AN ABSTRACT OF THE THESIS OF

Terri Ann Abbett for the Master of Science

in Biology presented on April 18, 1994

Title: Avian density, diversity, and species richness in riparian corridors and shelterbelts of east-central Kansas

Abstract Approved: Elmer J. Finck

A comparison of bird diversity, density, and species richness, as well as vegetative structure, was made between single row shelterbelts and narrow riparian corridors in east-central Kansas in 1992 and 1993. Both habitat types were essentially linear wooded islands surrounded by grassland and agricultural fields. All study sites were located on two areas, Flint Hills National Wildlife Refuge and Melvern Reservoir Wildlife Management Area.

Bird censuses were conducted on 26 sites from 1 July to 1 August, 1992 and from 1 June to 20 June, 1993. Line transects were used to census birds. One transect was established along the edge of each study site, and all transects were walked once during each year of the study. Bird diversity was calculated for each habitat each year. Bird density and species richness were calculated for each transect, and statistical comparisons were made among habitats, areas, and years. Bird species were categorized into three guilds, based on migratory status, to test for homogeneity of species' distributions over four habitat-areas.

Vegetation structure variables included percent tree

canopy, tree density, diameter at breast height (DBH), tree species richness, snag density, percent bare ground, percent grass cover, percent forb cover, and percent shrub cover. Vegetation variables were measured every 100 m along the transects used for bird censuses. Means for each vegetation variable were calculated for each transect, and statistical comparisons were made among habitats, areas, and years.

A t-test indicated that bird diversity was higher in shelterbelts in 1992. Three-factor analysis of variance indicated that bird density was higher in riparian zones, on Melvern sites, and in 1993. Bird species richness was higher in riparian zones, on Melvern sites, and in 1992.

There were no differences among habitats, areas, or years for tree density and DBH. Percent tree canopy was higher on Melvern sites and in 1992. Snag density was higher in 1992. Tree species richness was higher in riparian zones. Percent grass cover was higher on Melvern sites. Percent bare ground was higher at Flint Hills sites and in 1993. Percent forb cover was higher in riparian zones, on Melvern sites, and in 1992. Birds in each migratory guild were not distributed homogeneously among habitat-area types either in 1992 or 1993.

AVIAN DENSITY, DIVERSITY, AND SPECIES RICHNESS IN RIPARIAN CORRIDORS AND SHELTERBELTS OF EAST-CENTRAL KANSAS

A Thesis

Submitted to

the Division of Biological Sciences

Emporia State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Terri Ann Abbett

April 1994

Approved by Major Advisor

Approved by Committee Member

Approved by Committee Member

Approved by Committee Member

Approved for Major Department

Approved for Graduate Council

ACKNOWLEDGEMENTS

I would like to thank several people for contributing to my success in completing my master's degree. I would especially like to thank my major professor, Elmer Finck, for all his suggestions and encouragement. I would like to thank the other members of my committee: D. Edds, J. Horak, and L. Robbins for all their help. A special thanks to L. Scott for his patience and time spent aiding me with my data analysis. I am also grateful to D. Wiseman and D. Patton for helping me choose my study sites and for the use of their equipment. I would like to thank C. Olawsky for his help with data collection in the field and L. Zuckerman for the use of equipment from the Kansas Department of Wildlife and Parks. Finally, I would like to thank T. Bannon, P. Fredricks, C. Olawsky and L. Cannistra for their friendship and emotional support throughout this process.

PREFACE

This manuscript will be submitted for publication to the Wilson Bulletin, therefore it is written in the style of that journal.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

In east-central Kansas and much of the Great Plains, most of the wooded areas available to birds are riparian corridors and tree plantings such as shelterbelts (Emmerick, 1978). Cable et al. (1992) reported that less than 3% of the Great Plains is forested. Shelterbelts are small forest islands surrounded by agricultural fields and grasslands (Martin, 1978; Yahner, 1981; Yahner, 1982; Cook and Cable, 1990). Riparian zones are narrow strips of dense woody and herbaceous vegetation adjacent to rivers, creeks, or streams which serve as extensions of deciduous forest into the grassland.

Riparian habitats and shelterbelts are critical to wildlife, especially in regions with intensive agriculture such as the Central Great Plains (Best et al., 1978; Odum, 1978). Many of the birds that use these areas are generalists that prefer edge habitat, and also tend to be found in association with more extensive wooded areas (Tubbs, 1980; Hamilton, 1986; Cable et al., 1992). Tubbs (1980) noted that 51% of the birds occupying primarily grassland communities in Kansas are woodland or forest species. It has also been estimated that 58% of Kansas' resident bird species are woodland or forest species (Ptacek, 1986). The presence of these woodland birds in an area dominated by grassland is due primarily to the presence of riparian zones and shelterbelts (Cable et al., 1992; Schroeder et al., 1992). Riparian zones and shelterbelts provide important foraging areas for bird species that require more continuous wooded areas to nest (MacClintock et al., 1977; Martin, 1978; Cassel and Wiehe, 1980; Yahner, 1983). Cable et al. (1992) reported that the presence of shelterbelts has a noticeable effect on the species composition and density of birds in adjacent habitats. Grassland species also make use of shelterbelts. For instance, Eastern Meadowlark (Sturnella magna) and Dickcissel (Spiza americana) often use the branches of trees on the edge of shelterbelts as singing perches during the breeding season.

The effects of vegetation structure on avian density, diversity, and species richness have been extensively documented (Anderson, 1979; Yahner, 1982; Cable et al., 1992; Schroeder et al., 1992). Vegetation strongly influences avian ecology because it provides a variety of requisites: nest sites, song posts, food, and protection. Mills et al. (1991) found strong correlations between bird density and vegetation volume, which they concluded was evidence that birds respond to critical resources, as estimated by vegetation volume.

Investigating overall bird density and bird species richness does not indicate how various groups of birds are responding to differences in habitat. To obtain this information it is necessary to group bird species into guilds. For the purpose of this study, guilds were based on migratory status of the bird species. The guild designations used were long-distance migrants, short-distance migrants, and year-round residents.

The purpose of my study was to compare how avian density, diversity, and species richness were related to vegetation structure in single row shelterbelts and long narrow riparian corridors during the breeding season. The null hypotheses tested were as follows: 1) there were no differences in bird density and bird species richness between habitat types, study areas, or years; 2) bird diversity did not differ between habitat type; 3) there were no differences in vegetation structure and composition between habitat types, areas, or years; and 4) birds in each migratory guild were distributed homogeneously among habitat-areas.

METHODS

Study Area

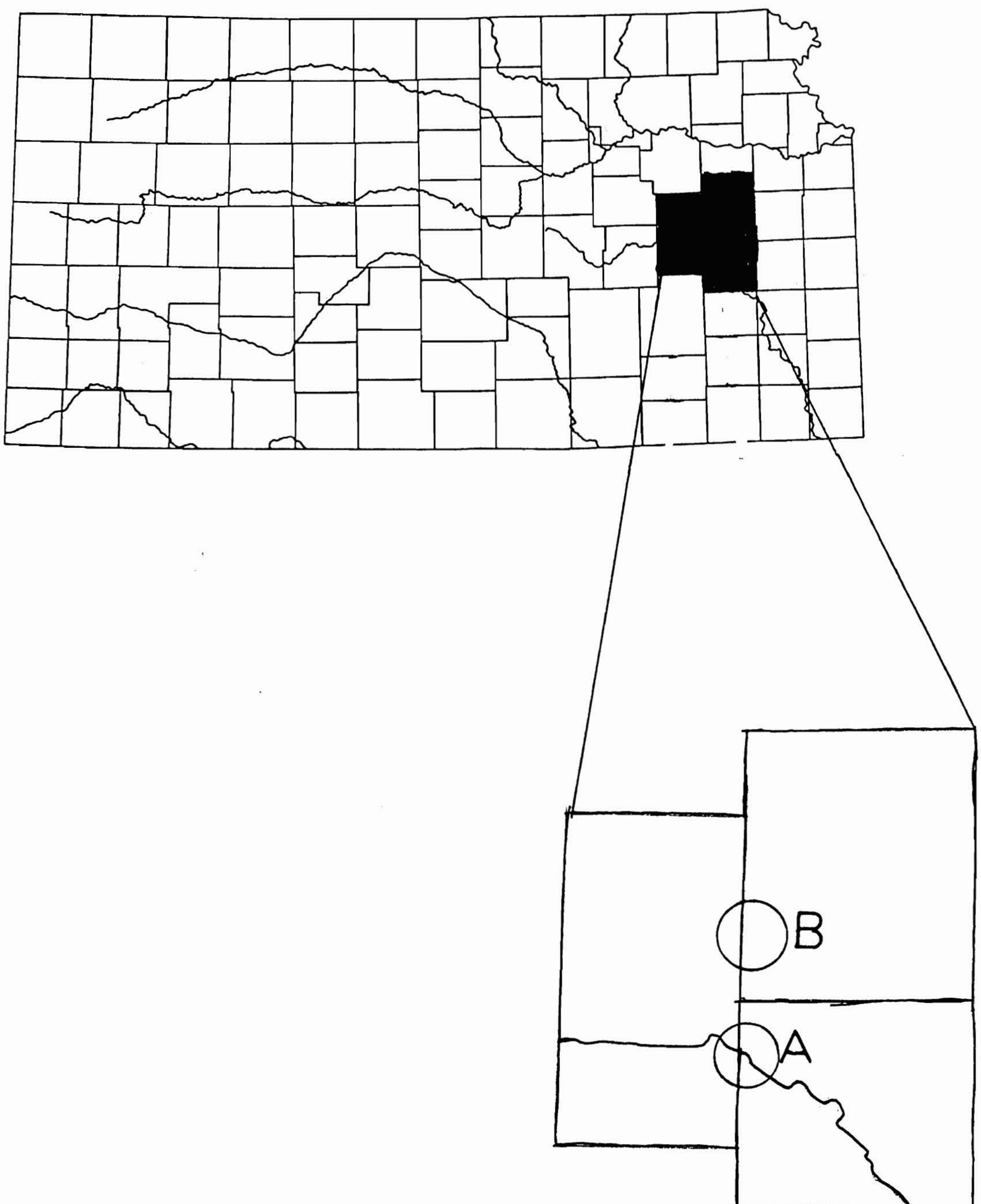
All study sites (Appendix E) were in east-central Kansas, within 20 km of Emporia. This area is in an ecotone between grassland and eastern deciduous forest biomes (Thompson and Ely, 1989). Five km of each habitat type was randomly chosen in each of two areas: Flint Hill National Wildlife Refuge in Lyon and Coffey counties; and Melvern Reservoir Wildlife Management Area in Lyon and Osage counties (Figure 1). Sites were randomly chosen by numbering all possible sites located on aerial photos, then drawing numbers from a container. All shelterbelt sites consisted of a single row of trees bordered by grassland or agricultural fields. All riparian zones were narrow strips of trees bordered by grasslands or agricultural fields.

Flint Hills National Wildlife Refuge and Melvern Reservoir are located in the Osage Cuesta physiographic region of Kansas, which is characterized by step-like shale and limestone outcroppings. Flint Hills National Wildlife Refuge was periodically flooded, during both years of my study, by overflow from the Neosho River. Parts of both areas are leased for agricultural use. There were many shelterbelts and narrow riparian zones in both areas.

Bird Census Techniques

I censused birds on 26 sites from 1 July to 1 August, 1992 and from 1 June to 20 June, 1993. These dates were

Figure 1. Study area locations: Flint Hills Wildlife Refuge (A) and Melvern Reservoir Wildlife Management Area (B) in Lyon, Coffey, and Osage counties, Kansas.


B
A

chosen to avoid late spring migrants that do not nest in this region (Conner and Dickson, 1980; Martin, 1981; Schroeder et al., 1992). In 1992, censusing began late because of major flooding in the spring and early summer. There was also flooding in 1993; however, because of the timing of the floods I did not have to postpone censusing in 1993.

Line transects were established along the edge of the habitat at each site (Emlen, 1971; Mikol, 1980; Burnham et al., 1985). Length of transects varied according to length of the shelterbelt or the amount of suitable riparian habitat available (Conner and Dickson, 1980), and ranged from 182 m to 1290 m. All birds seen or heard within the habitat were counted. In order to reduce observational bias, censusing was done between 0600 and 1100 hours when wind speed was less than 8 km per hour (Conner and Dickson, 1980; Martin, 1981; Emmerich and Vohs, 1982; Verner, 1985).

Vegetation Sampling

Vegetation variables were measured every 100 m along the same transects used for bird censuses. I also moved 1 m into the habitat to make sure I was measuring vegetation representative of that habitat type. Vegetation variables were measured once each year during the bird censusing period, and were divided into two categories: understory and overstory. Understory measurements were taken using a meter-square wooden frame and included percent shrub canopy, percent grass cover, percent forb cover, and percent bare ground (Schroeder, 1986). Overstory measurements were taken with a 2 m x 5 m rectangular plot and included percent canopy cover, number of snags, tree species richness, tree density, and diameter at breast height (DBH) of all trees included in density and species richness measurements. Percent canopy cover was estimated in two spots within the 2 m x 5 m plot, and the two estimates were then averaged. Snags were defined as standing dead trees of all species. All trees and snags in or overhanging the 2 m x 5 m plot were counted. Ages of shelterbelts used in this study were obtained by personal communication with employees of the U.S. Fish and Wildlife Service, the U. S. Army Corps of Engineers, and private landowners (Appendix D).

Analyses

Bird species diversity was calculated for each habitat each year using the Shannon-Weaver index (Shannon and Weaver, 1949):

$$H' = p_i \log p_i$$

where p_i is the proportion of observations found in category i, and log is logarithmic base 10. A Student's t-test was used to test for differences in diversity between habitat types within each year (Zar, 1984). A Student's t-test was also used to test for a difference in mean transect length between habitat types. Species richness was defined as the number of species of birds identified in each habitat. Bird density was expressed as number of birds per km for each habitat (Smith, 1980). Bird density data were square-root transformed to correct for deviation from normality. Vegetation plots for each transect were averaged to give a transect mean, then the transect means were used in calculating statistics. Trees measured were divided into three size classes, based on DBH, and the mean frequency of occurrence in each size class was used for analysis. Size classes included: A) 0-16 cm; B) 17-32 cm; C) >32 cm.

Statistical procedures were performed using the Statistical Analysis System (SAS Institute, Inc., 1988). Bird species richness, bird density, and vegetation variables were tested for significant differences and interactions among habitats, areas, and years using the SAS General Linear Models (GLM) procedure. The GLM procedure was used due to an unbalanced design that resulted from an unequal number of transects in each habitat and area. A three-factor model was used, the main factors were habitat, area, and year. The three-factor model tested each of the main factors independent from the other factors, and for interactions between factors.

Bird species were classified into three guilds based on migratory status (Appendix C) using data from the literature (Robbins et al., 1983; Askins and Philbrick, 1987; Blake and Karr, 1987; Thompson and Ely, 1989; Thompson and Ely, 1992). The migratory guilds were long-distance migrants, short distance migrants, and year-round residents. Chi-square analysis was used to test for homogeneity of distribution of the three migratory guilds across the four habitat-areas (McCauley, 1980). The four habitat-areas were Flint Hills riparian, Flint Hills shelterbelt, Melvern riparian, and Melvern shelterbelt. Unique species were defined as those species which were recorded three or more times in one habitat type, but not in the other.

Common and scientific names used in this study were taken from the following sources: trees (Stephens, 1969) and birds (American Ornithologist's Union, 1983). Bird species and tree species surveyed during this study are listed in Appendices A and B, respectively. In Appendix C bird species in each of the migratory guilds are listed. Ages of shelterbelts used in this study are listed in Appendix D, and in Appendix E legal descriptions of study sites are listed.

RESULTS

During the two years of my study, a total of 36 species of birds were counted on the study areas (Appendix A). In 1992, there was a significant difference between Shannon-Weaver diversity indices for the two habitats (Table 1). The shelterbelt habitat was significantly ($P<0.05$) more diverse than the riparian habitat. In 1993, there was no significant difference ($P>0.05$) in Shannon-Weaver diversity indices between the two habitat types (Table 1). There was no significant difference ($P>0.05$) in mean transect length between habitat types.

A three-way analysis of variance, adjusted for unequal sample size, was used to test for significant differences between means for bird density and species richness (Table 2). Bird density was higher ($P=0.0017$) at Melvern sites than Flint Hills sites, in riparian zones than in shelterbelts ($P=0.0001$), and in 1993 than 1992 ($P=0.0008$). There were significant area by habitat ($P=0.0294$) and habitat by year interactions ($P=0.0050$) for bird density. Bird species richness was higher ($P=0.0017$) on Melvern sites than Flint Hills sites, in riparian zones than shelterbelts ($P=0.0015$), and in 1992 than 1993 ($P=0.0001$). There was significant area by habitat interaction ($P=0.0245$) for bird species richness.

No significant differences ($P>0.05$) were found between area, habitat type, or year for number of trees in each of three size classes (Table 3). Percent tree canopy cover was higher (P=0.0410) at Melvern sites than Flint Hills sites, and in 1992 (P=0.0014) than 1993 (Table 4). Snag density was higher (P=0.0033) in 1992 than in 1993. Tree species richness was higher (P=0.0003) in riparian areas than shelterbelts (Table 4). There was also interaction between area and habitat for tree species richness.

Percent forb cover was higher (P=0.0213) on the Melvern area than on the Flint Hills area (Table 5), in riparian areas than in shelterbelts (P=0.0012), and in 1992 than in 1993 (P=0.0320). There was also significant (P=0.0165) area by year interaction for percent forb. Percent bare ground was higher (P=0.0001) on the Flint Hills area than the Melvern area (Table 6), and in 1993 than 1992 (P=0.0001). There was also an area by year (P=0.0001) interaction for percent bare ground. Percent grass cover was higher (P=0.0024) on the Melvern sites than Flint Hills sites (Table 6), and in 1992 than 1993 (P=0.0170).

Chi-square analysis revealed that birds in the three migratory guilds were not distributed homogeneously among the four habitat-areas in 1992 (P=0.0020) or 1993 (P=0.0001), thus there was an association between guild and habitat-area. In 1992, (Table 7) residents on the Melvern riparian habitat-area accounted for the highest frequency (88) of all birds on all habitat-areas. The highest frequency of all long-distance migrants surveyed occurred on the two Melvern habitat-areas. The highest frequency of all short-distance migrants surveyed occurred on the Melvern riparian habitat-area. The highest frequency of all residents occurred on the Melvern riparian habitat-area.

In 1993, (Table 8) residents on the Melvern riparian habitat-area also accounted for the highest frequency (60) of all birds on all habitat-areas. The highest frequency of all long-distance migrants surveyed occurred on the Melvern riparian habitat-area. The Melvern shelterbelt habitat-area had the highest occurrence of all short-distance migrants surveyed. The Melvern riparian habitat-area had the highest occurrence of all residents surveyed.

Unique species in shelterbelts included Eastern Meadowlark, Red-headed Woodpecker (Melanerpes erythrocephalus), and Scissor-tailed Flycatcher (Tyrannus forficatus). Unique species in riparian corridors included Eastern Phoebe (Sayornis phoebe), Gray Catbird (Dumetella carolinensis), and Carolina Wren (Thryothorus ludovicianus).

TABLE 1.

RESULTS OF STUDENT'S t-TEST ON SHANNON-WEAVER DIVERSITY INDICES IN 1992 AND 1993

	Shannon-Weaver Diversity Indices		
	Riparian Areas	Shelterbelts	t
1992	1.16	1.27	2.78*
1993	1.22	1.28	1.45

* Significant at the 0.05 level.

TABLE 2.

RESULTS OF THREE-FACTOR ANOVA ON THE AVIAN VARIABLES OF DENSITY AND SPECIES RICHNESS

Source	Density df	Density F	Density P	Species Richness df	Species Richness F	Species Richness P
Area	1	11.08	0.0017	1	11.08	0.0017
Habitat	1	23.01	0.0001	1	11.43	0.0015
Year	1	5.05	0.0008	1	5.42	0.0001
Area x Habitat	1	12.87	0.0294	1	37.10	0.0245
Area x Year	1	0.35	0.5581	1	0.01	0.9401
Habitat x Year	1	8.36	0.0050	1	2.54	0.1179
Area x Habitat x Year	1	0.63	0.4308	1	0.31	0.5833

TABLE 3.

RESULTS OF THREE-FACTOR ANOVA ON TREE SIZE CLASSES

	Size Class A			Size Class B			Size Class C		
Source	df	F	P	df	F	P	df	F	P
Area	1	1.95	0.169	1	0.02	0.885	1	0.52	0.474
Habitat	1	0.47	0.497	1	1.57	0.217	1	2.28	0.138
Year	1	0.43	0.513	1	2.16	0.149	1	1.18	0.282
Area x Habitat	1	3.75	0.060	1	1.76	0.191	1	0.01	0.958
Area x Year	1	0.01	0.946	1	0.01	0.938	1	0.01	0.985
Habitat x Year	1	0.33	0.568	1	0.15	0.670	1	1.01	0.320
Area x Habitat x Year	1	1.04	0.313	1	0.18	0.671	1	0.62	0.436

TABLE 4.

RESULTS OF THREE-FACTOR ANOVA ON PERCENT CANOPY COVER, NUMBER OF SNAGS, TREE SPECIES RICHNESS, AND STEM DENSITY

	Canopy			No. Snags			Sp. Richness			Stem Density		
Source	df	F	P	df	F	P	df	F	P	df	F	P
Area	1	4.43	0.0410	1	1.27	0.2657	1	2.93	0.0943	1	1.01	0.3215
Habitat	1	0.02	0.8856	1	1.52	0.2245	1	15.48	0.0003	1	0.01	0.9131
Year	1	11.57	0.0014	1	9.62	0.0033	1	1.07	0.3067	1	3.48	0.0689
Area x Habitat	1	2.34	0.1327	1	3.25	0.0783	1	8.69	0.0051	1	1.70	0.1994
Area x Year	1	1.03	0.3146	1	0.27	0.6053	1	0.06	0.8134	1	0.01	0.9583
Habitat x Year	1	0.63	0.4307	1	0.04	0.8470	1	0.38	0.5404	1	0.20	0.6536
Area x Habitat x Year	1	0.41	0.5243	1	0.56	0.4581	1	0.10	0.7569	1	0.77	0.3844

TABLE 5.

RESULTS OF THREE-FACTOR ANOVA ON PERCENT SHRUB AND PERCENT FORB COVER

	Percent Shrub			Percent Forb Cover		
Source	df	F	P	df	F	P
Area	1	0.63	0.4315	1	5.70	0.0213
Habitat	1	0.91	0.3448	1	11.95	0.0012
Year	1	0.28	0.6003	1	4.90	0.0320
Area x Habitat	1	0.90	0.3477	1	3.32	0.0753
Area x Year	1	0.02	0.8763	1	6.21	0.0165
Habitat x Year	1	0.39	0.5333	1	0.98	0.3264
Area x Habitat x Year	1	0.04	0.8453	1	1.82	0.1843

TABLE 6.

RESULTS OF THREE-FACTOR ANOVA ON PERCENT BARE GROUND AND PERCENT GRASS COVER

Source	Percent Bare Ground df	F	P	Percent Grass Cover df	F	P
Area	1	30.50	0.0001	1	10.37	0.0024
Habitat	1	0.01	0.9756	1	0.39	0.5351
Year	1	24.67	0.0001	1	0.29	0.0170
Area x Habitat	1	1.25	0.2693	1	1.94	0.5916
Area x Year	1	20.06	0.0001	1	3.05	0.0877
Habitat x Year	1	1.22	0.2747	1	0.86	0.3579
Area x Habitat x Year	1	3.27	0.0773	1	0.06	0.8101

TABLE 7.

MIGRATORY GUILD HABITAT-AREA PREFERENCE 1992 VALUES OF FREQUENCY, PERCENT FREQUENCY, ROW PERCENT, AND COLUMN PERCENT

Migratory Guild	Habitat-area*			
	FS	FR	MS	MR
Long-distance				
freq.	22	18	30	30
percent	6.3	5.0	8.4	8.4
row pct.	22	18	30	30
col. pct.	31.0	38.3	37.9	18.5
Short-distance				
freq.	9	10	22	44
percent	2.5	2.8	6.1	12.3
row pct.	10.6	11.7	25.9	51.8
col. pct.	12.7	21.3	27.9	27.2
Resident				
freq.	40	19	27	88
percent	11.1	5.3	7.5	24.3
row pct.	22.9	10.9	15.6	50.6
col. pct.	56.3	40.4	34.2	54.3

Chi-square P=0.002

* FS Flint Hills shelterbelt

FR Flint Hills riparian

MS Melvern shelterbelt

MR Melvern riparian

TABLE 8.

MIGRATORY GUILD HABITAT-AREA PREFERENCE 1993 VALUES OF FREQUENCY, PERCENT FREQUENCY, ROW PERCENT, AND COLUMN PERCENT

Migratory Guild	Habitat-area			
	FS	FR	MS	MR
Long-distance				
freq.	10	17	10	29
percent	3.3	5.6	3.3	9.6
row pct.	15.1	25.8	15.2	43.9
col. pct.	21.7	23.3	14.9	25.0
Short-distance				
freq.	16	11	38	27
percent	5.3	3.6	12.6	8.9
row pct.	17.4	11.9	41.3	29.4
col. pct.	34.8	15.1	56.7	23.3
Resident				
freq.	20	45	19	60
percent	6.6	14.9	6.4	19.9
row pct.	13.9	31.2	13.2	41.7
col. pct.	43.5	61.6	28.4	51.7

Chi-square P=0.001

DISCUSSION

Bird diversity in shelterbelts in 1992 may have been higher than bird diversity in riparian areas because both grassland and edge-woodland birds commonly use shelterbelts (Martin, 1978; Tubbs, 1980). Bird density may have been higher in riparian areas because of large numbers of insectivorous, woodland birds congregating in the small strips of available riparian habitat. Gray (1989) found positive correlations between densities of insectivorous birds and net emergence biomass of aquatic insects from a Kansas stream. Bird density may have been higher in 1993 than 1992 due to some combination of factors, including the effects of flooding, improvements in counting technique, or because 1993 censuses were done earlier in the breeding season than 1992 censuses. Habitat by year interaction indicated that density was highest in riparian habitat in 1993 and that the difference in mean density was greater between years in riparian corridors than in shelterbelts. Bird density was probably lower on Flint Hills sites because there was less vegetation and more bare ground than on the Melvern sites. Area by habitat interaction indicated that density was highest in the riparian corridors on the Melvern area. Mills et al. (1991) found their index of vegetation volume correlated strongly with bird density during the breeding season. They suggested that birds were responding to resources associated with vegetation. Bird species richness may have been higher in riparian corridors due to the presence of water attracting more species, or due to the greater tree species richness found in the riparian habitat. Bird species richness may have been negatively affected by the floods in May of 1993. It is possible that some of the birds that nested there in 1992 were unsuccessful in 1993, so they left the area in search of a better place to nest. It is possible that bird species richness was higher on the Melvern area due to the greater amount of vegetation found on that area. Area by habitat interaction indicated that bird species richness was highest in riparian corridors on the Melvern area, and that the difference in mean bird species richness was greater between areas in riparian corridors than shelterbelts. Emmerich and Vohs (1982) compared avian density and diversity in riparian woodlands, multi-row shelterbelts, single row shelterbelts, and tree claims in eastern South Dakota. They found that during the breeding season riparian habitats had a higher density than shelterbelt habitats. They also observed higher bird species richness in riparian woodlands than shelterbelts during the breeding season.

Percent canopy cover and number of snags may have been affected by flooding in May of 1993. It is possible that flood waters went through narrow creek channels and that many snags were carried away by the current. Tree species richness was higher in riparian areas than shelterbelts because single-row shelterbelts in east-central Kansas are often planted with few species of trees, whereas riparian zones tend to have most of the tree species that exist in woodlands of eastern Kansas.

Percent grass cover and forb cover were higher on Melvern sites than Flint Hills sites, probably because the former were higher in elevation than the latter. Therefore, on Melvern sites, flood waters receded and vegetation recovered faster than on Flint Hills sites. This may also explain why percent bare ground was higher on Flint Hills sites than on Melvern sites. Overall, percent bare ground was higher in 1993 than 1992, probably because of the severity of the 1993 spring floods. Area by year interaction indicated that percent bare ground was highest on the Flint Hills area in 1993 and that the difference in percent bare ground between years was larger on the Flint Hills area than the Melvern area. Percent forb cover may have been higher in riparian areas than in shelterbelts because forbs are typically the first plants to recolonize after a major habitat disturbance (Brewer, 1988). In 1993, forbs on many Flint Hills sites did not have a chance to completely recover from the flood before sampling took place and as a result Melvern sites had higher percent forbs.

The high frequency of resident birds found on all areas may be the result of fragmentation and high edge-to-area ratios typical for both narrow riparian zones and single-row shelterbelts (Galli et al., 1976; Odum, 1978; Smith, 1992). Anderson (1980) found that over a 30 year period long distance migrants showed a major decline, whereas permanent residents tended to maintain their populations in spite of forest fragmentation. He also mentioned that many resident species and short-distance migrants have adapted to edge habitats, whereas many long-distance migrants require large insular tracts of forest to reproduce successfully. In my study, the highest number of long-distance migrants was found in riparian habitats, which was probably the result of higher tree species richness, more structural complexity of vegetation, and the presence of water. The Melvern riparian habitat-area had more vegetation cover than any of the other habitat-areas, this may explain why more long-distance migrants were found there in 1993.

Of the three bird species unique to shelterbelts two, the Eastern Meadowlark and Scissor-tailed Flycatcher, are grassland inhabitants, and one, the Red-headed Woodpecker, prefers edge habitat, but is often seen in open prairie (Thompson and Ely, 1989; Thompson and Ely, 1992). Of the three species unique to riparian zones, two of these, the Eastern Phoebe and Carolina Wren, are found along edges, but tend to prefer larger tracts of woods and running water (Thompson and Ely, 1992). The third unique riparian species, the Gray Catbird, is considered to be primarily an edge dwelling species that prefers ample cover (Thompson and

Ely, 1992).

Results of my study indicated that bird density and species richness were higher in riparian zones, and on the Melvern area. There were no significant differences between habitat types in tree canopy cover, tree density, DBH, or snag density. Tree species richness was higher in riparian zones than in shelterbelts. Percent forb cover was higher in riparian zones. Tree canopy cover was higher on Melvern sites. Most of the birds found in all habitat-areas during my study were year-round residents; many of these birds could also be classified as having a preference for edge habitats. This may be a result of the narrow, linear nature of both habitat types investigated. The results of my study are general, to make more specific conclusions regarding the importance of these habitats to birds will require further study. Future research might include a comparison of use in narrow riparian corridors and shelterbelts by individual species of birds; an investigation of how avian use of these habitats differs from season to season; and investigation into how the presence of riparian areas and shelterbelts affect bird density, diversity, and species richness in habitats adjacent to them.

LITERATURE CITED

American Ornithologists' Union. 1983. Check-list of North American birds, 6th ed. Am. Ornithol. Union, Washington D.C.

Anderson, S. H. 1979. Habitat structure, succession and bird communities. Pp. 9-21 in Symposium on management of northcentral and northeastern forests for nongame birds (R. M. DeGraaf and K. E. Evans eds.). U.S.D.A. For. Serv. Gen. Tech. Rep. NC-51, St. Paul, Minnesota.

Anderson, S. H. 1980. Habitat selection, succession, and bird community organization. Pp. 13-25 in Workshop proceedings management of western forests and grasslands for nongame birds (R. M. DeGraaf and N. G. Tilghman eds.). U.S.D.A. For. Serv. Gen. Tech. Rep. INT-86, Ogden, Utah.

Askins, R. A. and M. J. Philbrick. 1987. Effect of changes in regional forest abundance on the decline and recovery of a forest bird community. Wilson Bull. 99:7-21.

Best, L. B., D. F. Stauffer, and A. R. Geier. 1978. Evaluating the habitat alteration on birds and small mammals occupying riparian communities. Pp. 117-124 in Strategies for protection and management of floodplain wetlands and other riparian ecosystems (R. R. Johnson and J. F. McCormick eds.). U.S.D.A. For. Serv. Gen. Tech. Rep. WO-12, Washington, D.C.

Blake J. G. and J. R. Karr. 1987. Breeding birds of isolated woodlots: area and habitat relationship. Ecology 68:1724-1734.

Brewer, R. 1988. The science of ecology. W. B. Saunders Co., Orlando, Florida.

Burnham, K. P., D. R. Anderson, and J. L. Laake. 1985. Efficiency and bias in strip and line transect sampling. J. Wildl. Manage. 49:1012-1017.

Cable, T. T., R. L. Schroeder, V. Brack, and P. S. Cook. 1992. Summer bird use of Kansas windbreaks. Prairie Nat. 24:175-183.

Cassel, J. F. and J. M. Wiehe. 1980. Uses of shelterbelts by birds. Pp. 78-87 in Workshop proceedings management of western forests and grasslands for nongame birds (R. M. DeGraff and N. G. Tilghman eds.). U.S.D.A. For. Serv. Gen. Tech. Rep. INT-86, Ogden, Utah.

Conner, R. N. and J. G. Dickson. 1980. Strip transect sampling and analysis for avian habitat studies. Wildl. Soc. Bull. 8:4-9.

Cook, P. S. and T. T. Cable. 1990. The economic value of windbreaks for hunting. Wildl. Soc. Bull. 18:337-342.

Emlen, J. T. 1971. Population densities of birds derived from transect counts. Auk 88:323-342.

Emmerich, J. M. 1978. Bird utilization of woodland habitat in the eastern quarter of South Dakota. M.S. thesis, South Dakota State University, Brookings, South Dakota.

Emmerich, J. M. and P. A. Vohs. 1982. Comparative use of four woodland habitats by birds. J. Wildl. Manage. 46:43-49.

Galli, A. E., C. F. Leck, and R. T. T. Forman. 1976. Avian distribution patterns in forest islands of different sizes in central New Jersey. Auk 93:356-364.

Gray, L. J. 1989. Correlations between insects and birds in tallgrass prairie riparian habitats. Pp. 263-265 in Proceedings of the eleventh North American prairie conference (T. B. Bragg and J. Stubbendieck eds.). University of Nebraska Printing, Lincoln, Nebraska.

Hamilton, R. G. 1986. Winter avian use of fragmented woodlands. M.S. thesis, Emporia State University, Emporia, Kansas.

MacClintock, L., R. F. Whitcomb, and B. L. Whitcomb. 1977. Island biogeography and "habitat islands" of eastern forest. II. evidence for the value of corridors and minimization of isolation in preservation of biotic diversity. Am. Birds 31:6-12.

Martin, T. E. 1978. Diversity and density of shelterbelt bird communities. M.S. thesis, South Dakota State University, Brookings, South Dakota.

Martin, T. E. 1981. Limitation in small habitat islands: chance or competition? Auk 98:715-734.

McCauley, E. A. 1980. Effects of Oklahoma cross timbers riparian vegetation composition on avian community dynamics. M.S. thesis, Oklahoma State University, Stillwater, Oklahoma.

Mikol, S. A. 1980. Field guidelines for using transects to sample nongame bird populations. FWS/OBS-80/58. Washington D.C.

Mills, G. S., J. B. Dunning, and J. M. Bates. 1991. The relationship between breeding bird density and vegetation volume. Wilson Bull. 103:468-479.

Odum, E. P. 1978. Ecological importance of the riparian zone. Pp. 2-4 in Strategies for protection and management of floodplain wetlands and other riparian ecosystems (R. R. Johnson and J. F. McCormick eds.). U.S.D.A. For. Serv. Gen. Tech. Rep. WO-12. Washington, D.C.

Ptacek, J. A. 1986. Avian community structure in Kansas riparian forests. M. S. thesis, Emporia State University, Emporia Kansas.

Robbins, C. S., B. Bruun, and H. S. Zim. 1983. A Guide to field identification: birds of North America. Golden Press, New York.

SAS Institute, Inc. 1988. SAS user's guide: statistics. Release 6.03 edition. SAS Institute, Inc. Cary, NC.

Schroeder, R. L. 1986. Habitat suitability index models: wildlife species richness in shelterbelts. U. S. Fish and Wildlife Service Biological Report. 82(10.128). Washington, D.C.

Schroeder, R. L., T. T. Cable, and S. L. Haire. 1992.

Wildlife species richness in shelterbelts: test of a habitat model. Wildl. Soc. Bull. 20:264-273.

Shannon, C. E. and W. Weaver. 1949. The mathematical theory of communication. Univ. Illinois. Press, Urbana, Illinois.Smith, R. L. 1980. Ecology and field biology. Third ed. Harper & Row Publ., New York.

Smith, R. J. 1992. Avian characteristics of an urban riparian strip corridor. Wilson Bull. 104:732-738.

Stephens, H. A. 1969. Trees, shrubs, and woody vines in Kansas. University of Kansas Press, Lawrence, Kansas.

Thompson, M. C. and C. Ely. 1989. Birds in Kansas. Vol. 1. Museum of Natural History. Lawrence, Kansas.

Thompson, M. C. and C. Ely. 1992. Birds in Kansas. Vol. 2. Museum of Natural History. Lawrence, Kansas.

Tubbs, A. A. 1980. Riparian bird communities of the Great Plains. Pp. 419-433 in Workshop proceedings management of western forests and grasslands for nongame birds (R. M. DeGraff and N. G. Tilghman eds.). U.S.D.A. For. Serv. Gen. Tech. Rep. INT-86. Ogden, Utah.

Verner, J. 1985. Assessment of counting techniques. Pp. 247-301 in Current Ornithology, Vol. 2 (R. F. Johnston ed.), Plenum Publishing, New York.

Yahner, R. H. 1981. Avian winter abundance patterns in farmstead shelterbelts: weather and temporal effects. J. Field Ornithol. 52:50-56.

Yahner, R. H. 1982. Avian use of vertical strata and plantings in farmstead shelterbelts. J. Wildl. Manage. 46:50-60.

Yahner, R. H. 1983. Avifauna in farmstead shelterbelts. J. Wildl. Manage. 47:80-103.

Zar, J. H. 1984. Biostatistical analysis. 2nd ed. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

APPENDIX A

BIRD SPECIES LIST

COMMON NAME	SCIENTIFIC NAME
Mourning Dove	Zenaida macroura
Yellow-billed Cuckoo	Coccyzus americanus
Hairy Woodpecker	Picoides villosus
Northern Flicker	Colaptes auratus
Downy Woodpecker	Picoides pubescens
Red-headed Woodpecker	Melanerpes erythrocephalus
Red-bellied Woodpecker	Melanerpes carolinus
Scissor-tailed Flycatcher	Tyrannus forficatus
Eastern Kingbird	Tyrannus tyrannus
Great Crested Flycatcher	Myiarchus crinitus
Eastern Phoebe	Sayornis phoebe
Eastern Wood-Pewee	Contopus virens
Blue Jay	Cyanocitta cristata
Black-capped Chickadee	Parus atricapillus
Tufted Titmouse	Parus bicolor
White-breasted Nuthatch	Sitta carolinensis
House Wren	Troglodytes aedon
Carolina Wren	Thryothorus ludovicianus
Brown Thrasher	Toxostoma rufum
Gray Catbird	Dumetella carolinensis
Northern Mockingbird	Mimus polyglottos
Eastern Bluebird	Sialia sialis
American Robin	Turdus migratorius
Red-eyed Vireo	Vireo olivaceus
Northern Parula	Parula americana

Common Yellowthroat	*Geothlypis trichas*
Northern Oriole	*Icterus galbula*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Brown-headed Cowbird	*Molothrus ater*
Northern Cardinal	*Cardinalis cardinalis*
Dickcissel	*Spiza americana*
American Goldfinch	*Carduelis tristis*
Indigo Bunting	*Passerina cyanea*
Field Sparrow	*Spizella pusilla*
Lark Sparrow	*Chondestes grammacus*

APPENDIX B

TREE SPECIES FOUND DURING STUDY

COMMON NAME	SCIENTIFIC NAME
Red Cedar	Juniperus virginiana
Black Willow	Salix nigra
Cottonwood	Populus deltoides
Black Walnut	Juglans nigra
Oak spp.	Quercus spp.
Bur Oak	Quercus macrocarpa
Pin Oak	Quercus palustris
American Elm	Ulmus americana
Hackberry	Celtis occidentalis
Red Mulberry	Morus rubra
Osage Orange	Maclura pomifera
Sycamore	Platanus occidentalis
Plum spp.	Prunus spp.
Black Cherry	Prunus serotina
Honey Locust	Gleditsia triacanthos
Redbud	Cercis canadensis
Silver Maple	Acer saccharinum
Box Elder	Acer negundo
Rough-leaved Dogwood	Cornus drummondii
Green Ash	Fraxinus pennsylvanica
Hibiscus spp.	Hibiscus spp.

APPENDIX C

MIGRATORY GUILD DESIGNATIONS

Long-distance Migrants

Yellow-billed Cuckoo

Eastern Wood-Peewee

Great Crested Flycatcher

Eastern Kingbird

Scissor-tailed Flycatcher

Red-eyed Vireo

Northern Parula

Indigo Bunting

Dickcissel

Lark Sparrow

Short-distance Migrants

Northern Flicker

Eastern Phoebe

House Wren

Gray Catbird

Northern Mockingbird

Brown Thrasher

American Robin

Common Yellowthroat

Field Sparrow

Red-winged Blackbird

Brown-headed Cowbird

Northern Oriole

Residents

Mourning Dove

Downy Woodpecker

Red-headed Woodpecker

Hairy Woodpecker

Red-bellied Woodpecker

Blue Jay

Black-capped Chickadee

Tufted Titmouse

White-breasted Nuthatch

Carolina Wren

Eastern Bluebird

Northern Cardinal

Eastern Meadowlark

American Goldfinch

APPENDIX D

APPROXIMATE AGES OF SHELTERBELT SITES

SITE	AGE (YEARS)
FS1*	55
FS2	30
FS3	25
FS4	25
FS5	20
FS6	20
FS7	40
FS8	40
FS9	35
MS1+	Information not available
MS2	100
MS3	60-70
MS4	75
MS6	>60
MS7	60
MS8	>60
MS9	Information not available

*FS Flint Hills Shelterbelt

+MS Melvern Shelterbelt

APPENDIX E

LEGAL DESCRIPTION OF STUDY SITES

SITE NUMBER	LEGAL DESCRIPTION	COUNTY
FR1#	Sec 9, T 20 S, R 13 E	Lyon
FR2	Sec 10, T 20 S, R 13 E	Lyon
FR4	Sec 7 and 18, T 20 S, R 13 E	Lyon
FR6	Sec 17 and 18, T 20 S, R 14 E	Coffey
FS1*	Sec 10, T 20 S, R 13 E	Lyon
FS2	Sec 8, T 20 S, R 13 E	Lyon
FS3	Sec 14, T 20 S, R 13 E	Coffey
FS4	Sec 13, T 20 S, R 13 E	Coffey
FS5	Sec 13, T 20 S, R 13 E	Coffey
FS6	Sec 12, T 20 S, R 13 E	Coffey
FS7	Sec 17, T 20 S, R 14 E	Coffey
FS8	Sec 17, T 20 S, R 14 E	Coffey
FS9	Sec 17, T 20 S, R 14 E	Coffey
MR1**	Sec 28, T 18 S, R 14 E	Osage
MR2	Sec 36, T 17 S, R 14 E	Osage
MR3	Sec 5,8,9, T 18 S, R 13 E	Lyon
MR4	Sec 25, T 17 S, R 14 E	Osage
MR5	Sec 26, T 17 S, R 12 E	Lyon
MS1+	Sec 34, T 17 S, R 12 E	Lyon
MS2	Sec 30, T 17 S, R 13 E	Lyon
MS3	Sec 27, T 17 S, R 13 E	Lyon
MS4	Sec 12, T 18 S, R 13 E	Osage
MS6	Sec 22, T 18 S, R 14 E	Osage
MS7	Sec 23, T 18 S, R 14 E	Osage

Site Number	**Legal Description**	**COUNTY**
MS9	Sec 4, T 18 S, R 15 E	Osage
MS8	Sec 23, T 18 S, R 14 E	Osage

* FS Flint Hills Shelterbelt

+ MS Melvern Shelterbelt

FR Flint Hills Riparian Area

** MR Melvern Riparian Area

Terri A. Abbett

Signature of Graduate Student

Elmer J. Finck

Signature of Major Advisor

Terri A. Abbett

Signature of Author

5 May, 1994

DATE

Avian density, diversity, and species richness in riparian corridors and shelterbelts of east-central Kansas.

Title of Thesis

Signature of Graduate Office Staff Member

May 6, 1994

Date Received