTRODUCTION

Birds tend to select particular habitats in which to establish breeding territories and place their nests (Cody 1985a). Some passerines breeding in grasslands have been shown to have nest microhabitats that differ structurally from surrounding habitats used during the breeding season (e.g., Sutter 1997). The selection of specific nest microhabitats may aid in nest thermoregulation or concealment from predators (Pleszczyńska 1978, Norment 1993). In addition, coexisting grassland passerine species appear to have different habitat affinities (Wiens 1973). For example, Wiens (1973) showed that certain broad-ranging grassland species, such as the Horned Lark (*Eremophila alpestris*) and the Grasshopper Sparrow (*Ammodramus savannarum*), have inversely related habitat affinities. In Illinois, Herkert (1994a) found that many grassland bird species showed affinities for different vegetative structure characteristics in addition to responding to grassland fragment area. The relationships of species-specific affinities for particular aspects of grassland vegetative structure are often indicated from estimations of territorial male density, probability of occurrence, or abundance correlated with local vegetative characteristics (Wiens 1973, Herkert 1994a, Swengel 1996, Delisle and Savidge 1997). However, males of some passerine species have been shown to select vegetation characteristics at song perch sites that differ from nest-site habitats (Collins 1981), which may confound comparisons of preferred breeding habitats among species based solely on habitats used by males. Comparisons among the nest sites of coexisting grassland bird species may reveal differences in their nest-site habitat characteristics. Information on microhabitat and relative nest-site habitat affinities

among the nest sites of some grassland bird species breeding in tallgrass prairie remains limited. This is especially so for the Grasshopper Sparrow (Vickery 1996), which has recently experienced significant population declines in the Midwest (Herkert et al. 1996).

I tested for nest microhabitat (defined here as the habitat within a 0.25 m<sup>2</sup> area around nests) characteristics within species and compared nest microhabitats and habitats in larger areas around nests (1- to 10-m radii) among Eastern Meadowlark (*Sturnella magna*), Dickcissel (*Spiza americana*), and Grasshopper Sparrow nest sites in the tallgrass prairie of the Flint Hills region of eastcentral Kansas. These coexisting species are common passerines occurring in the grasslands of this region (Wiens 1974, Elliot 1978, Cody 1985b) and form a large portion of a loose species association of grassland birds in North American tallgrass prairie (Wiens 1973). Nest-site habitat affinities of Eastern Meadowlark and correlates of Dickcissel nest density with vegetative structure in the Flint Hills have been described elsewhere (Zimmerman 1971, Finck 1984, Granfors et al. 1996), but Grasshopper Sparrow (*A. s. pratensis*) nest-site characteristics in this region are less well documented. Nest microhabitat affinities have been shown for another grassland passerine (Sutter 1997) at a spatial scale similar to the nest microhabitat defined in my study. I predicted that each species would have affinities for particular nest microhabitat characteristics that differ from habitats in the areas surrounding nest microhabitats. Comparisons among the nest sites of the three species were done at two spatial scales, nest microhabitats and the defined larger area around nests, to test for differences in these species' nest-site habitats. Delisle and Savidge (1997) showed Dickcissel abundance to be positively correlated with vertical vegetation

density and litter depth, and Grasshopper Sparrow abundance to be negatively correlated with those same variables in conservation reserve program (CRP) fields in Nebraska. In addition, previous descriptions of the preferred nesting and breeding territory habitats of Eastern Meadowlark, Dickcissel, and Grasshopper Sparrow (Roseberry and Klimstra 1970, Zimmerman 1971, Whitmore 1981, Finck 1984, Granfors et al. 1996), and my own personal observations of the nest sites of these species, suggested that these coexisting species would have affinities for different nest-site habitat characteristics in relation to one another. Therefore, my objective was to determine the relative, among species, affinities for different habitat structure characteristics at nest sites of Eastern Meadowlark, Dickcissel, and Grasshopper Sparrow at the two spatial scales mentioned above. Differences in nest-site habitat structure have been found among other coexisting passerine species at spatial scales similar to those used in my study (Norment 1993).

## METHODS

The study area was located on the east-central margin of the Flint Hills region of eastcentral Kansas, in Coffey, Greenwood, and Lyon counties. Six study sites were used per year and were composed of native tallgrass prairie, both privately and publicly (Kansas Department of Wildlife and Parks) owned, managed with annual to biennial burning, and grazing or haying regimes (see Appendix I for legal descriptions of study site locations).

Nest searching was done from 20 May to 26 July 1997 and 18 May to 25 July 1998, six days per week from 0600 to 1200. During mornings with inclement weather, study sites were searched for nests immediately after storms. Beginning the first week of each field season, nest searching was done every other week on each site by using rope drags. With this method, two people drag a 25-m long rope between them, perpendicular to the direction of travel across the prairie vegetation, while one to three evenly spaced observers walk 5 to 10 m behind the rope and watch for flushing birds. Locations of nests were determined by searching near where birds flushed. On the intervening weeks between rope drags, observers searched for nests by walking systematically across sites (without a rope) and observing parental nesting behaviors.

Nest-site habitat characteristics for each species were characterized by measuring 15 habitat variables within 50-cm x 50-cm quadrats. Vegetation variables recorded in each quadrat were percent canopy cover and average crown height (cm) of live grass, standing dead grass, live forbs, standing dead forbs, live woody vegetation, and standing dead woody vegetation. Ground cover components measured were percent

cover of bare ground, litter, and rock. All cover percentages were visually estimated and are non-overlapping, i.e., total coverage of all cover types equals 100%. An estimated average of the crown heights of all plants within each particular vegetative component, e.g., live grass, within each quadrat was made by using a meter stick. I made all habitat variable estimates to maintain consistency among observations. Nest microhabitat was measured with a quadrat placed on the ground with a nest at its center, hereafter, microhabitat quadrats. To characterize a larger area surrounding nests outside of the defined nest microhabitat, four quadrats were placed at random distances within a 1- to 10-m radius of nests and at random bearings within one of four 90° quadrants. Hereafter, these are referred to as around-nest quadrats. Since habitat variables were sampled within four weeks of the completion of each nesting attempt in 1997 but within two weeks in 1998, and four of the six study site locations were changed for the 1998 field season, year was entered as a factor in analyses. For all analyses that included around-nest quadrat variables, the four values per variable in these quadrats were averaged across the four around-nest quadrats per nest to yield a single value. Significant differences ( $\alpha = 0.05$ ) of each habitat variable among nest microhabitat quadrats and around-nest quadrats at nest sites of individual species were tested by using two-way analyses of variance (ANOVA) with quadrat type and year as the two main factors. Comparisons of each habitat variable among the three species' nest sites were done at the two spatial scales, nest microhabitats and 1- to 10-m radii around-nests, by using two-way ANOVA with species and year as main factors. Duncan's multiple-range tests were used to compare habitat variable means between species nest sites that were



significantly different ( $\alpha = 0.05$ ). Variables with significant interactions between species and year were analyzed separately by year with one-way ANOVA, otherwise observations from both years were pooled. All two-way ANOVA were performed with the SAS general linear models procedure (PROC GLM) due to unbalanced replication among species or years (SAS Institute 1990), and PROC ANOVA for separate analyses by year. Cover percentages were not arcsin transformed for ANOVA since the data were considered to be binomial and fit criteria suggested by Zar (1996) to not require transformations. Additionally, some variables were shown to be normally distributed, so analytical consistency was maintained by leaving all percentage data untransformed. For comparisons among species of variable values averaged across around-nest quadrats, all data were assumed to be normal due to the normality approximation of the central limit theorem (Zar 1996).

## RESULTS

Nests of Eastern Meadowlark, Dickcissel, and Grasshopper Sparrow were the most common, accounting for approximately 90% of the 287 nests found during the two years of the study (126 Dickcissel, 70 Eastern Meadowlark, and 62 Grasshopper Sparrow nests). (See Appendix II for a list of nests of all species found). The nest-site habitat of one Eastern Meadowlark nest was not measured due to the inability to relocate it. In the accompanying tables, the following study species codes are used: EAME = Eastern Meadowlark, DICK = Dickcissel, and GRSP = Grasshopper Sparrow.

Several habitat variable means differed ( $P < 0.05$ ) among nest microhabitats and habitats within 1- to 10-m radii of nests for all three species (Table 1). No quadrat-year interactions were found. The nest microhabitats of all three species had less bare ground cover than areas around nests; this was most significant for Dickcissel and Grasshopper Sparrow. Dickcissel nest microhabitats had greater live grass height, greater live forb cover and height, greater live woody vegetation cover, and less litter cover than areas around nests. Grasshopper Sparrow nest microhabitats had greater live grass cover than areas around nests.

Several habitat variable means were also found to differ ( $P < 0.05$ ) among the nest sites of the three species at both spatial scales measured (Tables 2 and 3). At the 0.25 m<sup>2</sup> nest microhabitat scale (Table 2), Eastern Meadowlark nested in greater standing dead grass cover and height; Dickcissel in greater live forb and woody cover and height, less live grass cover in 1998 only, and less litter cover; and Grasshopper Sparrow in lower live grass height, and greater bare ground and rock cover. At the largest scale

measured, 1- to 10-m radii around nests (Table 3), Eastern Meadowlark nest sites had greater live grass cover and greater standing dead grass cover and height; Dickcissel nest sites had greater live forb cover and height (height in 1998 only) and greater live woody cover and height; and Grasshopper Sparrow nest sites had lower live grass height, greater bare ground cover, and less litter cover.

Table 1. Habitat variables that differ ( $P < 0.05$ ) with respect to spatial scale at nest sites of Eastern Meadowlark, Dickcissel, and Grasshopper Sparrow in eastcentral Kansas.

Species	n	Variable <sup>a</sup>	Microhabitat (0.25 m <sup>2</sup> )	Around-nests (1 to 10 m)	F <sup>c</sup>
			$\bar{x}^b$ (% or cm) $\pm$ SE	$\bar{x}^b$ (% or cm) $\pm$ SE	
EAME	69	BARE	8.55 $\pm$ 1.34	15.90 $\pm$ 1.02	10.41**
DICK	126	GHT	41.43 $\pm$ 0.99	37.18 $\pm$ 0.49	12.99***
		FCOV	26.76 $\pm$ 1.42	16.40 $\pm$ 0.56	36.68***
		FHT	37.18 $\pm$ 1.31	29.66 $\pm$ 0.68	22.16***
		WCOV	4.88 $\pm$ 1.25	1.72 $\pm$ 0.31	4.44*
		BARE	8.49 $\pm$ 0.84	15.34 $\pm$ 0.69	21.19***
GRSP	62	LIT	9.10 $\pm$ 0.71	16.30 $\pm$ 0.62	29.66***
		GCOV	52.82 $\pm$ 1.87	48.54 $\pm$ 0.82	4.20*
		BARE	15.71 $\pm$ 1.78	25.38 $\pm$ 1.16	13.67***

<sup>a</sup> Variables listed: GCOV = % grass cover, GHT = average live grass height (cm), FCOV = % forb cover, FHT = average live forb height (cm), WCOV = % live woody cover, BARE = % cover bare soil; LIT = % cover litter.

<sup>b</sup> Means listed include observations of zero in some quadrats for certain variables.

<sup>c</sup> df from two-way ANOVA = 1, 134 for EAME; 1, 248 for DICK, and 1, 120 for GRSP.

\* =  $P < 0.05$ , \*\* =  $P < 0.01$ , \*\*\* =  $P < 0.001$ .

Table 2. Habitat variable means that differed ( $P < 0.05$ ) among Eastern Meadowlark, Dickcissel, and Grasshopper Sparrow nest microhabitats (0.25 m<sup>2</sup> around nests).

Variable <sup>a</sup>	EAME		DICK		GRSP		F <sup>c</sup>
	$\bar{x}^b$ (% or cm) $\pm$ SE		$\bar{x}^b$ (% or cm) $\pm$ SE		$\bar{x}^b$ (% or cm) $\pm$ SE		
GCOV (1997)	51.62 $\pm$ 2.74	A	49.86 $\pm$ 2.07	A	48.71 $\pm$ 2.47	A	0.33
(1998)	59.14 $\pm$ 2.43	A	47.63 $\pm$ 1.95	B	58.15 $\pm$ 2.55	A	8.52***
GHT	41.16 $\pm$ 1.21	A	41.43 $\pm$ 0.99	A	32.50 $\pm$ 1.23	B	21.15***
DGCOV	5.44 $\pm$ 1.20	A	1.64 $\pm$ 0.37	B	1.40 $\pm$ 0.56	B	10.16***
DGHT	13.33 $\pm$ 2.16	A	6.11 $\pm$ 1.25	B	4.92 $\pm$ 1.51	B	7.55***
FCOV	11.07 $\pm$ 1.34	B	26.76 $\pm$ 1.42	A	12.57 $\pm$ 1.19	B	39.98***
FHT	25.51 $\pm$ 2.01	B	37.18 $\pm$ 1.31	A	22.90 $\pm$ 1.46	B	28.57***
WCOV	0.07 $\pm$ 0.07	B	4.88 $\pm$ 1.25	A	0.16 $\pm$ 0.16	B	5.83**
WHT	0.36 $\pm$ 0.36	B	7.50 $\pm$ 1.74	A	0.65 $\pm$ 0.65	B	6.31**
BARE	8.55 $\pm$ 1.34	B	8.49 $\pm$ 0.84	B	15.71 $\pm$ 1.78	A	9.35***
LIT	19.06 $\pm$ 1.72	A	9.10 $\pm$ 0.71	B	16.74 $\pm$ 2.01	A	16.80***
ROCK	0.00 $\pm$ 0.00	B	0.00 $\pm$ 0.00	B	0.57 $\pm$ 0.37	A	3.38*

<sup>a</sup> Variables listed: GCOV = % grass cover, GHT = average live grass height (cm), DGCOV = % standing dead grass cover, DGHT = average standing dead grass height (cm), FCOV = % forb cover, FHT = average live forb height (cm), WCOV = % live woody cover, WHT = average live woody height (cm), BARE = % bare soil cover, LIT = % litter cover, ROCK = % rock cover.

<sup>b</sup> Means labeled with the same letter are not significantly different among species (Duncan's multiple-range test); Means listed include observations of zero in some quadrats for certain variables.

<sup>c</sup> df from two-way ANOVA: species = 2, 251; species\*year = 2, 251. Species df from one-way ANOVA = 2, 116 (1997); and 2, 135 (1998).

\* =  $P < 0.05$ , \*\* =  $P < 0.01$ , \*\*\* =  $P < 0.001$ .

Table 3. Habitat variable means that differed ( $P < 0.05$ ) among Eastern Meadowlark, Dickcissel, and Grasshopper Sparrow nest sites within 1 to 10 m of nests.

Variable <sup>a</sup>	EAME		DICK		GRSP		$F^c$
	$\bar{x}^b$ (% or cm) $\pm$ SE		$\bar{x}^b$ (% or cm) $\pm$ SE		$\bar{x}^b$ (% or cm) $\pm$ SE		
GCOV	52.55 $\pm$ 0.84	A	48.23 $\pm$ 0.66	B	48.54 $\pm$ 0.82	B	3.27*
GHT	38.32 $\pm$ 0.73	A	37.18 $\pm$ 0.49	A	31.67 $\pm$ 0.70	B	13.86***
DGCOV	2.96 $\pm$ 0.36	A	1.60 $\pm$ 0.19	B	1.08 $\pm$ 0.20	B	5.38**
DGHT	10.56 $\pm$ 1.08	A	6.29 $\pm$ 0.63	B	4.32 $\pm$ 0.71	B	5.65**
FCOV	9.08 $\pm$ 0.57	B	16.40 $\pm$ 0.56	A	11.66 $\pm$ 0.68	B	16.04***
FHT	(1997) 29.82 $\pm$ 1.38	AB	31.28 $\pm$ 1.02	A	25.00 $\pm$ 1.15	B	3.50*
	(1998) 18.54 $\pm$ 1.41	B	28.60 $\pm$ 0.90	A	17.49 $\pm$ 1.20	B	15.02***
WCOV	0.24 $\pm$ 0.13	B	1.72 $\pm$ 0.31	A	0.02 $\pm$ 0.02	B	4.48*
WHT	0.56 $\pm$ 0.29	B	3.75 $\pm$ 0.60	A	0.12 $\pm$ 0.12	B	5.01**
BARE	15.90 $\pm$ 1.02	B	15.34 $\pm$ 0.69	B	25.38 $\pm$ 1.16	A	10.50***
LIT	18.97 $\pm$ 0.90	A	16.30 $\pm$ 0.62	A	12.65 $\pm$ 0.77	B	5.32**

<sup>a</sup> Variables listed: GCOV = % grass cover, GHT = average live grass height (cm), DGCOV = % standing dead grass cover, DGHT = average standing dead grass height (cm), FCOV = % forb cover, FHT = average live forb height (cm), WCOV = % live woody cover, WHT = average live woody height (cm), BARE = % bare soil cover, LIT = % litter cover.

<sup>b</sup> Means labeled with the same letter are not significantly different among species (Duncan's multiple-range test); Means listed include observations of zero in some quadrats for certain variables.

<sup>c</sup>  $df$  from two-way ANOVA: species = 2, 251; species\*year = 2, 251. Species  $df$  from one-way ANOVA = 2, 116 (1997); and 2, 135 (1998).

\* =  $P < 0.05$ , \*\* =  $P < 0.01$ , \*\*\* =  $P < 0.001$ .

## DISCUSSION

Eastern Meadowlark, Dickcissel, and Grasshopper Sparrow nest microhabitats differed from habitats within 1 to 10 m of their nests (Table 1). Less bare ground cover at nest microhabitats than areas around nests was found to be consistent among all study species' nest sites, however, only Dickcissel and Grasshopper Sparrow nest microhabitats had greater vegetative variable means. Dickcissel nest microhabitats had taller vegetation, mostly forbs, with greater canopy cover than in areas around nests, which supports findings of Dickcissel tendencies to nest in tall, dense forbs (Zimmerman 1971, Finck 1984). My findings indicate a non-random spatial distribution of nest vegetation structure within nest-sites for this species. However, in most cases, Dickcissel nests were placed in individual plants that covered a relatively large portion of the sampling quadrat, and the results from the nest-microhabitat analyses may simply indicate the spacing of these plants. The finding of less litter cover in Dickcissel microhabitats may simply be a negative correlation with greater canopy coverage of vegetation variables. Similarly, Grasshopper Sparrow nest microhabitats had a greater cover of live vegetation in the defined nest microhabitat, i.e., live grass, despite their apparent affinity for shorter live grass with much interspersed bare ground in breeding territories (Whitmore 1981, Tables 2 and 3). This also indicates a non-random spatial distribution of nest vegetation structure within Grasshopper Sparrow nest sites. While indications of preferred habitat characteristics at the territory scale of Dickcissel and Grasshopper Sparrow have been shown (e.g., Zimmerman 1971, Whitmore 1981), the habitat within a 10-m radius of these species' nests in east-central Kansas tallgrass

prairie appears to be heterogeneous, with the placement of nests being non-random with respect to that heterogeneity. High relative vegetative cover in nest microhabitats may aid in nest thermoregulation or concealment from predators (Pleszczynska 1978, Norment 1993), but these relationships were not considered here.

All three species appeared to show affinities for different nest-site habitat characteristics, relative to one another, at the defined nest microhabitat scale and in areas within 1 to 10 m of nests. Their relative affinities for particular habitat variables appeared to be generally consistent at both spatial scales measured. Eastern Meadowlark affinities for standing dead grass and litter coverage at nest sites have been noted previously (Roseberry and Klimstra 1970, Granfors et al. 1996), and were partially supported by my findings. Aside from a notable relative affinity of Eastern Meadowlark for greater live grass cover within 1 to 10 m of nests, this species seemed to associate its nests with vegetative coverages and heights intermediate to those of Dickcissel and Grasshopper Sparrow nest site habitats. Dickcissel abundance in CRP fields in Nebraska has been shown to be positively correlated with vertical herbaceous vegetation density (Delisle and Savidge 1997) and, in the Flint Hills of Kansas, this species tends to have highest nest densities in old fields dominated by forbs (Zimmerman 1971, Finck 1984). Dickcissel affinities for these vegetative characteristics at nest sites were also apparent relative to the other study species' nest site habitats. Grasshopper Sparrow appears to have an affinity for short, sparse vegetation at nest-sites in the Flint Hills region of the tallgrass prairie (Tables 2 and 3; D. Wiedenfeld, Oklahoma, pers. commun.). Although previous documentation of Grasshopper Sparrow nest-site characteristics was limited,



descriptions of breeding habitat based on observations of male territories in eastern states (Whitmore 1981) and abundance-habitat correlations in CRP fields (Delisle and Savidge 1997) and other grasslands (Knodel 1980, Herkert 1994a,b; Vickery et al. 1994, Swengel 1996) support this subspecies' (*A. s. pratensis*) affinity for short, sparse vegetation with exposed bare soil for breeding habitat. In Illinois, Herkert (1994b) found a tendency for Grasshopper Sparrow to be more abundant in recently burned prairies, and Swengel (1996) found this species to be most abundant in xeric portions of tallgrass prairie and during the first year after haying in hay meadows in Missouri. A greater relative affinity for exposed rock outcrops in the nest microhabitat of this species (Table 1-2), although it rarely nested near this structure type (3 of 62 nests), may further substantiate its affinity for exposed areas in nest microhabitats. Exposed areas within nest microhabitats of the Grasshopper Sparrow subspecies in Florida (*A. s. floridanus*) are hypothesized to facilitate predator distraction displays near nests (Delany and Linda 1998).

Interpretations of the habitat variable means presented in Tables 1, 2, and 3 should be made carefully. These means may not be actual means for all variables measured due to observations of zero for certain variables in some quadrats, with the exception of live grass, which was recorded in all quadrats. For example, Dickcissel nests were more often associated with greater live woody vegetation than the other two species nest sites, yet only 17.5% of the 126 Dickcissel nest-sites sampled had these vegetative characteristics present. A similar scenario was mentioned above with rock in Grasshopper Sparrow nest microhabitats. In addition, Grasshopper Sparrow nests were found in recently burned, heavily grazed pastures where no other species were found

nesting, which probably contributed to their apparent relative affinity for short grasses with much interspersed bare ground. However, their nests were also found among the nests of the other two study species in previously unburned hay meadows, although they appeared to select relatively shorter, sparser vegetation for nest sites there. I do suggest, however, that the data presented here are reflective of each species' habitat affinities in relation to the nest site habitats of the other study species.

Eastern Meadowlark, Dickcissel, and Grasshopper Sparrow appeared to place their nests in unique nest microhabitats within nest sites in addition to having different relative, among-species, nest-site habitat affinities at the nest microhabitat scale and within 1- to 10-m radii around nests. Although there is some agreement between my findings and previous bird density and abundance-habitat correlations, assessing the use of prairie vegetation for breeding habitat by grassland birds on a per-field basis, e.g., per management regime, using simply point-count or line-transect techniques may only provide relatively coarse-scale measures of nest-site habitat affinities within fields. Nesting habitat preferences of some bird species have been shown to be potentially adaptive and under selection (Martin 1998), but opportunistic habitat selection strategies may be more adaptive for birds nesting in dynamic grassland environments (Wiens 1973), which may make observable fitness-based habitat selection problematic. Niche separation and the effect of nest-site selection by these grassland bird species on surrogate measures of fitness were not considered here and should be more thoroughly investigated with larger sample sizes and by including all bird species of this grassland community in the analyses.

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## CHAPTER 2

### INFLUENCES OF DIFFERENT HABITAT EDGES ON NESTING GRASSLAND PASSERINES

Abstract: Some grassland passerine birds have been shown to experience elevated rates of nest predation and brood parasitism when their nests are located near woodland edges in fragmented tallgrass prairie. Agricultural edges surround many grassland fragments but have received comparatively little attention with regard to potential indirect effects on the reproductive success of grassland birds. I compared nest predation, brood parasitism by brown-headed cowbird (*Molothrus ater*), and nest placement of three passerine species breeding in eastcentral Kansas tallgrass prairie in relation to their nest distances to woodland and agricultural edges. None of the daily nest survival rates of the three species were significantly ( $P > 0.05$ ) influenced by nest distance in relation to either edge type, and only eastern meadowlark (*Sturnella magna*) experienced significantly higher brood parasitism rates  $\leq 100$  m of woodland edges. Dickcissel (*Spiza americana*) nested farther from woodland edges than agricultural edges and grasshopper sparrow (*Ammodramus savannarum*) nested farther from agricultural edges relative to the nest placement of the other study species. Although the nesting success of these species was not significantly influenced by their nest distances to either edge type, woodland and agricultural edges may have different influences on the brood parasitism and nest-site selection of certain species  $\leq 100$  m of edges.

## INTRODUCTION

The tallgrass prairie in North America has been largely displaced by agricultural practices (Samson and Knopf 1994, Warner 1994). Additionally, a proliferation of woody vegetation resulting from fire suppression, irrigation, and the creation of shelter belts has occurred throughout the Great Plains (Knopf 1986, Johnson 1996), including the tallgrass prairie of the Flint Hills region of eastern Kansas (Bragg and Hulbert 1976). Alterations of native grassland landscapes through agricultural practices and the encroachment of woodland vegetation may cause changes in native grassland avifaunal communities (Knopf 1986, Herkert 1994*a*, Warner 1994). A recent review of bird populations breeding in the Midwestern United States by Herkert (1995) suggested that grassland birds have undergone more widespread population declines than any other habitat specialist guild.

The rarity of tallgrass prairie and other grassland habitats in the Midwestern United States, notable population declines of bird species that breed there, and habitat fragmentation models developed to explain influences on habitat-interior bird populations have inspired recent research in grassland bird ecology and conservation. In addition to research that has focused on the effects of various management regimes on habitat use by grassland birds (e.g., Kantrud 1981, Swengel 1996, Best et al. 1997), some researchers have found potential influences of habitat fragmentation on grassland bird communities (e.g., Johnson and Temple 1986, 1990; Vickery et al. 1994; Burger et al. 1994; Herkert 1994*a,b*; Helzer 1996). The indirect effects of certain habitat edges created through grassland fragmentation--namely prairie-woodland edges--on factors



influencing reproductive success of grassland birds have been investigated (Johnson and Temple 1986, 1990; Burger et al. 1994; Winter 1998), although not as extensively as edge effects on forest birds (see Paton 1994). In tallgrass prairie fragments in Minnesota, Johnson and Temple (1986, 1990) found that the nest distances to forest edges of five grassland passerine species influenced the incidences of these species' nests being parasitized by brown-headed cowbird (*Molothrus ater*, hereafter, cowbird) and lost to predation. Nests located <45 m from forest edges experienced higher rates of nest predation and brood parasitism than nests located  $\geq 45$  m from edges. Johnson and Temple (1986) also found that certain species did not place their nests randomly with respect to distance from forest edges; for example, grasshopper sparrow had higher nest densities in study plots  $\geq 45$  m from edges. Winter (1998) found significantly elevated nest predation rates on dickcissel and Henslow's sparrow (*Ammodramus henslowii*) nests and higher brood parasitism rates on dickcissel nests <50 m of woody shrub edges in prairie fragments in southwestern Missouri. Similar to the natural nest predation findings of Johnson and Temple (1986, 1990) and Winter (1998), Burger et al. (1994) found higher predation rates on experimental artificial nests <60 m from wooded edges in tallgrass prairie fragments in Missouri, relative to nests  $\geq 60$  m from edges. A pattern of elevated nest predation pressure near woody vegetation was found in another artificial nest predation experiment in Iowa roadsides (Bergin et al. 1997), where nests in grassy roadsides bordered by predominantly woody vegetation experienced higher predation rates than those with herbaceous vegetation borders only. Although the nests used by Burger et al. (1994) and Bergin et al. (1997) were artificial, their findings, along with the

findings of Johnson and Temple (1986, 1990) and (Winter 1998), suggested that encroaching woodland edges may have potentially harmful effects on a declining guild of birds whose breeding habitat has become scarce in the Midwestern United States. Woodland and woody shrub edges were suggested to be used as habitat by generalist mammalian nest predators in grasslands (Johnson and Temple 1990, Winter 1998), possibly as travel lanes (Fritzell 1978, Bergin et al. 1997), which results in increased incidental nest predation near these edges. Winter (1998) found that potential mid-sized mammalian nest predators were most active <50 m of forest edges as shown by track evidence, and <45 m of many other edge types as shown by imprints on clay eggs in artificial nests. Elevated nest predation rates on dickcissel and Henslow's sparrow nests near woody shrub edges in her study were attributed to this activity. Additionally, areas near prairie-woodland edges may serve as ecological traps resulting from a density-dependent relationship of increased prey density and the functional response of predators (Gates and Gysel 1978). An elevated intensity of nest predation imposes obvious limitations on the reproductive success of grassland birds. Elevated brood parasitism rates on grassland bird nests near woodland edges may result from cowbirds using convenient perches at these edges for surveying potential hosts (Normon and Robertson 1975), and may also reflect a density-dependent functional response by the brood parasites to increased host abundance near these edges (Gates and Gysel 1978, Evans and Gates 1997). Although grassland passerines in the Great Plains have probably been brood parasite hosts to cowbirds for centuries, many species still accept cowbird eggs in their nests, which may limit reproductive success (Hill 1976, Elliot 1978, Robinson et al.

1995a, Dearborn et al. 1998).

Few grassland bird species in the Midwestern United States use cultivated agricultural fields as nesting habitat (Best et al. 1997). However, prairie-cropland edges, i.e., borders between agricultural fields and grasslands (hereafter, agricultural edges), that are recognized as demarcating the boundaries of grassland habitat patches (as in Herkert 1994a), have received comparatively little attention with regard to having indirect effects on grassland bird reproductive success. However, Winter (1998) found that dickcissel nesting success, while being lowered near woody shrub edges, was not lowered near agricultural or roadside edges. Helzer (1996) found that both woodland and cornfield edges negatively influenced the abundance of grasshopper sparrow in wet meadow fragments in Nebraska. Similarly, in conservation reserve program (CRP) fields in Nebraska, Delisle and Savidge (1996) reported that only 1 of 31 grasshopper sparrow territories and no nests of this species had been found <50 m of edges, which consisted of wooded draws as well as agricultural fields. Many agricultural edges in remnant prairies lack the wooded habitat suggested to be used by various nest predators and cowbirds, yet these edges are common occurrences at the perimeters of many prairie fragments in Kansas. If agricultural edges lack associated edge effects on grassland bird reproductive success, then grasslands dissected by agricultural fields should provide more suitable habitats than similar grasslands fragmented by woodlands. However, assuming agricultural edges are benign features of grasslands with regard to grassland bird nesting activities may ignore any real, unrealized patterns. For example, structures such as fencerows occurring at agricultural edges may be used by certain predators as travel lanes

(Bergin et al. 1997, Winter 1998), thereby increasing incidental nest predation rates near these edges. The intensity of edge-related nest predation and brood parasitism in grasslands may vary depending on habitat edge characteristics, just as differences in edge effects have been found among different forest edge types (Ratti and Reese 1988, Fenske-Crawford and Niemi 1997, Suarez et al. 1997). Differences between the habitat structure of woodland and agricultural edges in grasslands are arguably more extreme than subtleties among forest edge types.

The objectives of Chapter 2 are to test for effects of woodland and agricultural edges on the nest predation, brood parasitism, and relative nest placement of eastern meadowlark, dickcissel, and grasshopper sparrow in eastcentral Kansas. These 3 species are the most common grassland birds nesting in this region (Wiens 1974, Elliot 1978, Cody 1985, Chapter 1) and were expected to provide the largest sample sizes. I predicted that nest predation and brood parasitism rates would be elevated near woodland edges and be random with respect to nest location relative to agricultural edges for all species. I also predicted that edge type would influence nest placement, either by individual species nesting farther from a certain edge type, e.g., woodland edges, than another or nesting farther from--or closer to--an individual edge type than other species.

## METHODS

### Study Area

Nest searching was done on tracts of both privately and publicly (Kansas Department of Wildlife and Parks) owned native tallgrass prairie, managed with annual to biennial burning, and grazing or haying regimes. The study area was located on the eastcentral margin of the Flint Hills region of Kansas in Coffey, Greenwood, and Lyon counties (see Appendix I for legal descriptions of study site locations). Although many large remnant tracts of tallgrass prairie remain in the Flint Hills (Steinauer and Collins 1996), the tallgrass prairie surrounding this region is dissected by upland and riparian woodlands, hedgerows, and agricultural fields. The habitat edges at each study site used were either woodland or agricultural, i.e., each site had only one of the defined edge types of interest, with the exception of small smooth sumac (*Rhus glabra*) and rough-leaved dogwood (*Cornus drummondii*) copses and a few isolated trees on two agricultural-edged sites. Hedgerows, and upland and riparian woodlands formed the woodland edges used and consisted of at least 6 trees with a diameter at breast height  $\geq 2.5$  cm and averaging  $\geq 3$  m in height with a continuous canopy cover and a shrub understory. Common trees and shrubs in these woodlands included cottonwood (*Populus deltoides*), Osage orange (*Maclura pomifera*), various elms (*Ulmus* spp.), sycamore (*Platanus occidentalis*), bur oak (*Quercus macrocarpa*), honey locust (*Gleditsia triacanthos*), and rough-leaved dogwood. Borders of cultivated agricultural fields forming edges in prairie lacked the woodland vegetation described above and consisted of herbaceous vegetation  $\leq 1$  m tall, with 5-wire fences at edges of pasture sites.

Agricultural fields were planted with soybeans, sorghum, or wheat. Woodland type and crop species were not considered as independent variables in the analyses. Nests were searched for on 6 separate sites per year in 1997 and 1998. Four woodland edge sites and 2 agricultural edge sites were used in 1997 and 3 sites per edge type were used in 1998.

### **Field Methods**

Nest searching was done from 20 May to 26 July 1997 and 18 May to 25 July 1998. All nest searching and monitoring activities were done 6 days a week from 0600 to 1200. On mornings with inclement weather, nests searching and monitoring were done immediately after storms. Nest searching was done by using rope drags every other week on each site (see Chapter 1) and on alternating weeks by observers walking systematically across sites, without a rope, observing parental nesting behaviors. After a nest was found, it was marked for relocation with a small orange surveyor flag, bearing a unique identification number, placed 4 m north of the nest. Flags were positioned in the ground such that their height did not exceed the height of the surrounding vegetation. On sites with grazing cattle, the bases of flags were surrounded with stones to facilitate nest relocation in the event of flag removal by cattle.

Nests were monitored by relocating them every 3 to 4 days and recording the number of host and cowbird eggs and nestlings remaining in nests. If nestlings were present, nestling age was estimated based on morphological characteristics to determine their developmental stage. If a relocated nest was empty, the observer would determine the fate of the nest as having fledged young, or having been depredated, abandoned, or

trampled by cattle. A nest was estimated to have fledged young if it was at an appropriate stage in the nesting attempt and parental behavior indicative of fledglings present was observed. A nest was estimated to have been depredated if it was found empty at a stage in the nesting attempt too early to have fledged young and if no parental behavior indicative of fledgling presence was observed. Destruction and severe disruption of nest material were also used in estimations of predation events. Nests were determined to have been abandoned during incubation if they were found with intact eggs but without incubating females on the last 3 visits of monitoring, and if other evidence that incubation had been terminated was present, e.g., cold and wet eggs, spider webs or insects remaining in nests, etc. Nests thought to have been destroyed by inclement weather during storms, i.e., wet and cold whole eggs and shells remaining in disturbed nest material, were considered to be abandoned. A nest was determined to have been trampled by cattle if it contained eggs or nestlings on the previous visit, was at a stage in the nesting attempt too early to have fledged young, and was flattened amidst vegetation trampled by cattle. I performed all nest monitoring to maintain consistent nest-fate estimations.

Habitat measures were performed after the completion of each nesting attempt. The distance of each nest to an edge (m) was measured by using one or multiple lengths of a 100 m measuring tape. Since the study species have been shown to have affinities for different habitat structure characteristics at nest sites in relation to one another (Chapter 1), they may nest at different distances from edges due to changes in vegetative structure along gradients perpendicular to edges rather than avoiding the edges

themselves. To test for potential changes in nesting habitat characteristics along this gradient, 100-m transects running perpendicular from edges into the prairie interior were randomly placed within 100-m intervals along edges. Each transect was divided into 5 intervals of 20 m each, where a 50-cm x 50-cm quadrat was placed at a random distance (m) within each interval. Eleven vegetation variables for which the 3 species are known to have unique affinities (Chapter 1) were measured within each quadrat. These variables include percent canopy cover and average crown height (cm) of live grass, standing dead grass, live forbs, and live woody vegetation. Ground cover components measured were percent bare ground, litter, and rock. Cover percentages were visually estimated and were non-overlapping, i.e., total coverage of all cover types = 100%. An estimated average of the crown heights of all plants within each particular vegetative component within each quadrat was made by using a meter stick. These data were collected from 19 July to 3 August in 1998. I estimated all habitat variables to maintain consistency among observations.

### **Data Analyses**

For analyses of nest predation and brood parasitism, nests were separated into two distance intervals from edges,  $\leq 100$  m and  $> 100$  m, based on observable trends in daily mortality and brood parasitism rates and to provide for sample sizes as nearly equivalent as possible while still characterizing potential edge effects. Although previous studies detected edge effects on natural grassland bird nests  $< 45$  m of woodland edges (Johnson and Temple 1986, 1990), there were not enough nests found within this distance interval



in my study to accurately characterize nesting success near edges for all species. For example, only 1 grasshopper sparrow nest was found <45 m of an agricultural edge and <5% of dickcissel nests on woodland edged sites were found <45 m from edges. There was also suggestion that avian predators at forested edges may only effectively survey nesting prey in non-forested habitats <100 m of edges (Paton 1994).

Daily nest survival probabilities ( $s$ ) for each species within respective distance intervals were calculated by using the method of Mayfield (1975),

$$s = 1 - (l / \Sigma d),$$

where  $l$  = the number of nest losses and  $d$  = the total number of days all nests were observed to be active, hereafter, exposure days. The daily nest mortality rate, ( $l / \Sigma d$ ) above, is an index of nest depredation; the daily nest survival rate,  $s$ , is the inverse of daily mortality and is used in the analyses below. The number of exposure days for any one nest included all days after it was found, after the onset of incubation, to the end of the nesting attempt, which was estimated to have been terminated at the midpoint between the last day the nest was observed active and the first day it was found empty. To best approximate actual nest predation, failed nests were only included in daily nest survival analyses if their fate was thought to be caused by a predation event and incubation had begun. Incubation typically begins with the penultimate or last egg laid and the daily survival estimates used did not include nests in the laying stage prior to incubation (as in Mayfield 1975). Therefore, nests that were abandoned, trampled by

cattle, or failed prior to incubation were excluded from daily nest survival analyses. Nests of the three species studied were also not included in these analyses if they contained only cowbird nestlings when found. Null hypotheses of homogeneity of daily nest survival probabilities among distance intervals from each edge type were tested for each species by using chi-square ( $\chi^2$ ) tests of the program CONTRAST (Hines and Sauer 1989, Sauer and Williams 1989). This program uses vectors of survival rate estimates, variance-covariance matrices created from standard errors of individual daily survival rates (per nest), and matrices of survival rate contrasts to calculate a  $\chi^2$  critical value.

Nests were considered to have been parasitized by cowbirds if they contained cowbird eggs or nestlings, and were only included in brood parasitism analyses if they were active long enough to have been parasitized. Cowbird hosts are typically parasitized during the egg laying stage prior to incubation (Robinson et al. 1995a), therefore, nests that failed while still in construction were not included in brood parasitism analyses. Nests of each species were separated by edge type and distance interval from edges for brood parasitism analyses, where nests were used as independent observations. Proportions of parasitized to non-parasitized nests of each species were compared among distance intervals from each edge type by using one-tailed Fisher's exact tests due to the small numbers of observations in each cell (Stokes et al. 1995).

Relative edge avoidance was tested within species among edge types and among species in relation to each edge type. Only nests  $\leq 100$  m from edges were used in these analyses since some study sites had little area beyond this distance from edges where birds could have nested. Individual nest distances to edges were used as independent

observations. Each species' mean nest distance to edge was compared among edge types by using *t*-tests. Mean nest distances to individual edge types were compared among species by using analyses of variance (ANOVA) and Duncan's multiple-range tests. Each nesting habitat variable--for which the study species are suggested to have different affinities (Chapter 1)--was compared among the 5 intervals along 100-m transects perpendicular to edges by using separate one-way ANOVA per edge type. These data were analyzed only from sites where nests of all 3 species were found. Cover percentages were not arcsin transformed for these ANOVAs since the data were considered to be binomial and fit criteria suggested by Zar (1996) to not require transformations, and significant differences had been found without data transformations in prior nest-site habitat analyses (Chapter 1). Additionally, some variables were shown to be normally distributed and were non-normal when arcsin transformed, so analytical consistency was maintained by leaving all percentage data untransformed.

## RESULTS

Eastern meadowlark, dickcissel, and grasshopper sparrow were the most common nesting species, accounting for approximately 90% of the 287 nests found during the 2 years of the study (126 dickcissel, 70 eastern meadowlark, and 62 grasshopper sparrow nests). (See Appendix II for a list of nests of all species found). Nest distances to edges were only measured for 257 out of the 258 nests of the study species due to the inability to relocate one eastern meadowlark nest. In the accompanying tables and figures, the following study species codes are used: EAME = eastern meadowlark, DICK = dickcissel, and GRSP = grasshopper sparrow.

### Nest Predation

Thirty-one nests of the study species (16 dickcissel, 7 eastern meadowlark, and 8 grasshopper sparrow nests) were excluded from analyses of daily nest survival due to abandonment, failure to enter the incubation stage, trampling by cattle, or if nests only contained cowbird nestlings. Daily nest survival rates of all study species were lower  $\leq 100$  m of both edge types as opposed to  $>100$  m, however, none of the differences were significant ( $P > 0.05$  in all cases, Table 1).

### Brood Parasitism

Four nesting attempts failed during nest construction (1 eastern meadowlark, 2 dickcissel, and 1 grasshopper sparrow nest) and were excluded from brood parasitism analyses. Total percentages of nests parasitized by cowbirds were as follows: eastern

meadowlark, 31%; dickcissel, 56%; and grasshopper sparrow, 34%. Higher proportions of nests of each study species were parasitized  $\leq 100$  m of woodland edges vs.  $> 100$  m, however, this was only statistically significant ( $P < 0.05$ ) for eastern meadowlark nests (Table 2). Differences in brood parasitism rates among the distance intervals adjacent to agricultural edges were not significant ( $P < 0.05$ ) or consistent among the study species.

### **Nest Placement**

Mean nest distances of the study species  $\leq 100$  m from both edge types are shown in Figure 1. Dickcissel nested significantly farther from woodland edges than agricultural edges ( $t = -3.7245$ , 43 df,  $P = 0.0006$ ), while eastern meadowlark and grasshopper sparrow nest distances to woodland edges were not significantly different from their nest distances to agricultural edges ( $t = -0.5158$ , 33 df,  $P = 0.610$ ; and  $t = -0.0091$ , 23 df,  $P = 0.993$ ; respectively). Dickcissel nests were not uncommon within 25 m of agricultural edges (25% of the 16 nests  $\leq 100$  m from agricultural edges) and were never found nesting within 25 m of a wooded edge. Dickcissel and grasshopper sparrow tended to nest farther from woodland edges than eastern meadowlark; however, this difference was not significant ( $F = 3.03$ ; 2, 44 df;  $P = 0.059$ ). Grasshopper sparrows nested significantly farther from agricultural edges than eastern meadowlark and dickcissel ( $F = 5.35$ ; 2, 55 df;  $P = 0.008$ ). The closest grasshopper sparrow nest to an agricultural edge was at 34 m, while the closest eastern meadowlark and dickcissel nests to agricultural edges were at 6 m and 15 m, respectively. Analyses of the 11 nest site habitat variables in relation to distance from edges revealed no significant differences

( $P > 0.05$  in all cases) among the 5 distance intervals along transects perpendicular to each edge type (Table 3). Therefore, I assumed that any relative edge avoidance detected was not the result of avoidance by a species of certain vegetative characteristics near edges.

Table 1. Daily nest survival probabilities of eastern meadowlark, dickcissel, and grasshopper sparrow in relation to nest distance from woodland and agricultural edges in eastcentral Kansas, 1997 and 1998.

Species	Woodland edges				Agricultural edges			
	≤100 m	>100 m	$\chi^2$ value*	P value	≤100 m	>100 m	$\chi^2$ value*	P value
Eastern meadowlark			0.0034	0.9537			0.2690	0.6040
Daily survival	0.9091	0.9134			0.9363	0.965		
SE	0.0537	0.0509			0.0519	0.0192		
Exposure days	77	127			251	200		
Dickcissel			1.2441	0.2647			0.5556	0.4560
Daily survival	0.8742	0.9190			0.8966	0.9437		
SE	0.0343	0.0209			0.0520	0.0359		
Exposure days	159	439			116	213		
Grasshopper sparrow			0.8604	0.3536			0.3161	0.5739
Daily survival	0.9024	0.9572			0.8699	0.9123		
SE	0.0488	0.0333			0.0643	0.0394		
Exposure days	61.5	187			61.5	114		

\* 1 df in all cases.

Table 2. Percent (%) of eastern meadowlark, dickcissel, and grasshopper sparrow nests parasitized by cowbirds in relation to nest distance from woodland and agricultural edges in eastcentral Kansas, 1997 and 1998.

Species	Woodland edges			Agricultural edges		
	≤100 m	>100 m	Fisher's <i>P</i> *	≤100 m	>100 m	Fisher's <i>P</i> *
Eastern meadowlark			0.039			0.320
% parasitized	62.5%	17.6%		37.0%	25.0%	
<i>n</i>	8	17		27	16	
Dickcissel			0.460			0.460
% parasitized	72.4%	53.4%		50.0%	42.9%	
<i>n</i>	29	58		16	21	
Grasshopper sparrow			0.454			0.674
% parasitized	55.6%	45.5%		20.0%	20.0%	
<i>n</i>	9	22		15	15	

\* 1 df in all cases.



**Table 3. Results from ANOVA of 11 preferred nest site habitat variables of eastern meadowlark, dickcissel, and grasshopper sparrow (Chapter 1) among 5 intervals of 20 m each along 100 m transects perpendicular to woodland and agricultural edges in eastcentral Kansas, 1998.**

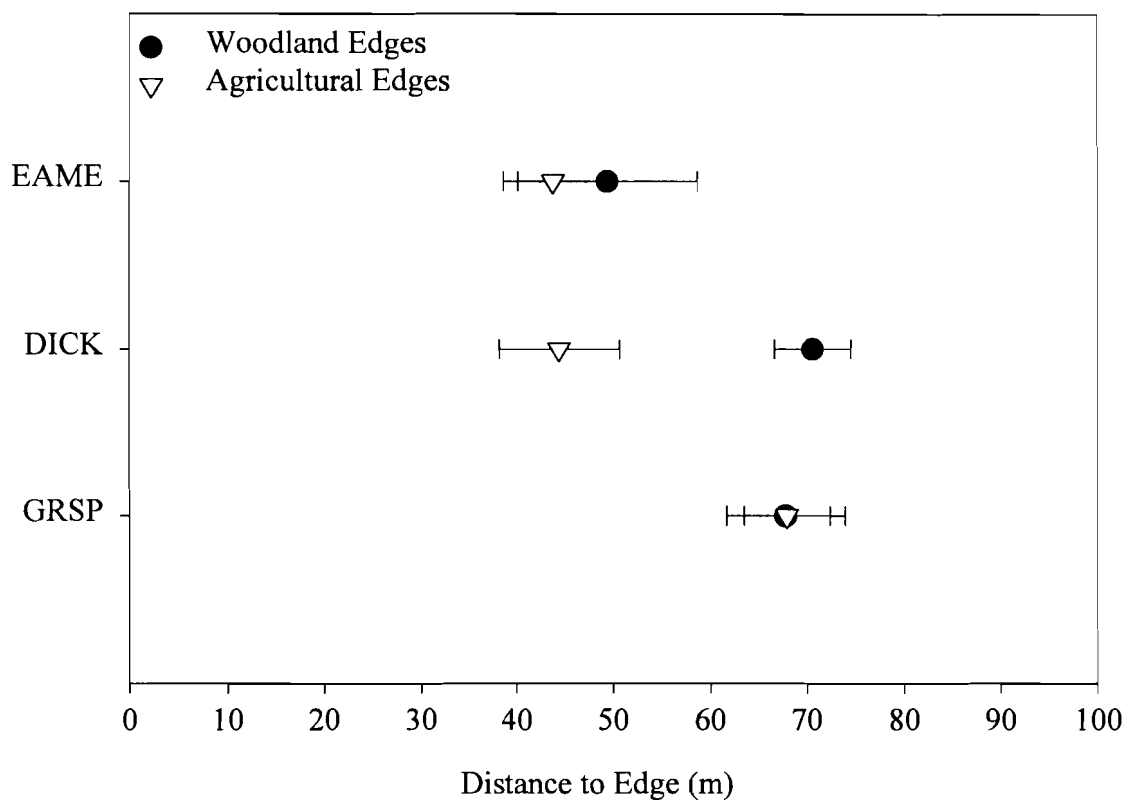
Variable <sup>a</sup>	Woodland edges		Agricultural edges	
	<i>F</i> value <sup>b</sup>	<i>P</i> value	<i>F</i> value <sup>b</sup>	<i>P</i> value
GCOV	1.19	0.3178	0.09	0.9847
GHT	0.15	0.9611	1.56	0.1874
DGCOV	0.27	0.8943	0.98	0.4182
DGHT	0.27	0.8976	0.93	0.4469
FCOV	0.92	0.4517	0.99	0.4173
FHT	1.60	0.1766	0.39	0.8183
WCOV	1.14	0.3384	NA <sup>c</sup>	NA <sup>c</sup>
WHT	1.01	0.4050	NA <sup>c</sup>	NA <sup>c</sup>
BARE	0.12	0.9754	0.75	0.5603
LIT	0.95	0.4349	0.09	0.9844
ROCK	0.67	0.6126	NA <sup>c</sup>	NA <sup>c</sup>

<sup>a</sup> Variables listed: GCOV = % grass cover, GHT = average live grass height (cm), DGCOV = % standing dead grass cover, DGHT = average standing dead grass height (cm), FCOV = % forb cover, FHT = average live forb height (cm), WCOV = % live woody cover, WHT = average live woody height (cm), BARE = % cover bare soil; LIT = % cover litter, ROCK = % cover rock.

<sup>b</sup> 4, 176 df for woodland edges; and 4, 148 df for agricultural edges.

<sup>c</sup> NA = habitat variable not present.

**Figure 1. Mean distances (m,  $\pm$  SE) to edges of eastern meadowlark, dickcissel, and grasshopper sparrow nests  $\leq 100$  m of woodland and agricultural edges in eastcentral Kansas, 1997 and 1998.**



## DISCUSSION

### Nest Predation

Although the consistency of lower daily nest survival rates  $\leq 100$  m of both edge types for all species suggested a pattern, the probability of these differences occurring by chance is quite high (see Table 1). Distance intervals from edges established to detect potential patterns in nest predation could have been narrowed to  $<45$  m of edges (as in Johnson and Temple 1986, 1990), but so few nests were found  $<45$  m of edges that those nests might not have accurately represented daily nest survival probabilities near edges. If the same number of nests found in my study were found on more, smaller, insular sites with greater densities of edge, theoretically, more nests would be located nearer edges and significant edge effects on nest predation may have been detected. However, significant edge related nest predation was not evident on my study sites, and may not be as ubiquitous as once thought. There may be an overall relaxation of woodland edge-related nest predation on grassland bird nests in this region of the tallgrass prairie. If nest predation in grassland interiors is sufficiently high, this may skew nest predation rates away from areas near woodland edges. Johnson and Temple (1990) and Winter (1998) suspected that generalist mammalian predators such as opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), and red fox (*Vulpes vulpes*) were responsible for elevated nest predation rates near wooded edges. Important nest predators in the Flint Hills may include various snake species (Zimmerman 1984) not found--or not as abundant--in northern states, such as Minnesota. In more highly fragmented prairies, such as those in Missouri, mammalian nest predators

may be more abundant--relative to snakes--near edges. Snakes may be less likely to disturb nest material when removing eggs from ground nests than medium-sized mammalian predators (Best 1978, Bergin et al. 1997), and the majority of depredated nests in my study contained no shell fragments and had nest material that was relatively undisturbed (55.3% of the 152 depredated nests). Snakes such as the racer (*Coluber constrictor*) are known to prey upon ground nesting bird eggs and nestlings (Fitch 1963, 1982; Best 1978) and were observed >200 m away from woodland edges on roughly 3 occasions during the two years of the study.

There may also be a landscape scale correlation with nesting success or variations in edge effects, as is suggested to occur in forested systems (Robinson et al. 1995b, Donovan et al. 1997, Tewksbury et al. 1998). The Flint Hills of Kansas has a far greater percentage of remnant tallgrass prairie than other highly fragmented states in the Midwest (Samson and Knopf 1994), which may partially explain why the results obtained from my study differ from those obtained in Minnesota (Johnson and Temple 1990) and Missouri (Burger et al. 1994, Winter 1998). Perhaps, as was mentioned above, grassland interior predators are more abundant in this grassland-dominated landscape than other highly fragmented regions where edge-associated predators are more abundant. This phenomena is suggested to explain conflicting results on the effects of habitat fragmentation on forest birds in western forests (Tewksbury et al. 1998).

Additionally, if any of the study species--notably dickcissel (Figure 1) and possibly grasshopper sparrow (Johnson and Temple 1986)--select nest sites far from woodland edges, this may negate any observable edge effects on nest predation. Winter

(1998) found dickcissel to not avoid nesting near woody shrub edges and experience higher nest predation as a result, in contrast to forest edges, which they did avoid. In addition to a possible relaxation of woodland edge-related nest predation in Kansas, woodland edge effects on grassland birds may not be evident in other regions of North America as well. For example, Vickery et al. (1992) found no relationship between nest distances to forest edges and nest predation rates on grassland bird nests in Maine.

### **Brood Parasitism**

All species experienced higher brood parasitism rates near woodland edges, but this was only significant for eastern meadowlark nests. Since eastern meadowlark nests were not significantly parasitized more frequently near agricultural edges than far from them, woodland edges probably had a greater impact on the brood parasitism of this species than agricultural edges. There may be an interaction between brood parasitism and nest placement: dickcissel and grasshopper sparrow tended to nest farther from woodland edges than eastern meadowlark (Figure 1) and therefore might have been affected less by cowbirds near these edges. This finding also indicates that edge effects on brood parasitism rates of some grassland birds may extend up to 100 m from woodland edges into grassland interiors.

As with nest predation near woodland edges, a pattern was suggested by brood parasitism rates being consistently higher for each study species near woodland edges, despite the lack of statistical significance for dickcissel and grasshopper sparrow nests. A lack of significant woodland edge effects on brood parasitism rates for these species

may be explained by reasons similar to those for the lack of detectable edge-related nest predation. The study by Johnson and Temple (1986, 1990), that found elevated brood parasitism rates near edges, did not include dickcissel as a study species. In eastern Kansas, dickcissel is a common acceptor of cowbird eggs and is among the most heavily parasitized grassland bird species in this region (Elliot 1978, Zimmerman 1983, my study). Dickcissel may avoid nesting near forest edges (Figure 1, Winter 1998) and their nests may be more abundant than nests of other potential hosts in or near woodland habitat. This may accentuate parasitism rates in grassland interiors rather than near woodland edges since dickcissel appears to be an important host for the cowbird. Zimmerman (1983) found that dickcissel nests were parasitized more frequently in prairie habitats relative to preferred old field habitats. In Zimmerman's study, the prairie site was located far from any woodland edges while the old field was bordered by woodlands (E. J. Finck, Emporia State University, pers commun). The findings of Winter (1998), however, do suggest an influence of woody shrub edges, which dickcissel do not seem to avoid nesting near or in (Chapter 1), on the brood parasitism of dickcissel nests. One could hypothesize a landscape scale correlation of brood parasitism of grassland birds in the Flint Hills. Grazed grasslands are used by cowbirds as foraging areas (Thompson 1994), and the majority of remnant grassland in Flint Hills is used as rangeland. Remnant grasslands and nesting cowbird hosts in the Flint Hills, e.g., dickcissel, are abundant. Therefore, these regional characteristics may negate edge effects on the brood parasitism of some grassland birds due to the abundant feeding and breeding areas for the cowbird population in this landscape (see Donovan et al. 1997).

## **Nest Placement**

The relative nest placement of eastern meadowlark appears not to be influenced by the presence of woodland or agricultural edges. Edge avoidance may not explain their grassland area sensitivity as described by Herkert (1994*a,b*). For example, in forested systems, few forest-dependent avian species may show edge avoidance and yet still be classified as being area-sensitive (Villard 1998).

There does appear to be an influence of different edge types on the relative placement of dickcissel and grasshopper sparrow nests, despite the absence of detectable effects of either edge type on their daily nest survival or brood parasitism rates.

Dickcissel appeared to nest much closer to agricultural edges than woodland edges. As discussed above, avoidance of woodland edges may have some fitness component due to predation pressure on this species near these edges. Small prairie fragments surrounded by agricultural edges may provide adequate dickcissel nesting habitat (given the presence of adequate nesting vegetation and perches, Zimmerman 1971), where small prairie fragments of similar size surrounded by woodland may not. Although consistent year-to-year grassland area-sensitivity has not been found in this species (Herkert 1994*a*, Helzer 1996), grassland habitat edge density (Helzer 1996) or edge type may have some influence on their probability of nest occurrence and should be investigated more thoroughly. There is evidence for avoidance of agricultural edges by grasshopper sparrow relative to the nest placement of eastern meadowlark and dickcissel adjacent to agricultural edges. My results are similar to those of Delisle and Savidge (1996), who found no grasshopper sparrow nests <50 m of woodland or agricultural edges and only 1



territory within this distance. Helzer (1996) also found reduced abundances of singing grasshopper sparrow males, and presumably territories (Delisle and Savidge 1996), near cornfield edges. In addition to the avoidance of agricultural edges by grasshopper sparrow relative to the other study species, their nests were not found near (<30 m) other structures such as roads and fences, near which eastern meadowlark and dickcissel nests had been found (pers. observ.). Evidence for edge avoidance by grasshopper sparrow from the among-species relative nest placement analyses (Figure 1), and studies elsewhere (Johnson and Temple 1986, Delisle and Savidge 1996), presents a consistent pattern. Avoidance of agricultural and other edges by grasshopper sparrow may explain the grassland area sensitivity relationships found for this species in agricultural landscapes (Herkert 1994*a,b*; Helzer 1996). Small grassland patches <100 m wide may support nesting by eastern meadowlark and dickcissel, but not grasshopper sparrow.

## **Conclusion**

There was not a marked influence of habitat edges on factors potentially influencing the reproductive success of the grassland bird species I studied. Nest predation rates were not significantly influenced by nest distances to woodland or agricultural edges, but they were consistently lower  $\leq 100$  m from both edge types among the nests of all study species. However, there appeared to be an influence of woodland and agricultural edges on where the nests of certain species are placed, most notably dickcissel and grasshopper sparrow. There also appeared to be an edge effect on the brood parasitism of eastern meadowlark  $\leq 100$  m of woodland edges, but not adjacent to

agricultural edges. Brood parasitism of the other two study species was not influenced by either edge type. Limitations of geographic area and sample size in my study may have prevented the detection of significant edge effects that may be evident in more highly fragmented grasslands. Certain habitat edges may only impose important pressures on grassland bird reproductive success on grassland fragments too small to even provide adequate breeding territories for many grassland birds in the middle latitudes of the United States (see Herkert 1994a).

Providing finer classifications of certain edge types may also help explain the variation in results on edge effects obtained among multiple studies (Paton 1994). For example, definitions of what constitutes a wooded edge of grassland bird habitat range from woody shrub patches to tracts of deciduous forest, which may differ in their influences on grassland birds (Winter 1998). Dickcissel have been reported to be more tolerant of woody shrub edges when selecting nest sites and experience significantly lower nest survival rates near these edges in fragmented Missouri tallgrass prairie (Winter 1998). My study used wooded edges that could be classified more specifically as forest edges. Further research is needed on the responses of grassland birds, and their predators and parasites, to the vast array of habitat edge types in the fragmented grasslands of the Midwest and Great Plains.

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**APPENDIX I. Legal descriptions of study sites.**

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**1997 (6 sites)**Coffey Co., KS

W ½, Sec. 31, T19S, R14E.

NE ¼, NW ¼, Sec. 6, T20S, R14E.

NW ¼, NE ¼, Sec. 32, T20S, R14E.

SW ¼, Sec. 32, T20S, R14E.

Greenwood Co., KS

SE ¼, Sec. 28, T22S, R10E.

SE ¼, SE ¼, Sec. 20, T22S, R10E.

**1998 (6 sites)**Coffey Co., KS

SW ¼, Sec. 31, T19S, R14E.

E ½, SW ¼, Sec. 20, T19S, R14E.

Greenwood Co., KS

SE ¼, Sec. 28, T22S, R10E.

SE ¼, Sec. 15, T22S, R10E.

Lyon Co., KS

SE ¼, SE ¼, Sec. 34, T17S, R12E.

SW ¼, SE ¼, Sec. 27, T17S, R12E.

---

**APPENDIX II.** Number of nests of all species found for which data have been recorded.

Common name	Scientific name	Number of nests found
Greater prairie-chicken	( <i>Tympanuchus cupido</i> )	3
Northern bobwhite	( <i>Colinus virginianus</i> )	1
Upland sandpiper	( <i>Bartramia longicauda</i> )	12
Mourning dove	( <i>Zenaida macroura</i> )	4
Common nighthawk	( <i>Chordeiles minor</i> )	3
Field sparrow	( <i>Spizella pusilla</i> )	1
Lark sparrow	( <i>Chondestes grammacus</i> )	2
Grasshopper sparrow	( <i>Ammodramus savannarum</i> )	62
Henslow's sparrow	( <i>Ammodramus henslowii</i> )	2
Dickcissel	( <i>Spiza americana</i> )	126
Red-winged blackbird	( <i>Agelaius phoeniceus</i> )	1
Eastern meadowlark	( <i>Sturnella magna</i> )	70

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Date

Nesting habitat and responses to habitat edges of three grassland passerine species  
Title of Thesis

*Doug Cooper*

Signature of Graduate Office Staff

*May 6, 1999*

Date Received