

AN ABSTRACT FOR THE THESIS OF

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Abstract approved: Elmer J. Finck

Grassland birds have declined faster than any other avian guild in North America during recent decades. The decline has been attributed to increased fragmentation of the grassland biome by anthropocentric activities. The area near the edge has been shown to have a lower nesting success for grassland birds in the most heavily fragmented areas. However, a study conducted in east-central Kansas and in other less fragmented areas have not shown a clear edge effect. Edge effects occur when predators use the ecotonal boundaries as travel lanes and are more successful at finding avian nests. Geographic variability in predator occurrence and abundance seems to have a large effect on the presence/absence of an edge effect. I used artificial nests to determine nest success and predator type along a distance gradient extending perpendicular to the habitat edge. Additionally, I used various monitoring techniques to identify characteristics of habitat used by potential predators within prairie fragments of east-central Kansas. I did not find an edge effect for artificial nests in my study. Small mammals belonging to the genus *Peromyscus* were the most common predator of artificial nests and the deer mouse (*P. maniculatus*) was the most common potential predator caught in the prairie fragments. Additionally, *Peromyscus* depredated nests and deer mouse was caught equally across the

entire distance from the habitat edge. The cotton rat (*Sigmodon hispidus*) did show an affinity for the habitat edge in occurrence and when depredated artificial nests. Other predators of artificial nests in my study were Elliot's short-tailed shrew (*Blarina hylophaga*), prairie vole (*Microtus ochrogaster*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and birds. Further research should focus on identifying what the egg shape limitations are for small predators of grassland birds. Additionally, more research should be conducted on the effects of haying on grassland birds and their predator community.

PREDATORS OF ARTIFICIAL NESTS IN GRASSLANDS
OF EAST-CENTRAL KANSAS

A Thesis

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by

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PREFACE

Only recently have grassland studies began showing up in great numbers in scientific journals. Forested ecosystem studies overshadowed grasslands even though grassland decline was much greater throughout North America. The decline of grasslands has created a problem for grassland specific avifauna. Many grassland birds have had dramatic population declines and some are on the verge of extinction. I strived to increase the awareness of our knowledge of grassland ecosystems and was able to do this in an area that still has much of its grasslands remaining. The grasslands of east-central Kansas are a critical asset for researchers to gain knowledge of grassland ecosystems. All chapters are written in the format suitable for submission to the journal *American Midland Naturalist*.

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CHAPTER 1

INTRODUCTION

Anthropocentric activities have dominated much of the landscape since European settlement of North America (Knopf, 1994; Samson and Knopf, 1994). Agriculture, urbanization, and fire suppression have altered a large portion of the grassland biome in the Great Plains of the central United States (Knopf, 1992; Herkert, 1994a, 1994b). As a result, grassland fauna and flora throughout the Great Plains have declined (Knopf, 1992). Wilcox and Murphy (1985) suggested habitat fragmentation is the biggest threat to biological diversity and is the primary cause of many current extinctions. Many studies have been conducted on effects of fragmentation on avifauna in the forests of the eastern United States. However, in comparison, few studies have been conducted looking at effects of fragmentation on grassland bird communities, even though grassland decline is greater than that of eastern deciduous forest (Herkert, 1994b).

The tallgrass prairie of the midwestern United States has seen the greatest portion of destruction among all types of habitats in North America. Samson and Knopf (1994) reported the loss of prairie ranged from 82 - 99% of the tallgrass prairie region. Illinois, for example, has seen more than a 99% loss in the amount of native grassland since the arrival of European settlers (Iverson, 1988). Consequently, grassland avifauna of the midwestern United States has been reduced (Samson, 1980; Johnson and Temple, 1990; Herkert, 1994b). Grassland-dependent bird species have declined faster than any other avian guild in North America (Herkert, 1994b). Knopf (1994) reported population

decreases of grassland avifauna ranging from 17-91%. Grasshopper sparrow (*Ammodramus savannarum*) and Henslow's sparrow (*A. henslowii*) have declined 69% and 68%, respectively, in the past 25 years. Eastern meadowlark (*Sturnella magna*) has had a 43% decline and dickcissel (*Spiza americana*) has seen a 35% decline over the same time period (Herkert, 1994b) The major cause of these declines has been attributed to habitat fragmentation caused by agriculture, human development, and woody invasion (Johnson and Temple, 1986, 1990; Burger *et al.*, 1994; Herkert, 1994a, 1994b; Vickery *et al.*, 1994).

Habitat fragmentation increases ecotonal boundaries in an area by dividing pre-existing habitat into smaller subsequent habitats (Bayne and Hobson, 1997). Fragmentation also decreases the area of individual grassland tracts, thus, decreasing available habitat to grassland specific avifauna (Vickery *et al.*, 1994). Habitat edges formed by fragmentation, create travel corridors that concentrate predators and increase the probability of the predators finding ground nests (Wilcove, 1985). The presence of an edge effect (reduced nest success close to the habitat edge) has been well documented in forested areas of the United States (see Paton, 1994). Grassland avifauna of the midwest and Great Plains have exhibited an edge effect in areas of high habitat fragmentation (Johnson and Temple, 1986, 1990, Burger *et al.*, 1994; Herkert, 1994a, 1994b; Helzer, 1996). However, lowered nest success along the edges of habitats has not been recognized clearly in all regions of the tallgrass prairie (Jensen, 1999). Therefore, my objectives were to further identify how habitat edges affect the dynamics of grassland bird populations in east-central Kansas. In addition, I was

interested in how habitat edges affect the distribution of potential predators in the grasslands of east-central Kansas.

LITERATURE CITED

- Bayne, E. M. and K. A. Hobson. 1997. Comparing the effects of landscape fragmentation by forestry and agriculture on predation of artificial nests. *Conserv. Biol.*, **11**:1418-1429.
- Burger, L. D., L. W. Burger and J. Faaborg. 1994. Effects of prairie fragmentation on predation on artificial nests. *J. Wildl. Manage.*, **58**:249-254.
- Helzer, C. J. 1996. The effects of wet meadow fragmentation on grassland birds. M.S. Thesis, University of Nebraska, Lincoln, Nebraska, 65 p.
- Herkert, J. R. 1994a. Breeding bird communities of Midwestern prairie fragments: the effects of prescribed burning and habitat-area. *Nat. Areas J.*, **14**:128-135.
- _____ 1994b. The effects of habitat fragmentation on Midwestern grassland bird communities. *Ecol. Appl.*, **4**:461-471.
- Iverson, L. R. 1988. Land-use changes in Illinois, USA: The influence of landscape attributes on current and historic land use. *Lands. Ecol.*, **2**:46-61.
- Jensen, W. E. 1999. Nesting habitat and responses to habitat edges of three grassland passerine species. M.S. Thesis, Emporia State University, Emporia, Kansas. 58 p.
- Johnson, R. G. and S. A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies. Pages 245-249 in J. Verner, M. L. Morrison, and C. J. Ralph, editors. *Wildlife 2000: modeling habitat*

relationships of terrestrial vertebrates. University of Wisconsin Press, Madison, Wisconsin, 470 p.

- _____ 1990. Nest predation and brood parasitism of tallgrass prairie birds. *J. Wildl. Manage.*, **54**:106-111.
- Knopf, F. L. 1992. Faunal mixing, faunal integrity, and the biopolitical template for diversity conservation. *Trans. North Am. Wildl. Nat. Res. Conf.*, **57**:330-342.
- Knopf, F. L. 1994. Avian assemblages on altered grasslands. *Stud. Avian Biol.*, **15**:247-257.
- Paton, P. W. C. 1994. The effect of edge on avian nest success: how strong is the evidence? *Conserv. Biol.*, **8**:17-26.
- Samson, F. B. 1980. Island biogeography and the conservation of prairie birds. Pages 293-305 in C. L. Kucera, ed. Proc. Seventh North American Prairie Conf. Springfield, Missouri.
- Samson, F. and F. Knopf. 1994. Prairie conservation in North America. *BioScience*, **44**:418-421.
- Vickery, P. D., M. L. Hunter Jr. and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. *Conserv. Biol.*, **8**:1087-1097.
- Wilcove, D. S. 1985. Nest predation in forest tracts and the decline of migratory songbirds. *Ecology*, **66**:1211-1214.
- Wilcox, B. A. and D. D. Murphy. 1985. Conservation strategy: The effects of fragmentation on extinction. *Am. Nat.*, **125**:879-887.

CHAPTER II

PREDATORS OF ARTIFICIAL NESTS IN GRASSLANDS OF EAST-CENTRAL KANSAS

Abstract.--Avian species nesting close to the habitat edge have been shown to have a lowered reproductive success compared to those nesting in the interior of the habitat fragment. Habitat edges create travel corridors for predators of grassland birds, which lead to a lowered nest success within the corridor. Several grassland bird studies have found lowered survival rates for nests close to a wooded edge; however, these studies were in areas of high habitat fragmentation. Avoidance of habitat edges by grassland birds has been demonstrated in areas of low habitat fragmentation. It has been suggested that edge avoidance is a response to a lowered survival rate of nests close to the habitat edge. My objectives were to identify if artificial nests experience a lowered survival rate close to the habitat edge compared to the interior of the grassland in a region that has shown edge avoidance by grassland birds. I also wanted to identify the major predators of grassland bird eggs in east-central Kansas and how they influence survival of grassland bird nests in relation to the habitat edge. Clay eggs and house sparrow (*Passer domesticus*) eggs were placed in artificial nests and tooth imprints from the clay eggs were used to identify predators. Fifty-nine percent of artificial nests were depredated in my study. Of all depredation events, 84.6% were by small mammals. *Peromyscus* sp. (hereafter *Peromyscus*) was the most common predator of artificial nests. Other predators included small mammals, birds, raccoon (*Procyon lotor*), and

striped skunk (*Mephitis mephitis*). In addition, I did not find an edge effect for artificial nests. Of all depredation events by *Peromyscus*, only 17% had both the clay and sparrow egg depredated. All other times only the clay egg was depredated. Other studies have reported that egg size has a large influence on depredation rates. Possibly house sparrow eggs are too large to all but the largest individuals of *Peromyscus* and the predation rate was elevated because of ease of manipulation the soft clay egg.

INTRODUCTION

Avian species sensitive to ecotonal boundaries especially are threatened in areas of high fragmentation (Johnson and Temple, 1990). Areas of suitable nesting habitat are lost when remnant habitats become heavily fragmented (Winter, 1998). Therefore, avian species could be forced to nest in areas that are of a lesser quality, leading to a lowered reproductive success (Fretwell and Lucas, 1969; Gates and Gysel, 1978; Winter *et al.*, 2000).

Avian responses to habitat edges are highly variable across species and geographic locations. Recent studies have shown that some grassland passerines avoid the edge of two distinct habitats (Johnson and Temple, 1990; Warner, 1994; Winter, 1998; Jensen, 1999). Jensen (1999) reported dickcissel (*Spiza americana*) and grasshopper sparrow (*Ammodramus savannarum*) avoided nesting near habitat edge (<5% were located <45 m from any edge type). Johnson and Temple (1990) found only four grasshopper sparrow nests <45 m from the edge compared to 42 nests that were >45 m from the edge. Winter *et al.* (2000) found Henslow's sparrow (*A. henslowii*) to actively avoid edges of habitat in Missouri.

The reason for edge avoidance behavior is not clear. Winter (1998) suggested that edge avoidance could be an adaptation for predator avoidance along the edge of a prairie fragment. In regions of high habitat fragmentation and small prairie fragments, grassland birds might be forced to nest near the habitat edge where survival rates for nest are lower (Fretwell and Lucas, 1969).

Regions that provide sufficient habitat to allow grassland birds to select nesting

areas where survival rates of nests are high, could explain the reason for edge avoidance. I tested to see if artificial nests experienced a higher depredation rate close to the habitat edge compared to nests in the interior of the grassland. My work was done in a region that has shown edge avoidance by grassland birds (Jensen, 1998).

The Osage Cuestas region in east-central Kansas includes fragmented areas of the tallgrass prairie, but is associated with the largest remnant of tallgrass prairie in the United States (Sampson and Knopf, 1994). Studies that have shown edge effects in grassland birds have been in regions of the tallgrass prairie that are heavily fragmented and very few large remnants of grassland remain (see Gates and Gysel, 1978; Johnson and Temple, 1986, 1990; Vickery *et al.*, 1994; Burger *et al.*, 1994; Herkert, 1994a, 1994b; Helzer, 1996; Winter, 1998; Winter *et al.*, 2000).

I used artificial nests to assess how habitat edges affect nest success and nest placement for grassland nesting birds. Artificial nest allow the researcher to select the placement of nests and reduce complications associated with edge avoidance. If grassland birds are avoiding the habitat edges due to an increased rate of depredation, than a lowered survival rate of nests near the habitat edge should be seen. Identification of specific predator types is also important when making management implications. I attempted to identify predators of artificial nests so that general suggestions on the management of the true predator assemblage could be made.

MATERIALS AND METHODS

Twelve prairie fragments were selected in Lyon and Osage counties in east-central Kansas during the 2001 and 2002 nesting season. For study site locations, see Appendix A. All study sites had haying as the primary management regime. All sites were hayed after July 4th in both years. Some sites were burned in the early spring before I conducted my research. The dominant plant species on each of the sites were big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), milkweeds (*Asclepias* spp.), purple prairie clover (*Dalea purpurea*), and spiderworts (*Tradescantia* spp.). All study sites had at least one wooded edge, which was made up of various species of mature trees forming a sharp boundary between the grassland fragment and woody vegetation. The most common tree species in the wooded edges included Osage orange (*Maclura pomifera*), honey locust (*Gleditsia triacanthos*), and white mulberry (*Morus alba*). The edge spanned the entire distance of the field boundary or was connected to a larger, more dense cluster of mature woody vegetation adjacent to the prairie fragment. Two trials were conducted in each of the two years. Six of the 12 study sites were designated as nest transect sites and the other sites were designated as predator monitoring sites (see Chapter III) for each trial. After the first trial was completed the nest transect sites were rotated and became predator monitoring sites and vice versa.

Artificial nests were placed in transects extending perpendicular from the wooded edge. The nests were placed at intervals of 5, 10, 20, 40, 80, and greater than 100 m. All of the study sites were large enough to allow for a 100 m

transect to be placed in the prairie fragment and not have the opposite or adjacent edge closer than the edge being studied. Nest material for the artificial nests were natural cup nests collected the previous fall from shrubs and trees in the vicinity of the study sites. Before being placed in the transects, nests were left outside for one week to reduce unnatural scent acquired from the storage area.

In 2001, I placed two house sparrow (*Passer domesticus*) eggs (hereafter sparrow eggs) and one clay egg in each nest. In 2002, because of a shortage of sparrow eggs, I put one sparrow egg along with one clay egg in each nest. The clay egg was made with Sculpie brand modeling compound (Polyform Products, Incorporated, Shiller Park, Illinois) and resembled the sparrow egg in size and shape. The clay egg stayed formable for the duration of the trial and marks made by predators were easily recognizable throughout the study. Nour *et al.* (1993) suggested that clay eggs alone in artificial nests might not offer the reward required for a predator to depredate the nest. Therefore, sparrow eggs were used in addition to the clay eggs. Sparrow eggs were collected within two weeks of the beginning of the trial and were refrigerated until used. Latex gloves were worn when setting out nests.

Motion sensitive cameras (TM1500 Trailmaster Camera Goodson and Assoc., Inc., Lenexa, Kansas) were positioned over one artificial nest in each transect in 2001. Assignment of nest was stratified randomly so that all distances had a camera within the six study sites in each trial. Cameras were positioned so that a predator depredating the nest would break an infrared beam,

thus, triggering the camera. Due to inconsistencies in depredation rates of camera monitored nests and lack of ability to successfully photograph predators, the Trailmaster cameras were not used on artificial nests in 2002.

Quail training scent (Buck Stop Lure Company, Inc., Stanton, Michigan) was sprayed onto the nest and contents when placing all nests. Nests were checked every three to four days until the end of the trial. Trial 1 in 2001 was for a duration of 12 days. However, by the end of the trial, the sparrow eggs were rotting and emitting a strong odor. Therefore, all other trials were set out for seven days. The typical incubation for grassland nesting birds is 10 – 14 days. However, the strong odor of rotting eggs likely would attract animals that would typically not depredate eggs or would deter other predators that normally would eat fresh eggs. A shortage of sparrow eggs prevented replacing fresh eggs with the rotting eggs. Nests were considered depredated if the sparrow or clay egg was missing or damaged. If the nest was depredated all contents were removed. If the nest was not depredated when checked, nests were re-sprayed with quail scent. Tooth or bill marks were identified in the clay eggs by comparing museum skull specimens. Reference eggs were made with the skulls of all potential predators and these were used for comparison.

After completing each trial, I estimated canopy coverage with a Robel pole (Robel et al., 1970). I also characterized vegetation composition with a 75 x 75 cm Daubenmire frame (Daubenmire, 1959). I took three estimates of the canopy coverage and vegetation composition, one centered over the nest, and two <1 m from the nest in two random directions. Vegetation composition consisted of

estimating the percent forbs, grass, litter, and bare ground in each Daubenmire frame. Logistic regression was used to determine if distance to edge, Robel pole readings, and a combination of vegetation variables covaried with the survival of an individual nest.

Vegetation variables collected in the Daubenmire frame analysis were combined into independent linear combinations with Principal Component Analysis (James, 1971). Kruskal-Wallis non-parametric ANOVA was used to test for a difference in daily survival rates (DSR) (Mayfield, 1961, 1975) as a function of distance. Two-way ANOVA was used to test an interaction effect between trials. Two-way ANOVA did not find any interaction among the four trials. Days 8-12 of trial 1, 2001, were removed from analyses so all trials could be pooled.

RESULTS

Of 132 artificial nests analyzed, 64 (49%, $P(20\% \leq p \leq 57\%) = 0.95$, daily survival rate = 0.914) were depredated. Of all depredation events, 80%, $P(71\% \leq p \leq 89\%) = 0.95$, were from small mammals. *Peromyscus* sp. (hereafter *Peromyscus*) was the most common predator (Fig. 2.1). Additionally, *Peromyscus* depredated eggs across all distances and showed no preference for the edge or interior of the habitat fragment ($\chi^2 = 2.11$, $P = 0.834$). Other predators identified from clay eggs were hispid cotton rat (*Sigmodon hispidus*), prairie vole (*Microtus ochrogaster*), Elliot's short-tailed shrew (*Blarina hylophaga*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and unidentified birds (Table 2.1, Fig. 2.1).

Logistic regression did not indicate distance from edge or any of the vegetation variables as having an effect on nest survival (Table 2.2). In addition, I did not find a significant difference in daily survival rates for nest distances along a gradient extending from the habitat edge ($\chi^2 = 2.157$, $P = 0.827$).

The clay and sparrow eggs were not depredated with the same frequency within artificial nests (Fig. 2.3). The clay egg alone was depredated more often ($n = 50$) than in instances where both the clay and sparrow egg were depredated ($n = 12$). Small mammals and birds tended to depredate the clay egg only, more often than depredating both the clay and sparrow egg.

Table 2.1. Number of depredation events on artificial nests in 2001 and 2002 at different distances (5, 10, 20, 40, 80, >100 m) from the habitat edge in grasslands of east-central Kansas.

Predator*	distance from habitat edge					
	5	10	20	40	80	>100
<i>Peromyscus</i>	3	3	6	4	5	6
Cotton rat	1	2	2	-	-	-
Prairie vole	1	1	-	-	1	-
Shrew	1	1	1	-	-	1
Small mammal	2	2	2	1	3	2
Raccoon	1	1	-	-	-	1
Skunk	-	-	1	-	-	1
Bird	-	-	1	1	3	1
Unidentified	1	1	-	-	-	-
Total	10	11	13	6	12	12

*Predators were included in the smallest group determined from tooth and bill markings.

Table 2.2 Output for logistic regression of distance and vegetation variables measured at artificial nests in east-central Kansas.

Variable	S.E.	Wald- χ^2	P- value
Distance	0.005	1.154	0.283
Daubenmire frame	0.188	1.080	0.299
Robel pole	0.034	0.332	0.564

Table 2.3. Depredation events by predators egg types in artificial nests in east-central Kansas.

Predator	Depredation Events			Total
	Both clay & Sparrow	Clay only	Sparrow only	
<i>Peromyscus</i>	4	23	0	27
Cotton rat	1	4	0	5
Prairie vole	0	3	0	3
Elliot's Short-tailed Shrew	1	3	0	4
Unidentified small mammal	1	11	0	12
Raccoon	3	0	0	3
Skunk	2	0	0	2
Bird	0	6	0	6
Unidentified	0	0	2	2
Total	12	50	2	64

Fig. 2.1. Predators determined from clay eggs in artificial nests in east-central Kansas for years 2001 and 2002. PER = *Peromyscus*, COT = hispid cotton rat (*Sigmodon hispidus*), VOLE = prairie vole (*Microtus ochrogaster*), SHREW = Elliot's short-tailed shrew (*Blarina hylophoga*), SM MAM = unidentified small mammal, RAC = raccoon (*Procyon lotor*), SKU = skunk, BIRD = unidentified bird, UNID = unidentified predator.

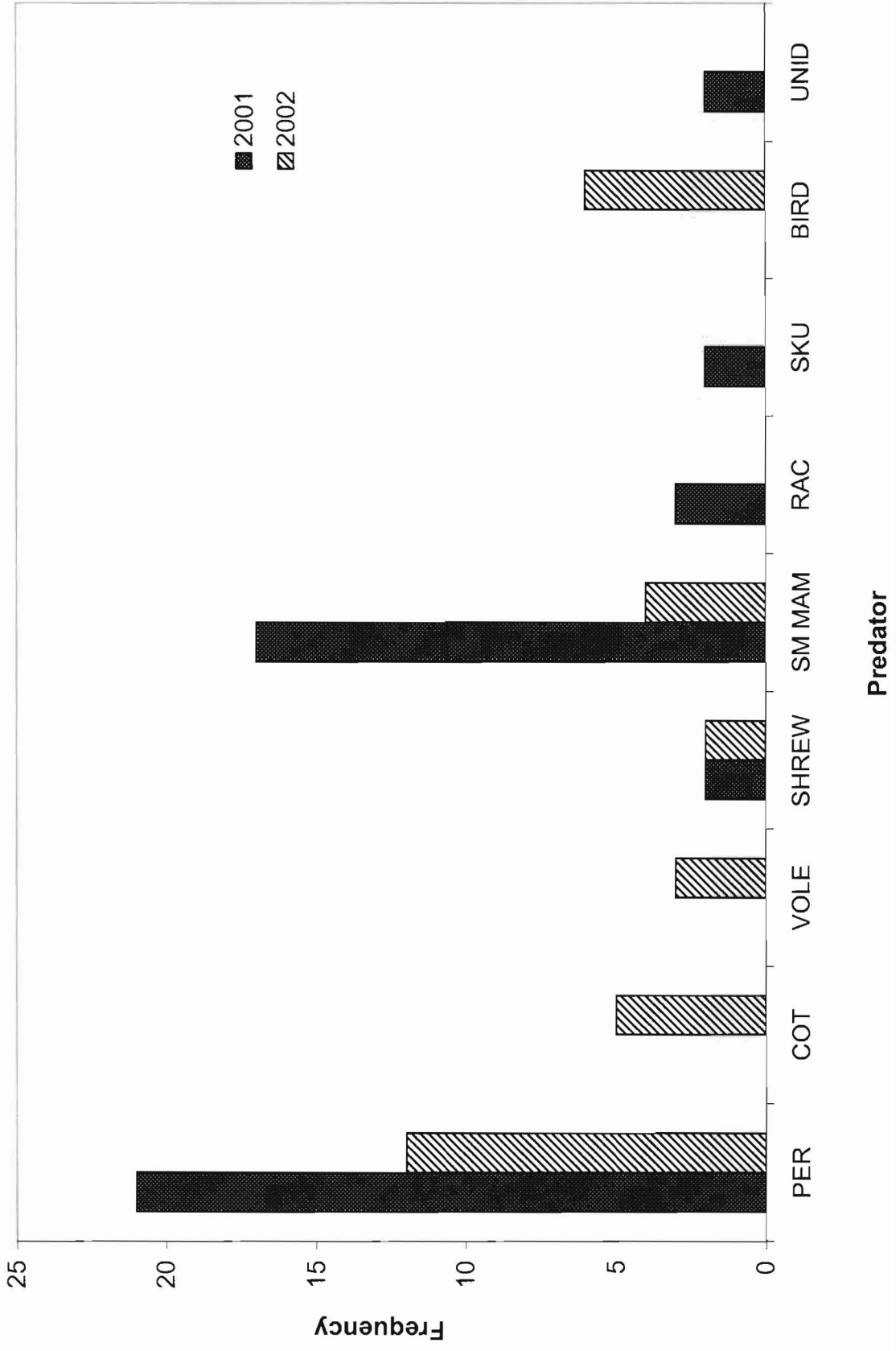
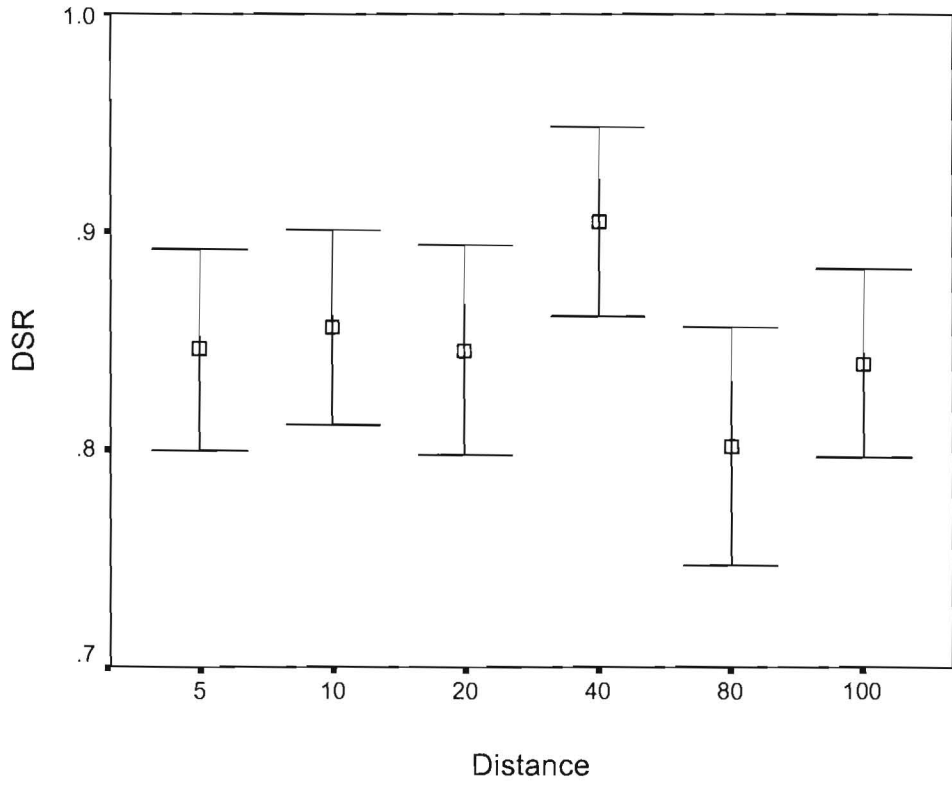


Fig. 2.2. Mean (\pm SE) daily survival rates (DSR) for all distances of artificial nests from woodland edges in east-central Kansas.



DISCUSSION

I did not find an edge effect in my study, supporting Jensen's (1999) findings for east-central Kansas. Predators that have caused edge effects in other studies were found to only depredate a few nests (*i.e.*, raccoon and striped skunk) or none at all (*i.e.*, opossum [*Didelphis virginiana*]). *Peromyscus* was a major predator of artificial nests in grasslands of east-central Kansas. Additionally, *Peromyscus* appeared to depredate nests at all distances from the habitat edge ruling out the possibility of an edge effect. Small mammal depredation was higher (84.6% of total depredation) in my study than most other studies examining grassland bird predators. Small mammals were the most common predator in Winter's (1998) artificial nest study, however, they only amounted to 44% of the total depredation. Ettel (1998) reported a range of 30-54% depredation rate by rodents in grasslands of Tennessee. He attributed rodent predation to the two most common rodents in the area, the white-footed mouse (*Peromyscus leucopus*) and hispid cotton rat. A study in North Dakota found thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) (26%, n = 8) and Franklin's ground squirrel (*S. franklinii*) (17%, n = 5) to be the two most common predators (Pietz and Granfors, 2000).

How small mammal depredation on artificial nests in east-central Kansas relates to actual depredation of natural grassland bird nests is difficult to ascertain. Of all nests considered depredated by *Peromyscus* in my study, only 17% of them had both the clay and sparrow egg depredated. Additionally, other small mammal predators showed a tendency to depredate the clay egg more

often than depredation of both clay and sparrow eggs as in my study (Table 2.3). Maier and Degraaf (2000) found similar results where 73% of all depredation of artificial nests that were baited with clay and sparrow eggs, had only the clay egg depredated. Maier and Degraaf (2000) demonstrated that white-footed mice did not depredate sparrow eggs in the wild, even though preliminary tests revealed captive wild-caught mice were able to fracture the eggshell and consume the contents. In addition, Rangen *et al.* (2000) found that deer mice (*Peromyscus maniculatus*) scored plasticine eggs more frequently than zebra finch (*Taeniopygia guttata*) eggs.

Degraaf and Maier (1996) showed that the white-footed mouse was unable to depredate Japanese quail (*Coturnix japonica*) eggs. However, it readily depredated smaller zebra finch eggs. Degraaf and Maier (1996) reported Japanese quail eggs averaged 33 x 23 mm and zebra finch eggs were 15 x 10 mm. In Kansas, the white-footed mouse is slightly larger than the prairie inhabiting deer mouse (Choate *et al.*, 1979). Thus, limitations for depredation of eggs by size are likely similar between these two species.

Egg shape could have a role in small mammal depredation of bird eggs (Degraaf and Maier, 1996). Maxson and Oring (1978) documented deer mice depredating eggs of spotted sandpipers (*Actitis macularia*) on a small island in Minnesota. Eggs of spotted sandpipers are 32 X 23 mm and are oval to pyriform in shape (Harrison, 1979). The pyriform egg shape could make it easier for a predator to puncture the egg because of the smaller circumference on one end of the egg. Sparrow eggs average 23 x 16 mm and are oval in shape (Harrison,

1979; Baicich and Harrison, 1997). However, the shapes of the sparrow eggs I used in my study tended to be highly variable. I did not differentiate egg shapes when placing eggs in the artificial nests, though, it is possible the sparrow eggs that were depredated by *Peromyscus* were eggs that were a shape that enabled *Peromyscus* to score the egg. Sparrow eggs are similar in size to dickcissel eggs (21 x 16 mm, oval [Harrison, 1979; Baicich and Harrison, 1997]); however, variability of shape in dickcissel eggs has not been studied. Grasshopper sparrow and Henslow's sparrow eggs are relatively smaller than dickcissel with egg sizes of 19 x 14 mm (oval) and 18 x 14 mm (oval), respectively, (Harrison, 1979; Baicich and Harrison, 1997) and could be susceptible to high rates of depredation by *Peromyscus*.

I expected predation by meso-mammals to be higher than what I found in my results. I also expected all predation by meso-mammals to be stratified as the distance from the habitat edge increases, with more depredation closer to the edge. Striped skunk and raccoon depredated artificial nests on two and three occasions, respectively. For both striped skunk and raccoon, a depredation event occurred at >100 m from the habitat edge. These two depredation events occurred in two separate prairie fragments, however, they had similar characteristics. Both sites had small ponds at opposite sides of the habitat fragment. Therefore, the striped skunk and raccoon likely were traveling across the center of the fragment toward the pond and came across the artificial nest.

Studies demonstrating edge effects in grassland fragments have attributed the cause to meso-mammals depredating large numbers of nests close to the habitat edge. However, in my study I only had five predation events by meso-mammals. In the Osage Cuestas and Flint Hills region of Kansas, most of the woody vegetation that is present is located in thin linear strips, which dissect existing fields of grassland and cropland. Dijak and Thompson (2000) found that raccoons were associated more with woodland/agriculture ecotones than any other edge type in Missouri. In addition, Lariviere and Messier (2002) found striped skunks to avoid large tracts of nesting cover where "attraction points" (*i.e.*, buildings, wetlands) were absent. Attraction points were found to congregate prey items and provide maternal den sites for striped skunks. Dijak and Thompson (2000) found opossum (*Didelphis virginiana*) to avoid homogenous habitats and were found more in areas with large patches of forest and high amounts of riparian habitat. The majority of my study sites were in areas devoid of agricultural edges, wetlands, buildings, and large expanses of forested habitats. Therefore, meso-mammal depredation on artificial nests might be limited in my study.

Trial 1 was set out for a period that resembles natural incubation periods for grassland passerines. However, due to problems with rotting of the sparrow egg before the termination of the trial, subsequent trials still were shortened to seven days. A shortened trial could have underestimated some predators that would have depredated nests in the latter portion of a 12 day trial. However, predation rates were still high for a shortened trial and I am confident by having

four trials, I sampled the entire suite of potential predators of artificial nests in grasslands of east-central Kansas. Other artificial nest studies using live eggs should take caution to not allow eggs to rot during the duration of the trial. Fresh eggs should replace old eggs whenever rotting is suspected.

Studies of predation rates on artificial and natural nests in grasslands of North America found artificial nests to underestimate the actual predation rates of natural nests (Hughes, 1996; Davison and Bollinger, 2000). High survivorship of artificial nests has been attributed to known predators of natural nests not depredating artificial nests (Davison and Bollinger, 2000). Some argue artificial nests do not have the appropriate cues to represent accurate depredation rates (Moller, 1987; Storaas, 1988; Willebrand and Marcstrom, 1988; Gotmark, 1992; Hoi and Winkler, 1994; Whelan *et al.*, 1994; Major and Kendall, 1996; Bayne *et al.*, 1997; Marini and Melo, 1998). By adding scent to the artificial nest, I attempted to alleviate this bias in my experiment. Daily survival rates were similar to that of dickcissel in Jensen's (1999) study. The addition of quail scent to my artificial nests might be adding the appropriate cues for a more "realistic" artificial nest. However, more research needs to be done on the consequences of applying scent to artificial nests before recommendations can be made.

Several studies have found snakes to be predators of grassland nesting birds (Fitch, 1963; Best, 1978; Thompson *et al.*, 1999; Davison and Bollinger, 2000). However, no clear evidence has been found that snakes will depredate artificial nests (Marini and Melo, 1998). Burghardt (1967) demonstrated the need for both visual and chemical cues present before snakes will take a prey item.

Artificial nests that do not have visual and olfactory cues of natural nests might underestimate predation by snakes. I was not able to document snakes depredating artificial nests, however, in two instances eggs disappeared without any sign left at the nest. In many studies, disappearance of eggs would be labeled as snake depredation, but a growing number of studies using video cameras have demonstrated numerous different predators removing eggs without disturbance of the nest (Major, 1991; Brown *et al.*, 1998; Marini and Melo, 1998; Pietz and Granfors, 2000). Therefore, I do not know if adding scent to the artificial nests in my study was able to entice snakes into depredating artificial nests.

I recorded six depredation events by avian predators. Identification of the avian predators from the bill marks left in the clay egg was difficult. In all cases the sparrow egg was not damaged. Bill marks in the clay egg were too small to be left by nest predators frequently found in other nest predation studies (*i.e.*, blue jay [*Cyanocitta cristata*] and American crow [*Corvus brachyrhynchos*]). Picman and Schriml (1994) documented eastern meadowlark (*Sturnella magna*) destroying artificial nests on 22 separate occasions in meadows in Ontario, Canada. Depredation by brown-headed cowbirds (*Molothrus ater*) also has been reported (Arcese *et al.*, 1996; DeGroot *et al.*, 1999). The bill marks on clay eggs in my study are similar to that of eastern meadowlark and brown-headed cowbird bill marks made intentionally in a clay egg, however, positive identification is difficult.

My results indicate small mammals are major predators of artificial nests in east-central Kansas. The use of artificial nests in avian research is problematic when attempting to compare the depredation rates of artificial nests to depredation rates of natural nests. However, I was only striving for a relative sample of the predator community of grassland birds in east-central Kansas.

Clearly, more research needs to be done on the effects artificial nests have on predator foraging. Additional research on the use of scent in artificial nest research is warranted to attempt to further eliminate the biases associated with artificial nests. Additionally, egg shape and size likely play a large role in whether predators are able to depredate eggs from artificial and natural nests. Further research on egg shape and its limitation to small predators is essential to recognize the role of small mammals as nest predators of grassland birds.

Several studies have used miniature video cameras to monitor the nests of various bird species. Currently most researchers are limited by this expensive technology. Future research can use these cameras to gain valuable information on the value of artificial nests and predator biology.

LITERATURE CITED

- Arcese, P. J., N. M. Smith and M. I. Hatch. 1996. Nest predation by cowbirds and its consequences for passerine demography. *Proc. Nat. Acad. Sci.*, **93**:4608-4611.
- Baicich, P. J. and C. J. O. Harrison. 1997. A guide to the nests, eggs, and nestlings of North American Birds. 2nd ed. Academic Press, San Diego, California, 350 p.
- Bayne, E. M., K. A. Hobson and P. Fargey. 1997. Predation on artificial nests in relation to forest type: contrasting the use of quail and plasticine eggs. *Ecography*, **20**:233-239.
- Best, L. B. 1978. Field sparrow reproductive success and nesting ecology. *Auk*, **95**:9-22.
- Brown, K. P., H. Moller, J. Innes and P. Jansen. 1998. Identifying predators at nests of small birds in a New Zealand forest. *Ibis*, **140**:274-279.
- Burger, L. D., L. W. Burger and J. Faaborg. 1994. Effects of prairie fragmentation on predation on artificial nests. *J. Wildl. Manage.*, **58**:249-254.
- Burghardt, G. M. 1967. Chemical cue preference of inexperienced snakes: comparative aspects. *Science*, **157**:718-721.
- Choate, J. R., R. C. Dowler and J. E. Krause. 1979. Mensural discrimination between *Peromyscus leucopus* and *Peromyscus maniculatus* (Rodentia) in Kansas. *Southwest. Nat.*, **24**:249-258.

- Daubenmire, R. F. 1959. A canopy-coverage method of vegetational analysis. *NW. Sci.*, **33**:43-64.
- Davison, W. B. and E. Bollinger. 2000. Predation rates on real and artificial nests of grassland birds. *Auk*, **117**:147-153.
- DeGraaf, R. M. and T. J. Maier. 1996. Effect of egg size on predation by white-footed mice. *Wilson Bull.*, **108**:535-539.
- DeGroot, K. L., J. N. M. Smith and M. J. Taitt. 1999. Cowbird removal programs as ecological experiments: Measuring community-wide impacts of nest parasitism and predation. *Stud. Avian Bio.*, **18**:229-234.
- Dijak, W. D. and F. R. Thompson. 2000. Landscape and edge effects on the distribution of mammalian predators in Missouri. *J. Wildl. Manage.*, **64**:209-216.
- Ettel, T. L. 1998. Predation of artificial nests in grassland/shrubland habitats in western Tennessee. M.S. Thesis, University of Tennessee, Knoxville, 96 p.
- Fitch, H. S. 1963. Natural History of the black rat snake (*Elaphe o. obsoleta*) in Kansas. *Copeia*, **4**:469-658.
- Fretwell, S. D. and H. L. Lucas Jr. 1969. On territorial behavior and other factors influencing habitat distribution in birds. I. Theoretical development. *Acta Bioth.* **19**:16-36.
- Gates, J. E. and L. W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. *Ecology*, **59**:871-883.

- Gotmark, F. 1992. The effects of investigator disturbance on nesting birds. *Curr. Ornith.*, **9**:63-104.
- Harrison, H. H. 1979. A field guide to western bird's nests. Houghton Mifflin Company, New York, New York. 279 p.
- Helzer, C. J. 1996. The effects of wet meadow fragmentation on grassland birds. M.S. Thesis, University of Nebraska, Lincoln, Nebraska, 65 p.
- Herkert, J. R. 1994a. Breeding bird communities of Midwestern prairie fragments: the effects of prescribed burning and habitat-area. *Nat. Areas J.*, **14**:128-135.
- _____ 1994b. The effects of habitat fragmentation on Midwestern grassland bird communities. *Ecol. Appl.*, **4**:461-471.
- Hoi, H. and H. Winkler. 1994. Predation on nests: A case of apparent competition. *Oecologia*, **98**:436-440.
- Hughes, J. P. 1996. The effect of vegetative structure and landscape composition on avian relative abundance and reproductive success in CRP fields in northeastern Kansas. M.S. Thesis, Kansas State University, Manhattan. 194 p.
- James, F. C. 1971. Ordinations of habitat relationships among breeding birds. *Wilson Bull.*, **88**:215-236.
- Jensen, W. E. 1999. Nesting habitat and responses to habitat edges of three grassland passerine species. M.S. Thesis, Emporia State University, Emporia, Kansas, 58 p.

- Johnson, R. G. and S. A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies. P. 245-249 *In* J. Verner, M. L., Morrison and C. J. Ralph, editors. *Wildlife 2000: modeling habitat relationships of terrestrial vertebrates*. University of Wisconsin Press, Madison, Wisconsin, 470 p.
- _____. 1990. Nest predation and brood parasitism of tallgrass prairie birds. *J. Wildl. Manage.*, **54**:106-111.
- Lariviere, S. and F. Messier. 2000. Habitat selection and use of edges by striped skunks in the Canadian prairies. *Can. J. of Zool.*, **78**:366-372.
- Maier, T. J. and R. M. DeGraaf. 2000. Predation on Japanese quail vs. house sparrow eggs in artificial nests: small eggs reveal small predators. *Condor*, **102**:325-332.
- Major, R. E. 1991. Identification of nest predators by photography, dummy eggs, and adhesive tape. *Auk*, **108**:190-195.
- _____, and C. E. Kendal. 1996. The contribution of artificial nest experiments to understanding avian reproductive success: a review of methods and conclusions. *Ibis*, **138**:298-307.
- Marini, M. A. and C. Melo. 1998. Predators of quail eggs, and the evidence of the remains: implications for nest predation studies. *Condor*, **100**:395-399.
- Maxson, S. J. and L. W. Oring. 1978. Mice as a source of egg loss among ground-nesting birds. *Auk*, **95**:582-584.

- Mayfield, H. 1961. Nesting success calculated from exposure. *Wilson Bull.*, **73**:255-261.
- _____ 1975. Suggestions for calculating nest success. *Wilson Bull.*, **87**:456-466
- Moller, A. P. 1987. Egg predation as a selective factor for nest design: an experiment. *Oikos*, **50**:91-94.
- Nour, N., E. Matthysen and A. A. Dhondt. 1993. Artificial nest predation and habitat fragmentation: different trends in bird and mammal predators. *Ecography*, **16**:111-116.
- Picman, J. and L. M. Schriml. 1994. A camera study of temporal patterns of nest predation in different habitats. *Wilson Bull.*, **106**:456-465.
- Pietz, P. J. and D. A. Granfors. 2000. Identifying predators and fates of grassland passerine nests using miniature video cameras. *J. Wildl. Manage.*, **64**:71-87.
- Rangen, S. A., R. G. Clark and K. A. Hobson. 2000. Visual and olfactory attributes of artificial nests. *Auk*, **117**:136-146.
- Robel, R. J., J. N. Briggs, A. D. Dayton and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. *J. Range Manage.*, **23**:295-297.
- Samson, F. and F. Knopf. 1994. Prairie conservation in North America. *BioScience*, **44**:418-421.
- Storaas, T. 1988. A comparison of losses in artificial and naturally occurring Capercaillie nests. *J. Wildl. Manage.*, **52**:123-126.

- Thompson, F. R., W. Dijak and D. E. Burhans. 1999. Video identification of predators at songbird nests in old fields. *Auk*, **116**:259-264.
- Vickery, P. D., M. L. Hunter Jr. and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. *Conserv. Biol.*, **8**:1087-1097.
- Warner, R. E. 1994. Agricultural land use and grassland habitat in Illinois: future shock for Midwestern birds. *Conserv. Biol.*, **8**:147-156.
- Whelan, C. J., M. L. Dilger, D. Robson, N. Hallyn and S. Dilger. 1994. Effects of olfactory cues on artificial-nest experiments. *Auk*, **111**:945-952.
- Willebrand, T. and V. Marcstrom. 1988. On the danger of using dummy nests to study predation. *Auk*, **105**:378-379.
- Winter, M. 1998. Nesting biology of dickcissels and Henslow's sparrows in southwestern Missouri prairie fragments. *Wilson Bull.*, **111**:515-527.
- _____, D. H. Johnson and J. Faaborg. 2000. Evidence for edge effects on multiple levels in tallgrass prairie. *Condor*, **102**:256-266.
- Zar, J. H. 1999. Biostatistical analysis, 4th ed. Prentice Hall, Upper Saddle River, New Jersey. 663 p.

CHAPTER III

PREDATOR OCCURRENCE WITHIN GRASSLANDS OF EAST-CENTRAL KANSAS

ABSTRACT.--Predators play a crucial role in reproductive success of birds, especially in fragmented areas. How the predator responds to habitat fragmentation can either result in a higher or lower nest success of grassland birds, depending on the situation. I attempted to identify habitat selection of potential predators of grassland birds in east-central Kansas. Additionally, I was interested in determining how specific predators respond to woodland/grassland ecotones. I used various monitoring techniques to identify potential predators and their locations in grassland fragments of east-central Kansas. I separated potential predators into four guilds: small mammals, meso-mammals, snakes, and birds. The deer mouse (*Peromyscus maniculatus*) was the most common predator caught, and was captured equally at all distances from the habitat edge. In addition, all cotton rats (*Sigmodon hispidus*) were captured within 40 m of the habitat edge. All other predators were not observed frequently enough for statistical analysis. The high numbers of deer mice and the low capture of snakes might be a result of the management practice at all my study sites. Additionally, the size of the woody vegetation fragmenting the grassland might not be large enough to be suitable habitat for meso-mammals and avian predators.

INTRODUCTION

Predator assemblage plays a crucial role in reproductive success of birds (Martin, 1987). Additionally, the effect of habitat fragmentation on avian species depends heavily on the predator assemblage of the area (Nour *et al.*, 1993). Wilcove (1985) found that predator type varies as fragment size changes. He demonstrated that small forested tracts had higher densities of avian nest predators than large forests. Additionally, Miller and Knight (1993) found less than 1% depredation rate on Savannah sparrows (*Ammodramus savannarum*) in Alaska. They suggested the predator assemblage did not include the common grassland predators that most studies in the midwestern United States have identified.

Identification of nest predators and how habitat characteristics interact with nest survival must be known to understand grassland bird declines (Pietz and Granfors, 2000). Some authors recently have attempted to identify the predator assemblage within their study site by using various techniques appropriate to the particular taxon. Studies have used track-stations, hair catchers, clay or plasticine eggs, and various photography methods (Major and Kendall, 1996). Pietz and Granfors (2000) used miniature video cameras at natural avian nests to tape predators actually depredating the nest in grasslands of North Dakota. Their study showed thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) and Franklin's ground squirrel (*S. franklinii*) to be the most common predators. However, in Missouri, Thompson *et al.* (1999) found the predators of nests in old fields to be snakes, raccoon (*Procyon lotor*),

mice (*Peromyscus* spp.), and various bird species belonging to the families Accipitridae, Corvidae, and Tytonidae. In Thompson *et al.* (1999), snakes depredated 16 of 23 nests, whereas, in North Dakota, only two snakes were observed depredating grassland bird nests (P.J. Pietz, pers. comm.). Other studies of grassland bird nest predators have identified the above predators; however, the dominance of any one of the predators varies depending on geographic location and degree of habitat fragmentation (Miller and Knight, 1993).

My objective was to identify where common grassland bird predators were located within the prairie fragment by using various monitoring techniques. Identification of predators in a geographic location is essential before appropriate management decisions can be made to try and reduce predation on grassland nesting birds. Additionally, identifying where predators forage within the habitat fragment is essential to further understand the dynamics of predator and prey relationships in the grassland ecosystem.

MATERIALS AND METHODS

Two trials were conducted in both of 2001 and 2002. Twelve sites were selected to monitor predators within the prairie fragment each year. Potential predator species were separated into four distinct guilds: small mammals, meso-mammals, birds, and snakes. Census techniques specific for each guild were used to estimate their occurrence in relation to the habitat edge.

Small mammal trapping was used to identify locations of small mammals in the habitat fragment. Sherman live traps (7.6 X 8.9 X 22.9 cm) were set in six transects extending perpendicular from the habitat edge. Six traps were set in each transect at 5, 10, 20, 40, 80, and >100 m from the habitat edge. Traps were set out for 10 days for both trial 1 and 2 in 2001 (720 trap nights) In 2002, traps were set for nine days for both trials (648 trap nights). Traps were baited with peanut butter and were checked daily. All small mammals caught were toe-clipped so recaptures could be identified (ASM Animal Care and Use Committee, 1998).

Funnel traps with drift fence arrays were used to trap snakes in relation to the habitat edge. Funnel traps were 1.0 X 0.6 X 0.3 m in size. Funnel traps were set out at three distance intervals (5-25, 40-60, 90-110 m), running perpendicular to the habitat edge. One funnel trap was assigned systematically to one of the six study sites so that two study sites would have each of the three distances. Twenty meter plastic sheeting drift fences were used to direct snakes into the funnel traps. Funnel traps were constructed from a design by Imler (1945). For each trial, funnel traps were set out for 10 days in 2001 and 11 days in 2002.

Scent stations were used to identify the presence of meso-mammals in relation to the habitat edge. Scent stations were assigned to one of the following distances: 5, 10, 20, 40, 80, >100 m. In 2001, scent stations were made from sifted sand with a Q-tip soaked in cod liver oil in the center of a 0.5 m diameter circle. Because of difficulties identifying tracks in the sand, a camera system was used in 2002. A TM1500 Trailmaster camera system (Goodson and Assoc., Incorporated, Lenexa, Kansas) was baited with canned cat food in Trial 1 of 2002. Because of the ineffectiveness of the cat food to attract predators, canned sardines were used in Trial 2 of 2002.

Point counts were used to determine habitat affinities for avian predators. Point counts were conducted at the same distances funnel traps were deployed. Point counts consisted of standing motionless in the same spot for five minutes. After five minutes expired, and for five additional minutes, all potential avian predators were counted by sight and sound and their distance from the habitat edge was estimated. Point counts were conducted within 2 hours after sunrise and were done when wind speed was < 10 mph and no precipitation was falling.

Predator use of the prairie fragment was analyzed by using Chi-square analysis. Expected observations were the mean frequencies across all distances. Chi-square analysis was run only for the cotton rat (*Sigmodon hispidus*) and deer mouse (*Peromyscus maniculatus*) due to a low sample size of other predators.

RESULTS

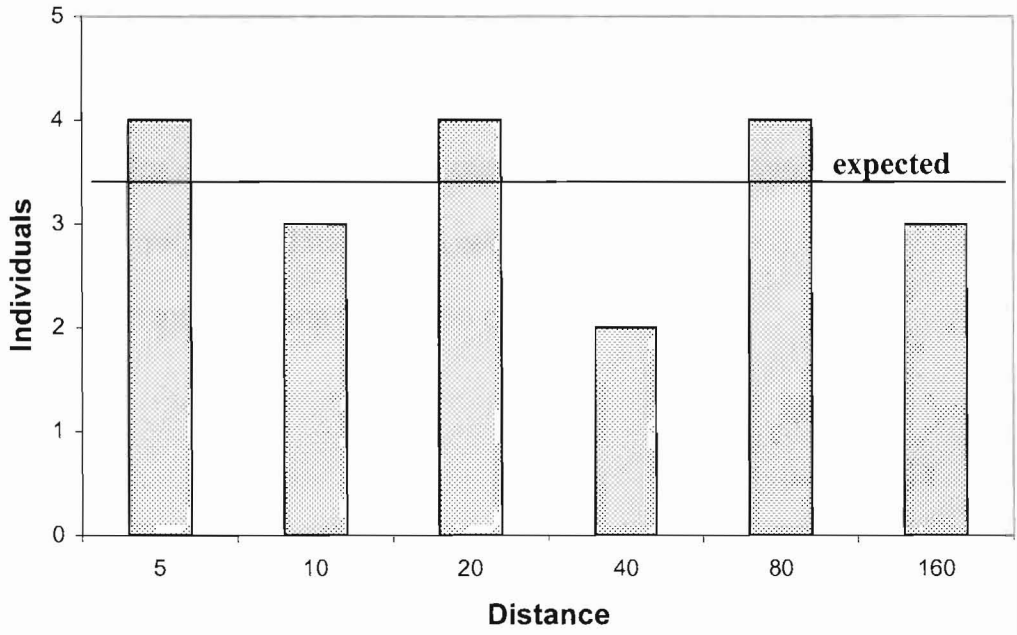
The deer mouse was the most common small mammal ($N_{\text{total}} = 20$, $N_{2001} = 10$, $N_{2002} = 10$) caught in the Sherman live traps. Its distribution did not show a significant difference ($\chi^2 = 0.878$, $N = 6$, $0.95 < P\text{-value} < 0.975$) from the expected values (Fig. 3.1). All deer mice caught (3.12 per 100 trap nights) in 2001 were from Trial 1. In 2002, 4 deer mice (1.23 per 100 trap nights) were caught in Trial 1, whereas sixteen (4.94 per 100 trap nights) were caught in Trial 2. The cotton rat was the only other small mammal caught in the Sherman live traps. Cotton rats did show a significant affinity ($\chi^2 = 11.6$, $N = 6$, $0.05 < P\text{-value} < 0.025$) for the habitat edge (Fig. 3.1). All cotton rats ($N = 10$) were collected in 2002 and only one of those individuals was captured in Trial 1 (Trial 1 = 0.3 per 100 trap nights, Trial 2 = 2.78 per 100 trap nights).

Six red-sided garter snakes (*Thamnophis sirtalis parietalis*) were caught in funnel traps during my study. Five red-sided garter snakes were caught in the same trap on the same day at the 90-110 m funnel trap array. The other snake was caught in the same funnel trap the following day. An Elliot's short-tailed shrew (*Blarina hylophaga*) and a prairie vole (*Microtus ochrogaster*) were caught in funnel traps set out at 5-25 m.

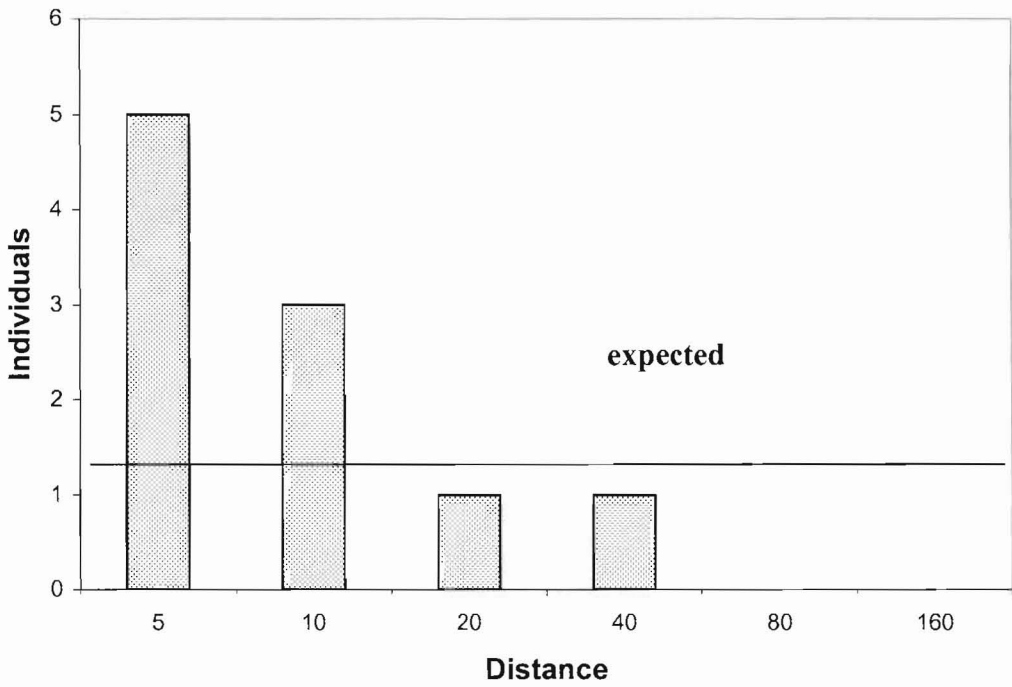
In Trial 2 of 2001, one Virginia opossum (*Didelphis virginiana*) was detected at a 20 m scent station. In the same trial, one raccoon was recorded at a 5 m scent station. Other scent stations were disturbed, however, there were no detectable tracks to identify potential predators. In 2002, Trailmaster cameras did not document any potential predators within the grassland habitat.

Fig. 3.1 Occurrence of (a) deer mouse and (b) cotton rat in relation to distance (m) from wooded edges in grasslands of east-central Kansas.

a. deer mouse



b. cotton rat



Non-target species the cameras documented were an ornate box turtle (*Terrapene ornata ornata*) and an unidentified juvenile grassland bird.

Avian point counts failed to identify potential avian predators actively using the grassland fragment. American crows (*Corvus brachyrhynchos*) were seen flying over the fragmented habitat on two separate occasions, but they obviously were not searching for nests within the prairie fragment.

DISCUSSION

Deer mice were the most frequent (N = 20) potential predator caught or observed in the prairie fragments of east-central Kansas. Deer mice did not avoid or select edge habitats and were found equally along a gradient extending from the habitat edge (Fig. 3.1). Deer mice prefer areas that are void of high levels of accumulated litter and frequently are found in areas that have been burned recently (Kaufman *et al.*, 1983; Sietman *et al.*, 1994). Annually hayed grasslands, like those in my study, do not have high levels of litter accumulation (L. A. Westerman, pers. obs.). Haying removes nearly all vegetation in middle to late summer, and the only accumulation of biomass occurs between the haying period and first frost. Therefore, if absence of litter accumulation was a critical factor in selection of habitat for deer mice, the entire hayed grassland fragment would be suitable habitat. I did not find a significant difference in litter accumulation across the distance gradient extending from the woody edge.

All cotton rats were captured within 40 m of the wooded edge. No studies reviewed specifically listed the cotton rat as an edge species. However, Swihart and Slade (1990) suggested that cotton rats are generalists when selecting habitats. Sietman *et al.* (1994) looked at how hayfields influence small mammal distribution in east-central Kansas and found only two cotton rats in hayed areas. In comparison they found 86 cotton rats in an old field habitat. However, their study design implemented transects in the center of a 5.2 ha hayfield and avoided the edges of the habitat. If they had sampled around the edges of the hayfield, more cotton rats might have been collected.

All cotton rats captured in my study were caught at four study sites. All the study sites had hedgerows as the edge habitat. In the area of my study sites, hedgerows consisted of Osage orange (*Maclura pomifera*) as the dominant woody vegetation. In addition, the two study sites with the most cotton rats captured both had road ditches on the opposite side of the hedgerow. As generalists, cotton rats possibly are using the entire suite of habitat types to forage but only venture out into the grassland a short distance.

I observed large fluctuations in capture of cotton rats. Fluctuations in cotton rat populations previously have been reported (Swihart and Slade, 1990). Cotton rats have colonized the state of Kansas within the last century (Cockrum, 1948) and Kansas' winters seem to have a large influence on the survivability of cotton rats (Slade *et al.*, 1984). A mild winter in 2002 might explain why I captured cotton rats only in 2002.

Only six red-sided garter snakes were caught during the entire study period, and five of those captured were in the same trap, on the same night. The study site where all red-sided garter snakes were captured was a wet meadow, a preferred habitat for this species (Fitch and Maslin, 1961). Cavitt (2000) observed that yellow-bellied racers (*Coluber constrictor flaviventris*) responded negatively to fire because of the resulting reduced litter layer. Haying might be similar to a fire by removing a large portion of accumulated dry vegetation which, some grassland snakes prefer (Fitch, 1963; Fitch and Shirer, 1971; Charland and Gregory, 1995). In addition, the rapid disturbance of the grassland habitat from

the haying equipment might destroy individuals and leave the area void of suitable habitat for snakes.

Scent stations were not effective in obtaining enough data to analyze patterns of meso-mammals. I expected to observe more meso-mammals using grassland habitat than was observed at scent stations in east-central Kansas. Numerous studies have used scent stations to monitor carnivore populations in North America (Conner *et al.*, 1983; Linscombe *et al.*, 1983; Leberg and Kennedy, 1987). However, their effectiveness is understood poorly (Roughton, 1979). Winter (1998) used scent stations to monitor predator activity in grasslands of southwestern Missouri. She reported ten opossum, nine raccoon, and five striped skunk visitations at her scent stations; however, she had a much larger sampling effort than in my study. The results from the scent stations did correlate with the artificial nest study (Chapter II). I did not have any depredation events by meso-mammals for my artificial nest study (Chapter II) in 2002, however, in 2001 I had three depredation events by raccoons and two by striped skunks. Sufficient data to support any trend is lacking in my study.

I did not observe potential bird predators using the grassland habitat in my study. Avian species (*i.e.*, corvids) are common predators in forested systems (Yahner and Wright, 1985; Yahner and Scott, 1988; Moller, 1989). However, they are not as abundant in grasslands (L. A. Westerman, pers. obs.). The absence of corvid species in my study sites is probably attributed to the lack of large forested tracks juxtaposed with row crop agriculture. Vegetation height has a large effect on the ability of avian predators to find ground nests of passerines.

Therefore, it might not be advantageous for corvids to forage in grassland habitats

Overall small mammals were found to have relatively high densities in the grasslands whereas, other potential predators (i.e. meso-mammals, snakes, and birds) were found to have lower densities. More in-depth research on predator occurrences in the grassland should be conducted to gain more knowledge on predator habitat selection. In addition, animal survey techniques should be refined to attempt to minimize human activity and foreign material in the habitat, thus, reducing bias in future research.

LITERATURE CITED

- ASM Animal Care and Use Committee. 1998. Guidelines for the capture, handling, and care of mammals as approved by the American Society of Mammalogists. *J. Mamm.* **79**:1416-1431.
- Cavitt, J. F. 2000. Fire and a tallgrass prairie reptile community: effects on relative abundance and seasonal activity. *J. Herp.*, **34**:12-20.
- Charland, M. B. and P. T. Gregory. 1995. Movements and habitat use in gravid and nongravid female garter snakes (Colubridae: *Thamnophis*). *J. Zool. Soc. London*, **236**:543-561.
- Cockrum, E. L. 1948. The distribution of the hispid cotton rat in Kansas. *Trans. Kan. Acad. Sci.*, **51**:306-312.
- Conner, M. C., R. F. Labisky and D. R. Progulske, Jr. 1983. Scent-station indices as measures of populations abundance for bobcats, raccoons, gray foxes, and opossums. *Wildl. Soc. Bull.*, **11**:146-152.
- Fitch, H. S. 1963. Natural history of the racer, *Coluber constrictor*. University of Kansas Publication, Museum of Natural History **15**:351-468.
- _____, and T. P. Maslin. 1961. Occurrence of garter snake, *Thamnophis sirtalis*, in the Great Plains and Rocky Mountains. University of Kansas Publication, Museum of Natural History **13**:289-308.
- _____, and H. W. Shirer. 1971. A radiotelemetric study of spatial relationships in some common snakes. *Copeia*, **1971**:118-128.
- Imler, R. H. 1945. Bullsnares and their control on a Nebraska wildlife refuge. *J. Wildl. Manage.*, **9**:265-273.

- Kaufman, D. W., G. A. Kaufman and E. J. Finck. 1983. Effects of fire on rodents in tallgrass prairie of the Flint Hills region of eastern Kansas. *Prairie Nat.*, **15**:49-56.
- Leberg, P. L. and M. L. Kennedy. 1987. Use of scent-station methodology to assess raccoon abundance. Ann. Conf. Southeastern Assoc. of Fish and Wildlife Agencies, **41**:394-403.
- Linscombe, G., N. Kinler and V. Wright. 1983. An analysis of scent-station response in Louisiana. Ann. Conf. Southeastern Assoc. of Fish and Wildlife Agencies, **37**:190-200.
- Major, R. E. and C. Kendal. 1996. The contribution of artificial nest experiments to our understanding of avian reproductive success: a review of methods and conclusions. *Ibis*, **138**:298-307.
- Martin, T. E. 1987. Artificial nest experiments: effects of nest appearance and type of predator. *Condor*, **89**:925-928.
- Miller, C. K. and R. L. Knight. 1993. Does predator assemblage affect reproductive success in songbirds? *Condor*, **95**:712-715.
- Moller, A. P. 1989. Nest site selection across field-woodland ecotones: the effect of nest predation. *Oikos*, **56**:240-243.
- Nour, N., E. Matthysen and A. A. Dhondt. 1993. Artificial nest predation and habitat fragmentation: different trends in bird and mammal predators. *Ecography*, **16**:111-116.

- Pietz, P. J. and D. A. Granfors. 2000. Identifying predators and fates of grassland passerine nests using miniature video cameras. *J. Wildl. Manage.*, **64**:71-87.
- Roughton, R. D. 1979. Development in scent-station technology. Pages 17-44 *In Proc. Midwest Furbearer Workshop, Kansas State University, Manhattan, Kansas.* 186 p.
- Sietman, B. E., W. B. Fothergill and E. J. Finck. 1994. Effects of haying and old-field succession on small mammals in tallgrass prairie. *Am. Midl. Nat.*, **131**:1-8.
- Slade, N. A., J. R. Sauer and G. E. Glass. 1984. Seasonal variation in field-determined growth rates of hispid cotton rat (*Sigmodon hispidus*). *J. Mammal.*, **65**:263-270.
- Swihart, R. K. and N. A. Slade. 1990. Long-term dynamics of an early successional small mammal community. *Am. Midl. Nat.*, **123**:372-382.
- Thompson, F. R., W. Dijak and D. E. Burhans. 1999. Video identification of predators at songbird nests in old fields. *Auk*, **116**:259-264.
- Wilcove, D. S. 1985. Nest predation in forest tracts and the decline of migratory songbirds. *Ecology*, **66**:1211-1214.
- Winter, M. 1998. Effect of habitat fragmentation on grassland-nesting birds in southwestern Missouri. Ph.D Dissertation. University of Missouri, Columbia, 234 p.
- Yahner, R. H. and D. P. Scott. 1988. Effects of forest fragmentation on depredation of artificial nests. *J. Wildl. Manage.*, **52**:158-161.

Yahner, R. H. and A. L. Wright. 1985. Depredation on artificial ground nests: effects of edge and plot age. *J. Wildl. Manage.*, **49**:508-513.

CHAPTER IV

CONCLUSION

In my study, artificial nests were not depredated at different frequencies for the various distances from the habitat edge. Individuals from the genus *Peromyscus* were the most common predator documented at artificial nests and the deer mouse (*Peromyscus maniculatus*) was the most common potential predator captured in the prairie fragments. My data suggest a relative lack of edge effect on depredation rates for ground nesting grassland birds. The lack of edge effect was due to the high predation rate by *Peromyscus* and its trend to be found at all distances from the habitat edge. Additionally, the low number of depredation events by edge specific meso-mammals, eliminated the chance for an edge effect. From my results, it is not clear the reason for edge avoidance in grassland birds is specifically caused by a lowered survival rate close to the habitat edge.

A general overview of the actual predators of grassland birds in east-central Kansas likely was gained through my study, However, caution should be taken when relating these findings to actual predation rates of natural nests due to the biases associated with artificial nests. Additional research should focus on the predators of grassland birds by using natural nests as well as artificial nests. Miniature video cameras are becoming more accessible and should be implemented on natural and artificial nests to more accurately identify predators.

Limitations from different egg size and shapes should be studied more thoroughly to understand how small predators (*i.e.* mice, birds, insects) affect survival of avian reproductive success. Eggs of the same size, but of different shapes likely would have different depredation rates because of the ability of small predators to score one egg and not the other.

The absence of sufficient data for predators in the nest monitoring study (Chapter III) is likely because of their overall absence in the prairie fragment. However, control sites were not monitored to compare the effectiveness of the monitoring techniques. Both the artificial nest study (Chapter II) and the predator monitoring study (Chapter III) were similar in the presence/absence of a particular predator, which, suggests low predator abundance in hayfield grasslands. However, additional research on predator occurrence in grasslands of east-central Kansas should be done.

APPENDIX A. Legal descriptions for 2001 and 2002 study sites in east-central Kansas.

2001

Osage County, KS

SW $\frac{1}{4}$, Sec. 27, T17S, R15E.

W $\frac{1}{2}$, Sec. 4, T18S, R15E.

NW $\frac{1}{4}$, Sec. 12, T18S, R14E.

NW $\frac{1}{4}$, Sec. 11, T18S, R13E.

Lyon County, KS

NW $\frac{1}{4}$, Sec. 29, T17S, R13E.

Sec. 24, T20S, R12E.

SW $\frac{1}{4}$, Sec. 13, T20S, R12E.

SE $\frac{1}{4}$, Sec. 31, T18S, R12E.

2002

Osage County, KS

SW $\frac{1}{4}$, Sec. 27, T17S, R15E.

W $\frac{1}{2}$, Sec. 4, T18S, R15E.

NW $\frac{1}{4}$, Sec. 12, T18S, R14E.

NW $\frac{1}{4}$, Sec. 11, T18S, R13E.

NE $\frac{1}{4}$, Sec. 12 T18S, R14E.

Lyon County, KS

NW $\frac{1}{4}$, Sec. 29, T17S, R13E.

Sec. 24, T20S, R12E.

SW $\frac{1}{4}$, Sec. 13, T20S, R12E.

I, Luke Alan Westerman, hereby submit this thesis to Emporia State University as partial fulfillment of the requirements for an advanced degree. I agree that the Library of the University may make it available to use in accordance with its regulations governing this document is allowed for private study, scholarship (including teaching), and research purposes of a nonprofit nature. No copying which involves potential financial gain, will be allowed without permission of the author.

Luke Westerman
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5-09-03
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Signature of Graduate Office Staff

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