AN ABSTRACT OF THE THESIS OF

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Title: Winter Avian Use of Fragmented Woodlands

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Winter birds inhabiting small fragmented woodlands were studied in three riparian areas near Emporia, Lyon County, Kansas. Study areas varied in size and shape, but all were dominated by hackberry (Celtis occidentalis) and were not significantly different in regard to overall vegetation structure or composition. Two study areas, of 4.0 ha and 8.3 ha, were roughly triangular in shape. The third study area (3.7 ha) was a linear-shaped woodlot that had a much higher edge ratio. The purpose of this research was to determine if size and shape of fragmented woodlands were important factors affecting wintering bird species richness, diversity, and density.

A total of 43 bird censuses was conducted in each study area during the winters of 1980-81 and 1981-82. Bird species richness, diversity, and density were calculated for each census, and statistical comparisons were made among the three study areas.

Results demonstrated that size and shape of forest fragments are important variables that affect winter avian use. The larger study area had significantly greater bird species richness, diversity, and densities. Comparisons of

the two smaller study areas revealed that the study area with the lower edge ratio had significantly greater bird species richness and density. Increased species richness was the result of the addition of both permanent-resident and migratory winter-resident bird species. When considered in combination with the findings of numerous breeding bird studies, these results suggest that permanent-resident woodland birds may be more selective of their habitat in winter than during the breeding season.

WINTER AVIAN USE
OF FRAGMENTED WOODLANDS

A Thesis

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by

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INTRODUCTION

The importance of woodland habitat to birds of the Great Plains has been well established (Hubbard 1977, Bull 1978). These forested areas are primarily concentrated along natural drainage systems, floodplains, and banks of reservoirs. Although the quantity of this habitat type is estimated at only one to three percent (Tubbs 1980), it harbors the majority of avian species. Johnsgard (1979) reported that 51% of the breeding birds of the Great Plains are classified as woodland species. The Kansas avifauna closely parallels this pattern. Johnston (1964) reported that 58% of the Kansas breeding birds are woodland species, and he found (Johnston 1965) that 56% of all resident species inhabited woodlands. Johnston (1977) and Ports (1979) also demonstrated the importance of this community type to the avifauna of Kansas.

Agricultural and other human activities have caused the destruction and ever increasing fragmentation of many important natural ecosystems; woodlands in particular. Considerable recent research has focused upon the avian use of the fragmented woodland "islands" that remain. In these studies, it has been established that breeding bird species richness increases with increasing woodland tract size (Forman et al. 1976, Galli et al. 1976, Willson and Carothers 1979, Ambuel and Temple 1983, Howe 1984). All of these studies point out that this positive correlation of stand size and breeding bird species richness was due to the addition of forest interior species. Blake (1983) also reported this same trend, adding that ecological generalist species are more abundant in small forests, while specialist species are poorly represented in small tracts, but become more abundant in larger forests. Additional insights were provided by Robbins (1979), Blake and Karr (1984), and Lynch and Whigham (1984). These authors reported that the forest interior/specialist birds that require large forest tracts are the long-distance migrant species that winter in the tropics. The permanent-resident and short-distant migrants are the more ecological generalist species that can use smaller woodlands.

Shape of woodland tracts, in regard to the ratio of perimeter to area (edge), also can apparently be an important factor in determining breeding bird use. Strelke and Dickson (1980) found significant differences in breeding bird species richness, densities, and diversities in the first 25 meters of forest edge when compared to forest interior regions. Stauffer and Best (1980) reported that breeding bird species richness increases with increasing widths of forested riparian habitat.

All of the above cited literature deals only with breeding birds. However, winter is the period of potentially greatest stress and selection pressure (Anderson and Ohmart 1977, Anderson et al 1983). Fretwell

(1972) stated that the quality of wintering habitat is critical to the survival of the breeding population, while Kricher (1975) suggested that bird populations are at least partially regulated by winter factors. In addition, Samson (1979) reported that little is known of the energetic requirements of wintering birds or the importance of thermal refuges.

There is a relative dearth of information regarding habitat requirements and selection mechanisms of winter woodland birds. The purpose of this research was to determine if size and shape of fragmented woodlands are important factors affecting wintering bird usage. Three woodland tracts of varying size and shape were studied to determine if those factors affect wintering bird species richness, diversity, density and composition.

METHODS AND MATERIALS

Study Areas

Three study areas were located from three to seven miles east and southeast of Emporia, Lyon County, Kansas (Figure 1). Study areas were located in the forested riparian corridor of the Neosho and Cottonwood Rivers in Township 19 South, Range 12 East. Soils common to each area were Ivan and Reading silty loams of the Chase-Osage Association. These soils are found on flood plains and low terraces, and are deep, nearly level, moderately and poorly drained soils that have a dominantly silty subsoil (U.S. Soil Conservation Service 1981).

Study areas were named for their respective owners: the Wood site, owned and managed by Commodore Wood, RFD 1, Emporia, Kansas; the Fowler site, owned and managed by Harry Fowler, Jr., RFD 1, Emporia, Kansas; and the Cook site, owned by the Cook Estate and managed by Claire Pearson, RFD 1, Emporia, Kansas. The Wood study area was a 3.7 hectare linear woodland on the Neosho River (Figure 2). The Fowler study area, located nearby on the Cottonwood River, was of comparable size (4.0 hectares), but was a roughly triangular shaped woodland tract (Figure 3). The Cook study area, located on the Neosho River, also was roughly triangularly shaped, but was more than twice as large (8.3 hectares) as each of the other two study areas (Figure 4).

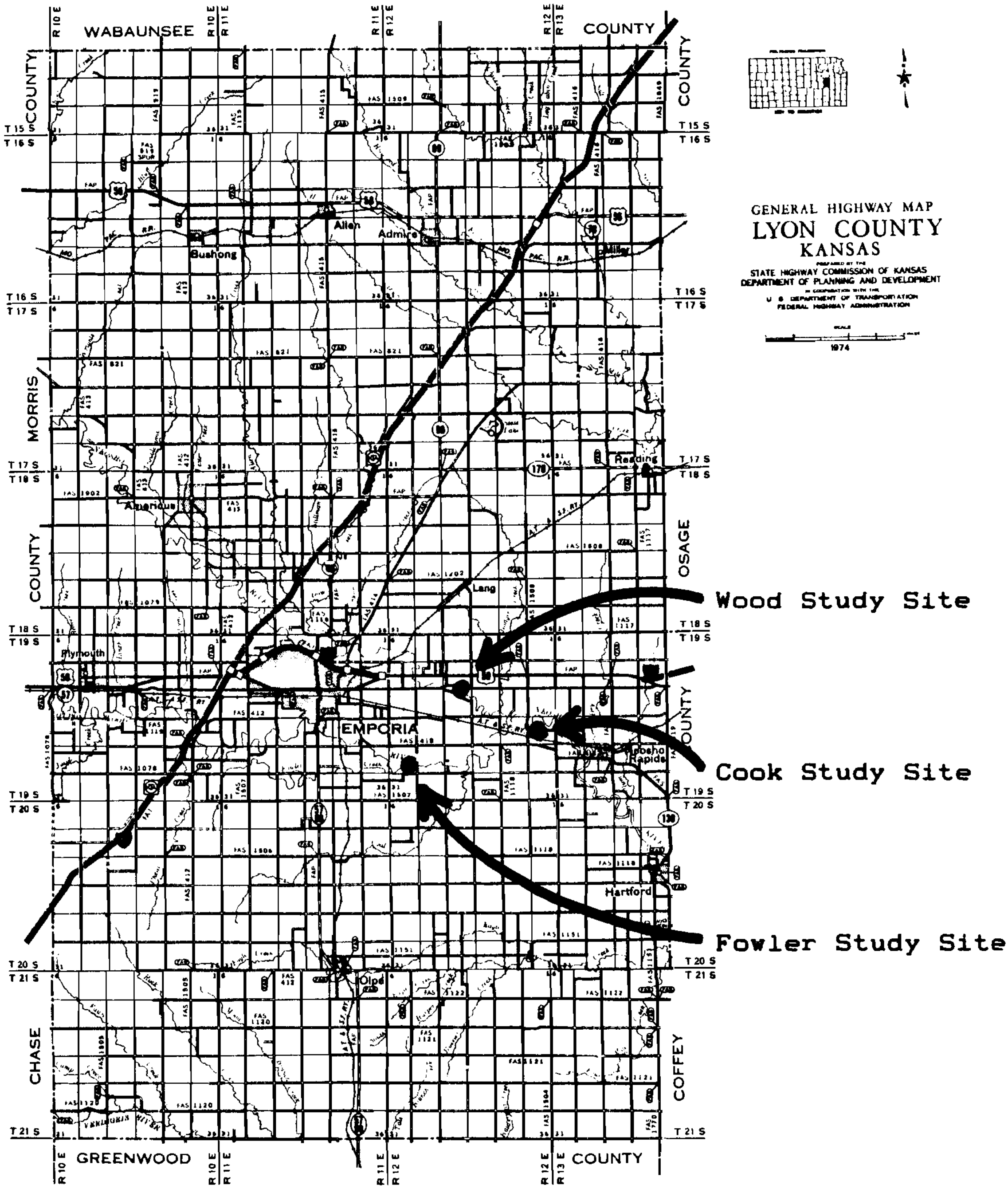

FIGURE 1. Lyon County, Kansas, highway map identifying locations of forested study sites.

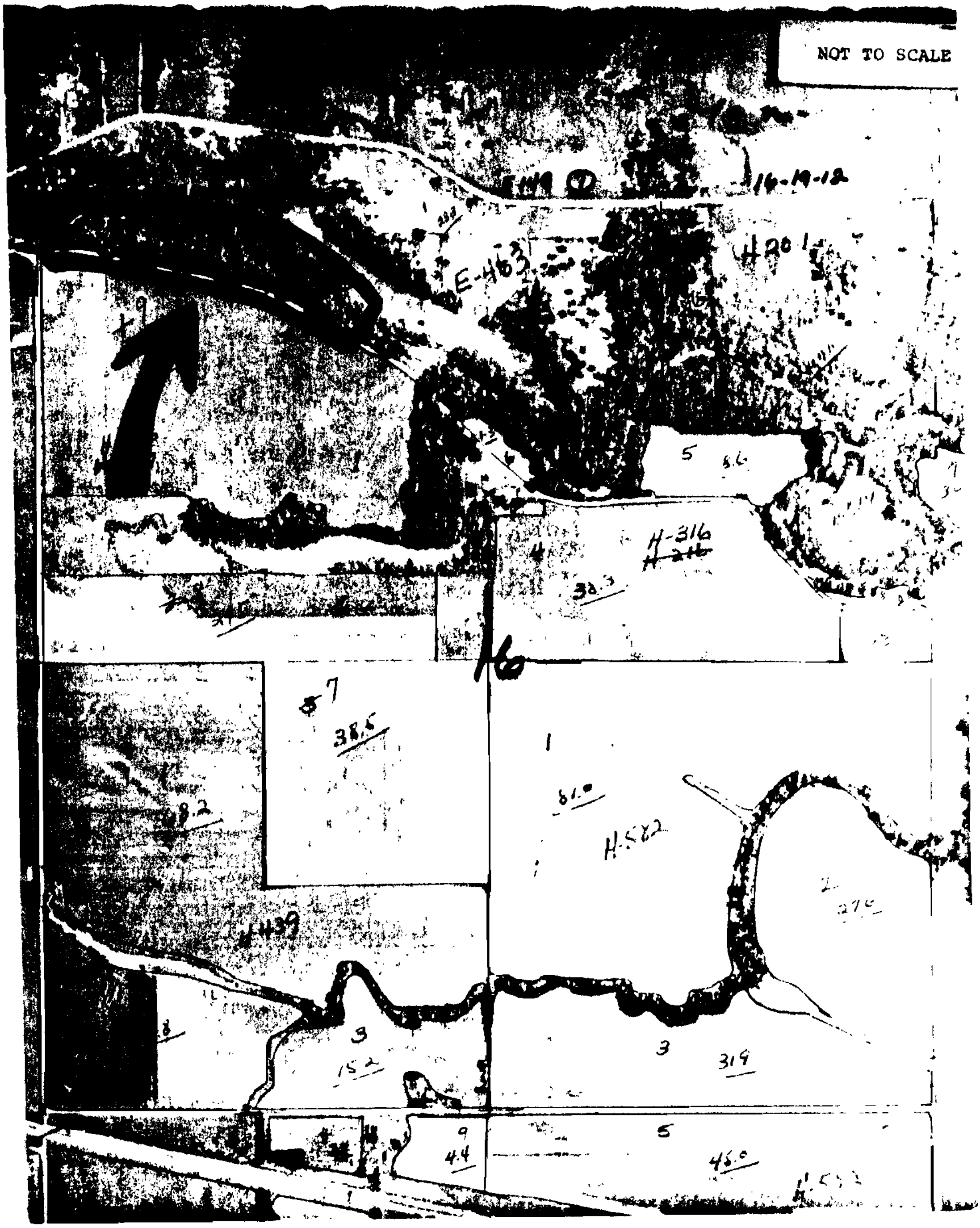

FIGURE 2. Wood study site aerial photograph.

FIGURE 3. Fowler study site aerial photograph.

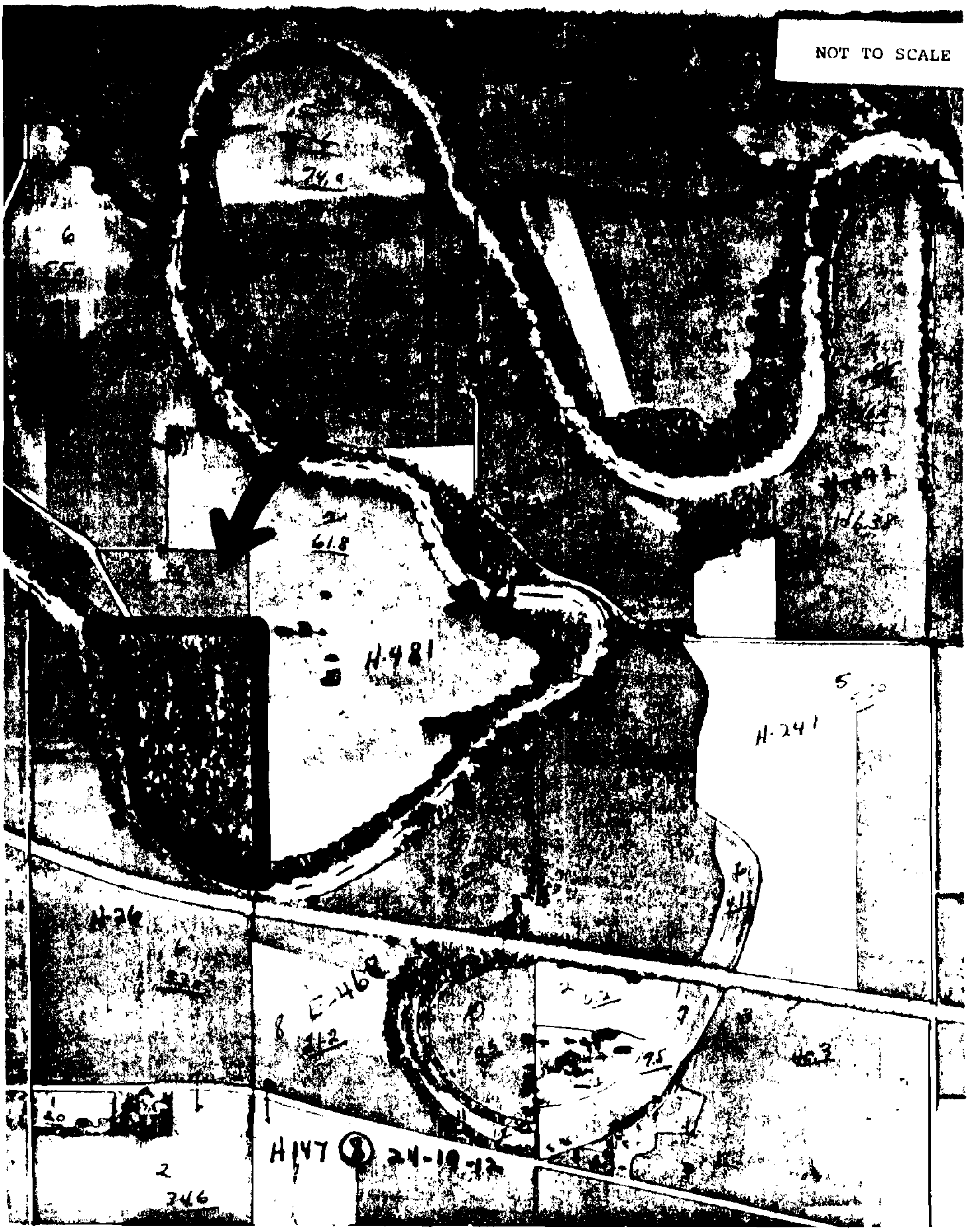

FIGURE 4. Cook study site aerial photograph.

The Wood study area had an edge ratio of 1.58, whereas the Fowler and Cook sites had edge ratios of 1.24 and 1.23, respectively. The edge ratio was calculated as the study area perimeter divided by the circumference of a circle of equal area to the study site. The minimum obtainable edge ratio of one (1) would occur with a perfectly circular area (minimum perimeter to area ratio possible).

Information collected from each owner/manager indicated that all study areas have experienced similar woodlot management treatments. Each area has been lightly to moderately logged over the past 30-40 years. Larger trees were removed, with selection being principally for those species with high commercial or fuel value. No major wood-harvesting took place during this study, although the removal of several large trees was observed from each study area over the course of this research. Cattle had access to the Fowler and Cook study areas during both winters of this research, but the resulting disturbance was judged to be very light and of negligible impact.

Vegetation Sampling

Trees and saplings were sampled using the point-centered quarter method (Cottam and Curtis 1956). The sampling design in each study area consisted of randomly locating a transect parallel to the river, and from it, perpendicular spur transects. Forty sample points were then randomly located along the spur transects. At each sample point the closest tree and sapling in each 90° quarter was sampled. Distance from the sample point to the center of the tree/sapling (point-to-plant distance), species, and diameter at breast height (dbh) were recorded. One hundred and sixty trees and the same number of saplings were sampled in each study area. Trees were classified as having a dbh of equal to or greater than four inches, while saplings were considered to be young trees of less than four inches dbh and greater than 2 meters in height.

From this information, average total tree and sapling density, point-to-plant distance, and dbh were calculated for each study area. The Kruskall-Wallis test and nonparametric multiple comparisons statistical tests were then used to determine if significant differences existed among study areas and their respective point-to-plant distances and dbh data. Nonparametric tests were utilized only after it became apparent that logarithmic transformations were unable to make the data conform to the required assumptions of analysis of variance (Sokal and Rohlf 1981). The data were inherently nonnormally distributed with heteroscedastic variances. All statistical analyses were performed at the .05 level of probability.

For descriptive and general comparative purposes, importance values and similarity indices were calculated for all tree and sapling species in each study area.

The importance value is defined as the summation of the relative density, relative dominance, and relative frequency of a tree or sapling species (maximum value of 300). The index of similarity formula of Ellenberg (1956) was modified to permit the comparison of three areas rather than just two. It is defined as the sum of the relative frequencies of all species common to all three study areas, multiplied by 100, and divided by the sum of the relative frequencies of species not common to all three areas. The maximum possible similarity index is 100.

The frequency of herbaceous and shrubby vegetation and tree seedlings (less than 2 meters in height) was recorded in one m^2 quadrats centered at each of the 40 sampling points. A similarity index also was calculated from this information to assess the similarity of forest understories of the three study areas.

Vertical structural diversity of the vegetation was also measured at each of the 40 sample points. At each point, a vertically held camera with 200mm lens was used to record the presence or absence of vegetation in four height classes: 0-1 m, 1-3 m, 3-10 m, >10 m. These data were used to calculate percent vegetative cover, which is defined as the sum of the frequency of vegetative cover for all height classes (maximum of 400 possible). Foliage height diversities also were computed for each study site using the formula of Shannon (1948):

$$H' = \sum_{i=1}^{s} p_i \log_{10} p_i$$

where s is the number of categories (height classes) and p_i is the proportion of observations in the i^{th} category. Foliage height diversity values for each study area were compared using Hutcheson's (1970) method of testing for differences in diversity. Common and scientific names of plants were taken from Barkley (1977).

<u>Avian Sampling</u>

Forty-three bird censuses were conducted over the two winters of the study: 21 from 15 November 1980, to 16 March 1981, and 22 from 6 November 1981, to 15 March 1982. All study sites were censused approximately once per week on the same morning, with the sampling order being constantly rotated among the study areas. Censuses were conducted from 08:00 a.m. through noon. Each census took about one hour to perform, and consisted of slowly walking a circular route through the sample area, and recording all individual birds positively identified by sight or call. Only a 3.5 hectare area in the northwest corner of the Cook study site was censused, whereas the entire tracts of the Wood and Fowler study sites were inventoried with each census.

Birds entering or leaving a stand were recorded, but birds only flying over the canopy were excluded to avoid overly influencing the data with observations of highly transient flocks that only infrequently used the study sites. Censuses were not conducted during periods of precipitation or when winds were in excess of 24 kilometers per hour. Climatic information such as wind speed and direction, temperature, snow cover, precipitation and cloud cover were recorded for each census.

Census data for the two winter sampling periods were combined and analyzed as a single data set. The number of species seen on each census was summed to give a richness value per census. Likewise, the total number of individuals were summed for each census to determine bird densities. Density values were extrapolated to bird density per 40 hectares to allow comparisons among the slightly different sized sample areas. The previously mentioned Shannon (1948) formula was used to compute the bird species diversity for each census. Avian richness, density, and diversity values per census among study sites were then statistically compared. As was the case with statistical evaluations of the vegetation data, analysis of the bird census data also required the use of the nonparametric Kruskal-Wallis test. The nonnormal distribution and heteroscedastic variances of the data could not be corrected by transformations to allow the use of parametric testing techniques. The .05 level of probability was used in all analyses.

Importance values also were calculated for each bird species at each study site. The importance value was defined as the relative frequency plus the relative density of a species. The maximum importance value obtainable was 200. Common and scientific names of birds were from the American Ornithologists' Union (1982).

RESULTS

Vegetation Analyses

The measured vegetation parameters of the study areas are summarized in Table 1. Results of statistical comparisons between study areas are also noted. The foliage height diversities of the three areas were very similar, and were found to not be significantly different. Similarly, no significant differences were found in comparisons of point-to-tree distances (from point-centered quarter sampling), indicating very similar tree densities among all three study areas.

Table 2 presents the tree species importance values for each study area, and Table 3 presents the same information for sapling species (see Appendix 1). Hackberry (*Celtis occidentalis*) was by far the dominant and most important tree and sapling species in all three study areas. American elm (*Ulmus americana*) was the second most important tree and sapling species in the Wood study area. Green ash (*Fraxinus pennsylvanica*) was the second most important tree and sapling species in the Fowler study area. The second most important tree species in the Cook study area was red mulberry (*Morus rubra*), while pawpaw (*Asimina triloba*) had the second highest sapling importance value. Similarity index calculations of 62.0% for tree species, and 47.8% for sapling species indicate a high degree of similarity, since an index value of 50% or larger

TABLE 1. Summary of vegetation data and statistical tests.

Parameter	Study Area: Wood	Fowler	Cook
Structural diversity			
Fol. ht. diversity[1]	.599^{a}	.597^{a}	.597^{a}
% Veg. cover	355.0	317.5	330.0
Species richness			
Trees	14	10	12
Saplings	12	12	14
Total density			
Trees (#/ha)	483.0	441.4	493.8
Saplings (#/ha)	594.9	375.6	907.2
Point-to-plant distance[2]			
Trees (ft)	14.9±9.1^{a}	15.6±8.8^{a}	14.8±9.7^{a}
Saplings (m)	4.1±3.3^{a}	5.2±3.8^{b}	3.3±2.3^{c}
Diameter at breast height[2]			
Trees (inches)	10.2±8.1^{a}	10.0±5.6^{a}	8.4±5.8^{b}
Saplings (inches)	1.2±.7^{a}	1.4±.7^{b}	1.3±.6^{c}

[1] Nonsignificant differences with Hutcheson's test (P>.05).

[2] Mean and ± standard deviation of the data. Groups tested with Kruskal-Wallis test. Significant differences (P<.05) indicated by different superscript letters in each row. Nonsignificant differences (P>.05) indicated by similar superscript letters.

TABLE 2. Tree species importance values.[1]

	Study Area		
Tree Species	Wood	Fowler	Cook
Hackberry	129.9	143.0	112.6
Red Mulberry	25.2	35.4	39.1
American Elm	50.1	12.8	27.1
Green Ash	9.8	45.5	20.2
Snag (standing dead tree)	25.7	7.7	25.1
Black Walnut	3.4	-	27.6
Silver Maple	3.5	24.9	1.5
Slippery Elm	7.8	-	15.7
Kentucky Coffee Tree	3.8	6.7	9.8
Sycamore	15.6	2.3	-
Box Elder	4.2	10.7	-
Bur Oak	13.4	-	-
Red Bud	1.6	-	7.4
Bitternut Hickory	-	-	8.8
Cottonwood	-	7.7	-
Honey Locust	4.1	-	1.4
Osage Orange	-	-	3.5
Black Willow	-	3.2	-
Downy Hawthorn	1.8	-	-

[1] Importance value equals the sum of the relative density, relative dominance, and relative frequency. Maximum possible importance value for a species = 300.

TABLE 3: Sapling species importance values.[1]

Sapling Species	Study Area		
	Wood	Fowler	Cook
Hackberry	160.0	164.1	122.0
American Elm	68.9	22.0	38.4
Pawpaw	23.1	8.3	39.9
Green Ash	11.1	35.5	24.1
Red Mulberry	-	18.1	7.9
Snag (standing dead sapling)	-	8.5	10.8
Kentucky Coffee Tree	-	4.3	11.8
Black Walnut	4.4	-	10.8
Slippery Elm	13.4	-	1.5
Bitternut Hickory	2.5	3.8	7.8
Elderberry	-	6.0	7.3
Silver Maple	-	9.4	2.8
Rough-leaved Dogwood	8.2	-	3.4
Redbud	-	-	9.6
Bur Oak	2.4	7.1	-
Box Elder	-	8.9	-
Wahoo	1.7	4.1	-
Sycamore	2.4	-	-
Honey Locust	1.8	-	-
Osage Orange	-	-	1.8

[1] Importance value equals the sum of the relative density, relative dominance, and relative frequency. Maximum possible importance value for a species = 300.

indicates a high degree of similarity.

Table 4 presents the frequency values for understory vegetation species sampled with one m^2 quadrats. Only those species with 10% or greater frequency in one or more of the study areas are shown in Table 4. Wild rye (*Elymus*) had the highest frequency in all three study areas. The understory species with the second highest frequency was different for all three study areas: chervil (*Chaerophyllum procumbens*) at the Wood study area; stinging nettles (*Urtica dioica*) at the Fowler study area; and sedge (*Carex*) at the Cook study area. The similarity index value of 61.0% for understory species frequencies indicates a high degree of similarity among study areas. From the information and analyses presented above, it was determined that the three study sites were not qualitatively or statistically different in regard to internal forest structure and species composition.

Avian Analyses

Bird census results are summarized in Tables 5 and 6 (see Appendix 2). Table 5 presents the census means for bird species richness, diversity, density, and groupings (migratory winter- and permanent-residents) for each study area. Statistical test results are noted also. The Cook study area had significantly the highest levels of avian use in all of the above categories. The Fowler study area had significantly higher levels of avian use than the Wood

TABLE 4. Herbaceous, shrub, and seedling frequencies.[1]

	Study Area		
Species	Wood	Fowler	Cook
Wild Rye	65	92	55
Sedge	38	12	52
Stinging Nettle	40	25	35
Chervil	50	22	10
Buckbrush	22	8	48
Bristly Greenbriar	38	15	12
Bluegrass	-	-	40
Hackberry	12	8	10
Poison Ivy	12	10	-
White Avens	15	2	5
Missouri Gooseberry	10	-	-

[1] Percentage of occurrence in 40 one m^2 quadrats. Only species sampled with 10% or greater frequency in one or more of the study areas are shown.

TABLE 5. Bird census means and species groupings.

	Study Area		
Parameters	Wood	Fowler	Cook
Census means[1]			
Richness	9.0±3.5[a]	9.9±2.9[b]	11.5±2.8[c]
Diversity	.814±.179[a]	.821±.181[a]	.904±.106[b]
Density	247.8±191.8[a]	328.4±240.1[b]	399.7±214.1[c]
Species group sizes			
Perm. residents	19	23	25
Winter residents	9	12	15
Total species	28	35	40

[1] Mean and ± standard deviation of the data. Census data analyzed with Kruskal-Wallis test. Significant differences (P<.05) indicated by different superscript letters in a row. Nonsignificant differences (P>.05) indicated by similar superscript letters.

TABLE 6. Bird species importance values.[1]

Bird Species	Study Area: Wood	Fowler	Cook
Sharp-shinned Hawk*	-	2	-
Red-tailed Hawk	10	14	5
Northern Bobwhite	-	6	-
American Woodcock	-	-	2
Mourning Dove	-	11	5
Great Horned Owl	-	5	-
Barred Owl	-	2	8
Red-headed Woodpecker	12	-	-
Red-bellied Woodpecker	108	100	105
Yellow-bellied Sapsucker*	-	2	31
Downy Woodpecker	74	89	98
Hairy Woodpecker	27	34	36
Northern Flicker	57	44	60
Pileated Woodpecker	12	-	5
Blue Jay	38	63	72
American Crow	12	16	22

TABLE 6. (Continued)

Bird Species	Study Area Wood	Fowler	Cook
Black-capped Chickadee	114	110	116
Tufted Titmouse	72	70	80
White-breasted Nuthatch	69	78	75
Brown Creeper*	66	60	50
Carolina Wren	10	2	12
Winter Wren*	-	2	2
Golden-crowned Kinglet*	14	2	20
Eastern Bluebird	21	20	8
Hermit Thrush*	-	2	-
American Robin	42	38	22
Cedar Waxwing*	-	2	4
European Starling	30	24	31
Orange-crowned Warbler*	4	-	-
Northern Cardinal	96	98	115
Rufous-sided Towhee	-	-	2
American Tree Sparrow*	-	10	17

TABLE 6. (Continued)

Bird Species	Study Area		
	Wood	Fowler	Cook
Fox Sparrow*	-	-	4
Song Sparrow*	5	10	12
White-throated Sparrow*	-	-	4
Harris' Sparrow*	7	24	37
Dark-eyed Junco*	52	79	90
Red-winged Blackbird	-	14	14
Rusty Blackbird*	2	-	2
Brewer's Blackbird*	-	-	2
Common Grackle	6	4	2
Brown-headed Cowbird	-	-	2
Purple Finch*	2	-	8
Pine Siskin*	8	5	26
American Goldfinch	27	30	33
House Sparrow	-	17	4

[1] Importance value equals the sum of the relative density and relative frequency (maximum of 200).
* Denotes migratory winter-resident species. All other species are classified as permanent-residents.

study area in all but the diversity category. Approximately two thirds (62-68%) of the bird species recorded at each site were permanent-resident species, while migratory winter-residents accounted for the remainder (32-38%).

Table 6 presents the bird species importance values for each study area, and denotes those species considered to be migratory winter-residents. All other species were classified as permanent-residents. Classifications primarily followed those of Johnston (1965). A total of 46 bird species was observed during the study: 18 migratory winter-residents; and 28 permanent-residents.

The highest bird species importance values (greater than 95) were recorded for Red-bellied Woodpeckers, Black-capped Chickadees, and Northern Cardinals in all three study areas; all of which are permanent-resident species. Migratory winter-resident species with importance values of 50 or more in all three study areas were Brown Creepers and Dark-eyed Juncos. Birds with importance values of 50 or more in at least one study area included the picids, corvids, parids, sittids, certhiids, and emberizids. The emberizids in particular were much more abundant in the Cook study area. The Cook study area had more emberizid species (13) than the other two study areas (each with seven), and the summation of the importance values for those species was much higher for the Cook study area (303) than either the Wood (172) or Fowler (239) study areas.

DISCUSSION

This research has demonstrated that the size and shape of fragmented woodlands are important variables that affect wintering avian use. The larger study area (Cook) had significantly greater bird species richness, diversity, and density (Table 5). Significant differences also were detected between the two approximately equally sized smaller study areas (Table 5). The Fowler study area, with the lower edge ratio, had significantly greater bird species richness and density than the study area with the higher edge ratio (Wood). Increased species richness was the result of the addition of both permanent-resident and migratory winter-resident species.

Results from the present winter woodland bird study very closely parallel some of the results of various breeding bird studies. They are similar to the results of Forman et al (1976), Galli et al (1976), Ambuel and Temple (1983), and Howe (1984) in demonstrating that increasing woodland tract size increases bird species richness. However, the breeding bird studies of Robbins (1979), Blake and Karr (1984), and Lynch and Whigham (1984) reported that this positive correlation of stand size and species richness was due to the addition of forest interior species that were long-distant migrant species. The permanent-residents and short-distance migrants are the more ecological generalist species that will utilize smaller woodlands.

In contrast, information from this study indicates that increased avian species richness on larger forested "islands" in winter results from the addition of both permanent-resident and migratory winter-resident species. This indicates that permanent-resident species may be more selective of their habitat in winter than during the breeding season. Winter is possibly the period of greatest stresses and selection pressures (Anderson and Ohmart 1977), and apparently both permanent-resident and migratory winter-resident bird species are attracted to larger woodland areas that offer greater protection from the elements and more abundant food resources. Lower levels of winter bird usage in the high edge ratio Wood study area was probably a result of the decreased environmental insulation offered by that relatively narrow habitat.

SUMMARY

Winter birds inhabiting small fragmented woodlands were studied in three riparian areas near Emporia, Lyon County, Kansas. Study areas varied in size and shape, but all were dominated by hackberry (*Celtis occidentalis*) and were not significantly different in regard to overall vegetative structure or composition. Two study areas, of 4.0 ha and 8.3 ha, were roughly triangular in shape. The third study area (3.7 ha) was a linear-shaped woodlot that had a much higher edge ratio. The purpose of this research was to determine if size and shape of fragmented woodlands were important factors affecting wintering bird species richness, diversity, and density.

A total of 43 bird censuses was conducted in each study area during the winters of 1980-81 and 1981-82. Bird species richness, diversity, and density were calculated for each census, and statistical comparisons were then made among the three study areas.

Results demonstrated that size and shape of forest fragments are important variables that affect winter avian use. The larger study area had significantly greater bird species richness, diversity, and densities. Comparisons of the two smaller study areas (roughly of the same size) revealed that the study area with the lower edge ratio had significantly greater bird species richness and density. Increased species richness was the result of the additional

presence of both permanent-resident and migratory winter-resident bird species. When considered in combination with the findings of numerous breeding bird studies, these results suggest that permanent-resident woodland birds may be more selective of their habitat in winter than during the breeding season.

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APPENDIX 1

List of common and scientific names of plants used in this text.

Sedge.	Carex
Bluegrass.	Poa
Wild Rye	Elymus
Bristly Greenbriar	Similax hispida
Pawpaw	Asimina triloba
Sycamore	Platanus occidentalis
Hackberry.	Celtis occidentalis
American Elm	Ulmus americana
Slippery Elm	Ulmus rubra
Osage Orange	Maclura pomifera
Red Mulberry	Morus rubra
Stinging Nettle.	Urtica dioica
Bitternut Hickory.	Carya cordiformis
Black Walnut	Juglans nigra
Bur Oak.	Quercus macrocarpa
Cottonwood	Populus deltoides
Black Willow	Salix nigra
Missouri Gooseberry.	Ribes missouriense
Downy Hawthorn	Crataegus mollis
White Avens.	Geum canadense
Redbud	Cercis canadensis
Honey Locust	Gleditsia triacanthos
Kentucky Coffee Tree	Gymnocladus dioica
Rough-leaved Dogwood	Cornus drummondii
Wahoo.	Euonymus atropurpureus
Box Elder.	Acer negundo

Silver Maple . . . . Acer saccharinum

Poison Ivy . . . . Toxicodendron radicans

Chervil. . . . . Chaerophyllum procumbens

Green Ash. . . . . Fraxinus pennsylvanica

Elderberry . . . . Sambucus canadensis

Buckbrush. . . . . Symphoricarpos orbiculatus

APPENDIX 2

List of common and scientific names of birds used in this text.

Sharp-shinned Hawk	Accipiter striatus
Red-tailed Hawk.	Buteo jamaicensis
Northern Bobwhite.	Colinus virginianus
American Woodcock.	Scolopax minor
Mourning Dove.	Zenaida macroura
Great Horned Owl	Bubo virginianus
Barred Owl	Strix varia
Red-headed Woodpecker. . . .	Melanerpes erythrocephalus
Red-bellied Woodpecker . . .	Melanerpes carolinus
Yellow-bellied Sapsucker . .	Sphyrapicus varius
Downy Woodpecker	Picoides pubescens
Hairy Woodpecker	Picoides villosus
Northern Flicker	Colaptes auratus
Pileated Woodpecker.	Dryocopus pileatus
Blue Jay	Cyanocitta cristata
American Crow.	Corvus brachyrhynchos
Black-capped Chickadee . . .	Parus atricapillus
Tufted Titmouse.	Parus bicolor
White-breasted Nuthatch. . .	Sitta carolinensis
Brown Creeper.	Certhia americana
Carolina Wren.	Thryothorus ludovicianus
Winter Wren.	Troglodytes troglodytes
Golden-crowned Kinglet . . .	Regulus satrapa
Eastern Bluebird	Sialia sialis
Hermit Thrush.	Catharus guttatus
American Robin	Turdus migratorius

Cedar Waxwing.	Bombycilla cedrorum
European Starling.	Sturnus vulgaris
Orange-crowned Warbler . . .	Vermivora celata
Northern Cardinal.	Cardinalis cardinalis
Rufous-sided Towhee.	Pipilo erythrophthalmus
American Tree Sparrow. . . .	Spizella arborea
Fox Sparrow.	Passerella iliaca
Song Sparrow	Melospiza melodia
White-throated Sparrow . . .	Zonotrichia albicollis
Harris' Sparrow.	Zonotrichia querula
Dark-eyed Junco.	Junco hyemalis
Red-winged Blackbird	Agelaius phoeniceus
Rusty Blackbird.	Euphagus carolinus
Brewer's Blackbird	Euphagus cyancocephalus
Common Grackle	Quiscalus quiscula
Brown-headed Cowbird	Molothrus ater
Purple Finch	Carpodacus purpureus
Pine Siskin.	Carduelis pinus
American Goldfinch	Carduelis tristis
House Sparrow.	Passer domesticus