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FIFTY YEARS OF EARLY WINTER BIRD COUNTS IN HARVEY COUNTY, KANSAS

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Abstract - The Halstead-Newton Christmas Bird Count in south central Kansas was done annually from 1949 through 1998. One hundred twenty species were recorded on the 50 counts. Median numbers seen per 10 party hours for the 47 species observed on at least half of the counts were compared for the five decades using Kruskal-Wallis analysis of variance. Characteristics of the counts and weather preceding the counts were also compared. Nineteen species showed no statistically significant differences in the medians for the five decades and 9 species showed significant fluctuations but no significant trend. These included most of the permanent residents, year-round residents that are migratory and winter residents. Fourteen species, including most of the summer residents and migratory species that have small wintering populations, showed significant increases in median numbers for the five decades. These also included the Red-bellied Woodpecker, Northern Flicker, White-breasted Nuthatch, Cedar Waxwing and the exotic European Starling and Rock Dove. Five species, Northern Harrier, Rough-legged Hawk, Great Horned Owl, American Crow and Tufted Titmouse, showed significant decreases. The Hairy Woodpecker and American Tree Sparrow made consistent but non-significant decreases. Two species, House Finch and Wild Turkey, spread into the count area during the five decades.

INTRODUCTION

The first Halstead-Newton Christmas Bird Count in Harvey County in south central Kansas was conducted on 31 December 1949, and the fiftieth consecutive annual count was done on 19 December 1998. This report analyzes five decades of counts that monitored the early winter bird populations in the Halstead-Newton area. The report includes conditions of the physical environment, and characteristics of the counts that might have affected the results. Although the results from a single locality may not be generalized to the larger population, they nevertheless describe the continuous dynamics of local populations over a significant time period. Such continuous long-term datasets are not common.

COUNT HISTORY

The Hesston Audubon Society did the first bird counts in Harvey County along the Emma creeks near Hesston in six years between 1922 and 1932. However, three counters, hiking along Sand Creek north of Newton in 1949, completed the first of the 50 consecutive annual counts in the Halstead-Newton area which will be analyzed in this report. In 1950 two counts were done, one north along Sand Creek and one along the Emma Creeks east of Halstead in the center of the present count circle. From 1951 through 1966 the count was organized in Halstead, and it included mainly Halstead counters until Newton birders joined in 1958. In 1951 the count area was a 13-mile diameter circle centered one-half mile west of Halstead. Since 1952 the

count circle has been 15 miles in diameter. It was centered three miles northwest of Halstead in 1952, one mile west of Halstead from 1953 through 1957, 3.5 miles northeast of Halstead from 1958 through 1964, and 5.75 miles northeast of Halstead from 1965 to the present (Fig. 1). The counts in the early 1950s covered areas in and around the town of Halstead, in Harvey County West Park, along the Emma, Black Kettle, and Kisiwa creeks and the Little Arkansas River, and around some wetlands in southwest Harvey County. In 1958, areas around Newton and along Sand Creek were added. The Sand Prairie Natural History Reservation in the sandhills of western Harvey County was added in 1965. In the last three decades, areas throughout the count circle were covered when there were enough counters. Since 1966 the count has been organized in Newton, sponsored at various times by the Bethel College Biology Department, Harvey County Natural History Association and Kauffman Museum.

Since 1950 the count area has always included the central part of Harvey County, which contains mostly cultivated fields of wheat, milo, alfalfa, soybeans, and corn on fertile soils developed in old alluvium from Pleistocene drainage (Hoffman and Dowd 1974). This area is traversed by the Little Arkansas River, which before European settlement was the only well-wooded stream in what is now Harvey County, and its tributaries, Emma, Black Kettle and Kisiwa creeks, originally prairie streams but now wooded along much of their length (Klaassen 1979). Black Kettle Creek joins the Little Arkansas River at the town of Halstead. On the eastern edge of the count circle are the towns of Newton and North Newton and Sand Creek, another tributary of the Little Arkansas River. In the northern part of the count circle is the town of Hesston. The western part of the count circle just enters the eastern edge of an area of windblown sand (mainly rangeland) with many temporary ponds and marshes. Both Sand Prairie Natural History Reservation and Harvey County West Park are in this sandhills area (Fig. 1). Wetlands within the circle are the river, tributary creeks and small ponds and marshes, with the amount of water highly variable.

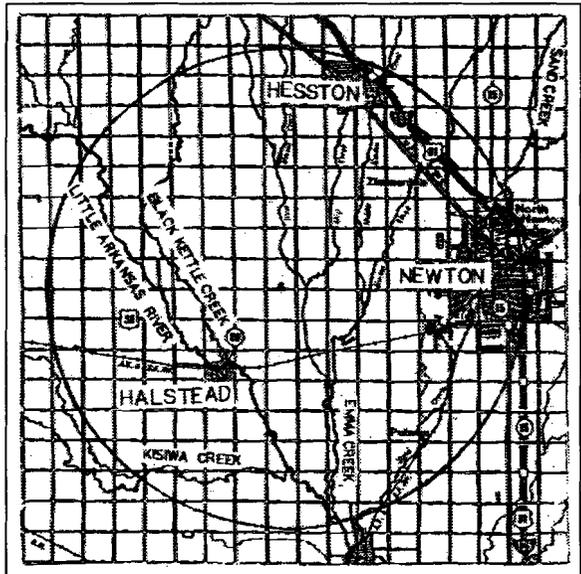


Figure 1. — The Halstead-Newton Christmas Bird Count circle as used from 1965 to 1998.

enters the eastern edge of an area of windblown sand (mainly rangeland) with many temporary ponds and marshes. Both Sand Prairie Natural History Reservation and Harvey County West Park are in this sandhills area (Fig. 1). Wetlands within the circle are the river, tributary creeks and small ponds and marshes, with the amount of water highly variable.

METHODS

The field methods were those specified by the National Audubon Society for Christmas Bird Counts. On these 50 counts no owling has been done and very little data from feeder watchers have been included in the counts. The data have been gathered by field parties counting birds in assigned areas.

The numbers of birds counted are directly related to the count effort – the number of field parties and the number of hours they count. Several methods have been proposed to make the counts comparable by adjusting for count effort (Link and Sauer 1999). The Halstead-Newton count has been run consistently for these 50

years, and parties have spent similar amounts of time in the field, have operated independently and have counted only in an assigned part of the count circle. Effort has varied from 8 party hours in 1966 to 78.5 party hours in 1998. The variation in party hours has resulted mostly from different numbers of parties in the field. Although all areas of the count circle have been assigned in most counts, parties have never been able to cover the entire habitat in the circle. The number of species found on a count is linearly related to the number of party hours (Fig. 2). There is no evidence in my data that the counts of individual birds are other than linearly related to the number of party hours. Therefore, all count data in this report have been adjusted to make them comparable by computing the number of individual birds seen per 10 party hours.

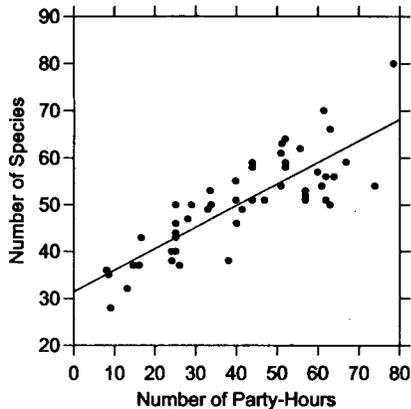


Figure 2. — Regression of number of species of birds seen on number of party hours for the first fifty Halstead-Newton Christmas Bird Counts.

For analysis, the 50 count years were divided into five decades. The measures of central tendency for each decade in these data are asymmetrically distributed, with 76% of the means greater than, and only 13% less than, the medians. Medians of the ten counts in each decade are used exclusively in tables and discussion in this report, except in a very few instances when means are used in the discussions of species uncommonly observed. The nature of the count day, nature of the count, and count data are variable from year to year in a survey like the Christmas Bird Count. By pooling the data for a decade, the variability is reduced, but the variability still makes only substantial changes detectable.

Median values of physical conditions, count characteristics, and counts of individual birds per 10 party hours for the years in each decade were compared. Significant variation in medians was determined by the nonparametric Kruskal-Wallis analysis of variance. When significant differences were indicated by the Kruskal-Wallis test, Tukey-type nonparametric multiple comparisons of rank sums were used to determine which differences were significant (Zar 1984). In the tables, significant differences are indicated by superscript letters.

The medians for each pair of successive decades were tested by a Mann-Whitney U test to determine which changes between successive decades were significant (Zar 1984). In the tables an asterisk between two decades indicates a significant change. The best fit regression line of number of species observed on number of party hours was estimated by least squares. The significance of this regression was tested by analysis of variance (Zar 1984). All testing was done at the 5% significance level. Zero counts were included in the analysis. The above statistical tests were computed only for species that had nonzero values on at least half of the counts.

The six counts done by the Hesston Audubon Society along the Emma Creeks in 1922, 1923, 1924, 1928, 1931, and 1932 were done with only 6 to 12 party hours. No waterbirds were seen and identification of hawks was problematical. However, the data from these counts have been summarized and the results are compared with the data from the Halstead-Newton counts where relevant.

WEATHER PRECEDING THE COUNT

The weather in the weeks before the count can affect the populations of birds at the time of the count by affecting the timing of the fall migration. The data for the analysis of fall weather were taken from NOAA weather summaries for the Newton

Table 1. - Median measures of temperature and precipitation in the weeks preceding the count for the five decades of the Halstead-Newton Christmas Bird Count. The differences between decades are not statistically significant for any measure ($P > 0.05$).

	1949-58	1959-68	1969-78	1979-88	1989-98
Precipitation, inches, Sep 1 – Dec 15	5.08 ^a	9.68 ^a	8.26 ^a	8.02 ^a	6.50 ^a
Heating degree days, Nov 1 – Dec 15	1065.5	1043.0	1047.5	999.5	1121.0
First fall minimum temp. of 32°F, Oct.	26	24	16	24	18
No. of days minimum temp. below 25°F, Nov 1-Dec 15	13.0	14.5	12.0	9.5	10.0

weather station located in the western part of Newton within the count circle. There are no statistically significant differences among the five decades in median values for a number of weather factors related to temperature and precipitation in the same period of weeks in late fall and early winter (Table 1). Heating degree days (one heating degree day is accumulated for each whole degree that the daily mean temperature is below 65°F) measure the relative coldness during the period from 1 November to 15 December. The median date of the first fall minimum temperature of 32°F or below indicates the first major cold front. The number of days with a minimum temperature below 25°F in the period 1 November to 15 December measures the length of time with cold fronts. Also, the median number of times a cold front lowered the minimum temperature below 25°F after warmer days during this period varied from 4.4 to 5.7 and the differences were not statistically significant. Temperature and precipitation in the weeks before the count varied from year to year but the median values for each of the five decades were similar.

Table 2. - Characteristics of the count day in the five decades of the Halstead-Newton Christmas Bird Count. Significant differences in the median values are indicated by superscript letters. The critical value of H at the 5% level of significance is 9.488.

	1949-58	1959-68	1969-78	1979-88	1989-98	H
Median date in Dec.	27 ^a	30 ^a	18 ^b	18 ^b	18 ^b	31.544
Median temperature	42°F	34°F	37°F	37°F	38°F	3.417
Median wind speed, miles per hour	8.5	9.5	9.0	10.2	6.5	2.817
Mostly cloudy, number of counts	1	2	4	4	5	
Ponds frozen, number of counts	2	4	3	2	2	
Snowcover, number of counts	2	2	1	1	1	

NATURE OF THE COUNT DAY

The only significant difference among the decades in characteristics of the count days was in the date of the count (Table 2). The median count day was approximately 10 days earlier in the last three decades than it had been in the first two. The heating degree days and the number of days with a minimum temperature of 25°F or less measured from 1 November to the count day were also significantly less in the last three decades ($H = 21.746$ and 14.010 respectively; $P < 0.01$). Not only was there less time for migration to be completed, but also

Table 3. - Count participants and their participation in the first 50 Halstead-Newton Christmas Bird Counts.

Number of counts	Number of participants
1	119
2-9	94
10-19	20
20-36	5

fewer cold fronts and less cold weather to stimulate movement. This might bias the counts if fall migration was less complete and result in higher counts of migrants and summer residents and/or, less probably, lower counts of winter residents in the last three decades. Median values of median count temperatures and median count wind

Table 4. - Characteristics of the counts in the five decades of the Halstead-Newton Christmas Bird Count. Significant differences in the median values are indicated by superscript letters. Critical value of H at the 5% level of significance is 9.488.

	1949-58	1959-68	1969-78	1979-88	1989-98	H
Median number of parties	3.0 ^a	3.0 ^a	6.5 ^b	6.5 ^b	6.0 ^b	31.863
Median number of party hours	24.0 ^a	25.0 ^a	57.0 ^b	56.0 ^b	52.1 ^b	33.298
Median number of species per count	37.5 ^a	43.5 ^{ab}	51.5 ^{bc}	56.5 ^c	61.5 ^c	33.097
Percent hours on foot	60%	54%	60%	58%	54%	

speeds for each decade were not significantly different. There were a few more cloudy days in the last three decades and more count days on which ponds were frozen in the second and third decades, but these differences are probably not sufficient to bias the counts.

NATURE OF THE COUNT

One of the weaknesses of Christmas Bird Counts is the change in counters from year to year. Two hundred thirty-eight persons have participated in the first 50 Halstead-Newton counts, but most of them have participated only one or a few times (Table 3). The leadership of counting parties has been more stable, however, and 25 persons have participated in ten or more counts. Organization of the count has been consistent. Although five persons have served as compilers, 39 of the 50 counts were compiled by Edna L. Ruth or Dwight R. Platt.

Table 4 lists some characteristics of the count. There were significantly more count parties and more party hours in the last three decades. Although the non-zero values for bird counts have been adjusted for these differences in effort, the number of zero counts for a species were not adjusted, and this could bias the medians for species with many zero counts. The largest percentages of time on foot occurred in the first and third decades, but differences were small.

Habitat coverage is another characteristic that can affect the counts of particular species. The amount of time spent by parties in each habitat was recorded in all of the counts except 1995. However, the habitat types recorded throughout the fifty

Habitats	1949-58	1959-68	1969-78	1989-98
Wooded	62%	50%	51%	34%
Grassland	8%	12%	13%	18%
Agricultural	21%	27%	26%	29%
Residential	3%	7%	7%	12%
Wetlands	4%	3%	3%	6%

Table 5. - Median per cent time coverage of the habitats in the decades of Halstead-Newton Christmas Bird Counts. The fourth decade is omitted, since the percentages are unreliable.

year history were not consistent. Therefore, general categories were used in the summarization of this data. Assigning habitat types to categories was not always clear and in some cases had to be estimated. The median percentages of time in each habitat category for each decade are listed in Table 5. Since most of the percentages in the fourth decade were simply copied from one year to the next, they are not reliable measures of the actual habitat covered and this decade is not included. No statistical tests were done on these data because of their approximate nature. The wooded category includes riparian woodland, upland woods, shelterbelts, and hedgerows. The highest percentage in wooded habitats was in the first decade, during which more

time was probably spent walking creek and river banks. Agricultural lands include crop fields, fallow fields, fencerows, and oldfields. Residential areas include urban areas, cemeteries, city parks, and farmyards. Wetlands include ponds, marshes, creeks and rivers. More time was spent in grasslands, residential areas and wetlands in the last decade. These median percentages are obviously approximate but they do indicate a general similarity in habitat coverage with the exceptions noted above.

RESULTS

Number of species: On the 50 counts, 120 species of birds have been seen. Of these, 17 species have been observed on all 50 counts, whereas 25 species have been seen on only one count (Fig. 3). Very rare species may be disproportionately represented because counters seek them out (Root 1988). The number of species seen per count has varied from 28 (1949) to 80 (1998). The median number of species seen per count has increased from 37.5 in the first decade to 61.5 in the fifth decade (Table 4). One factor determining the number of species found is the number of party hours of effort. Figure 2 shows a regression of number of species on the number of party hours. The number of species found for each year has been corrected for taxonomic changes to conform to the species list for the 1973 count. The least squares regression formula is $Y = 31.4 + 0.46X$, where Y is the number of species found and X is the number of party hours. The formula estimates that there are 30 to 35 bird species that can be found with little searching, and this corresponds well to the number of species that have been found on the majority of counts (Fig. 3). An additional species is projected for the count for each approximately two additional party hours. The slope of this regression line is significantly different from zero ($F = 106.3$; $P < 0.001$). The coefficient of determination is 0.69, indicating that 69% of the variation in number of species can be explained by variation in the number of party hours.

Trends in counts for individual species: Of the 120 species observed on the Halstead-Newton count, only 117 taxa were considered for analysis. Although Sharp-shinned Hawks and Coopers Hawks were observed, there were many observations that did not distinguish between them. Therefore, they are lumped as *Accipiter* sp. for analysis. The same is true for Eastern and Western Meadowlarks which are lumped as meadowlark sp. A distinction between the Spotted Towhee and the Eastern Towhee was not made in count data until 1996. Therefore all towhees in count data are lumped as Spotted Towhees, but they may include a few Eastern Towhees.

Only data from the 47 species seen on at least half of the counts were statistically tested. Nineteen species had no significant changes in the median numbers counted over the five decades in the Kruskal-Wallis analysis of variance. Table 6 lists the median numbers counted per 10 party hours for these species and the number of counts on which each was found for each decade. Nine of these 19 species (Mallard, Ring-necked Pheasant, Belted Kingfisher, Red-breasted Nuthatch, Brown Creeper, Winter Wren, Golden-crowned Kinglet, Common Grackle and American Goldfinch) were not found on the six counts done in the 1920s and 1930s by the Hesston Audubon Society. However, similar counts of two of the more common species, Black-capped Chickadee (median of 37.0/10 party hours for the six counts) and Harris's Sparrow (188.8/10 party hours), were reported. Two species were seen in

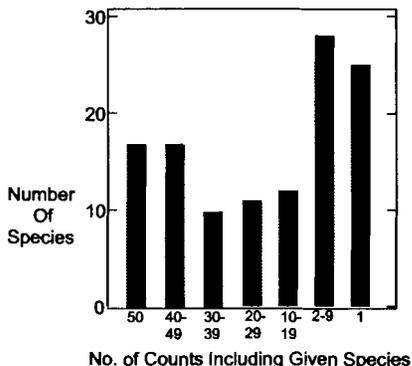


Figure 3. — Numbers of species of birds that have been seen on from one to fifty counts on the first fifty Halstead-Newton Christmas Bird Counts.

Table 6. - Median counts per 10 party hours for species that showed no significant differences among medians for the five decades of the Halstead-Newton Christmas Bird Count by the Kruskal-Wallis analysis of variance. Critical value of H at the 5% level of significance is 9.488. Number of counts on which the species was found is listed in parentheses. A significant difference in pair-wise comparisons of two successive medians by the Mann-Whitney U test is indicated by an asterisk between them.

	1949-58	1959-68	1969-78	1979-88	1989-98	H
Mallard	2.5 (7)	0.8 (7)	4.4 (9)	1.8 (9)	6.2 (8)	3.040
American Kestrel	2.8 (10)	4.8 (10)	4.6 (10)	5.3 (10)	4.7 (10)	4.247
Ring-necked Pheasant	3.7 (8)	2.0 (9)	3.2 (10)	5.7 (10)	* 2.4 (10)	6.938
Belted Kingfisher	0.3 (5)	0.2 (5)	0.4 (9)	0.8 (10)	0.7 (10)	6.628
Hairy Woodpecker	2.8 (9)	1.6 (9)	1.4 (10)	1.4 (10)	1.0 (10)	7.971
Horned Lark	244.6 (9)	238.8 (10)	112.2 (10)	291.9 (10)	149.2 (10)	5.171
Black-c. Chickadee	32.4 (10)	33.6 (10)	25.8 (10)	*48.4 (10)	39.0 (10)	8.754
Red-br. Nuthatch	0 (3)	0.5 (6)	0.2 (7)	0.2 (7)	0.2 (7)	4.409
Brown Creeper	1.6 (8)	2.0 (9)	1.6 (9)	1.4 (10)	* 0.6 (10)	8.675
Winter Wren	0.6 (6)	0.4 (7)	0.4 (7)	0.1 (6)	0.1 (5)	3.302
Golden-cr. Kinglet	3.1 (7)	1.2 (8)	1.4 (7)	2.6 (8)	2.5 (9)	0.870
Loggerhead Shrike	0.8 (9)	1.2 (8)	0.9 (10)	0.8 (9)	0.6 (8)	3.285
Spotted Towhee	0.6 (6)	0.9 (9)	0.5 (6)	1.4 (9)	2.0 (10)	8.354
Am. Tree Sparrow	182.4 (10)	158.7 (10)	* 76.4 (10)	90.9 (10)	106.5 (10)	7.634
Song Sparrow	8.8 (10)	4.0 (10)	4.0 (10)	3.0 (10)	7.2 (10)	3.347
Harris's Sparrow	199.3 (10)	148.3 (10)	133.6 (10)	165.7 (10)	205.2 (10)	6.924
Lapland Longspur	0 (3)	0.6 (7)	3.1 (8)	11.3 (8)	6.9 (6)	7.326
Common Grackle	0.4 (5)	0.2 (5)	1.0 (9)	0.6 (8)	0.2 (6)	5.235
American Goldfinch	15.2 (10)	9.3 (10)	14.0 (10)	12.0 (10)	* 21.8 (10)	8.300

higher numbers in these early counts - American Tree Sparrow (442.5/10 party hours) and Hairy Woodpecker (3.3/10 party hours). These last two species showed a rather consistent but nonsignificant decline over the five decades of the Halstead-Newton counts, and the median count numbers of the tree sparrow made a significant decline in the third decade when compared with the second decade (Table 6). It is unlikely that this is due to the earlier count date in the last three decades as most tree sparrows migrate in late October.

Nine species had significant fluctuations in median counts for the five decades but showed no overall upward or downward trend (Table 7). Three of these, *Accipiter*

Table 7. - Median counts per 10 party hours for species that showed significant fluctuations by the Kruskal-Wallis analysis of variance but no overall trend in numbers counted for the five decades of the Halstead-Newton Christmas Bird Count. Critical value of H at the 5% level of significance is 9.488. Significant differences in the medians tested by Turkey-type nonparametric multiple comparison of rank sums are indicated by superscript numbers. A significant difference in pair-wise comparisons between two successive medians by the Mann-Whitney U test is indicated by an asterisk between them. Number of counts on which the species was found is listed in parentheses.

Species	1949-58	1959-68	1969-78	1979-88	1989-98	H
<i>Accipiter</i> sp.	0.4 ^{ab} (6)	0.4 ^{ab} *	0 ^a (4)	0.6 ^b (9)	0.7 ^b (8)	11.459
Northern Bobwhite	1.4 ^a *	8.0 ^{ab} (9)	18.2 ^b *	10.1 ^{ab} (9)	12.3 ^b (10)	20.810
Downy Woodpecker	10.8 ^a (10)	8.8 ^{ab} *	5.9 ^b (10)	6.7 ^{ab} *	9.3 ^a (10)	14.288
Carolina Wren	0.6 ^{ab} (7)	0 ^a (2)	0 ^a (4)	0 ^a *	1.4 ^b (10)	22.313
Northern Cardinal	25.4 ^a (10)	16.8 ^{ab} (10)	15.9 ^b (10)	18.9 ^{ab} *	27.2 ^a (10)	17.183
Dark-eyed Junco	66.4 ^{ab} (10)	78.2 ^{ab} *	38.3 ^a *	91.2 ^{ab} (10)	95.2 ^b (10)	12.713
Meadowlark sp.	60.2 ^a *	123.6 ^b (10)	108.8 ^b (10)	87.7 ^{ab} (10)	95.2 ^{ab} (10)	11.675
Brown-head. Cowbird	0 ^a (4)	4.4 ^{ab} *	26.4 ^b *	2.7 ^{ab} (8)	22.2 ^b (9)	20.103
House Sparrow	95.4 ^a *	253.3 ^a (10)	254.6 ^a (10)	211.2 ^a (10)	101.3 ^a (10)	11.331

Table 8. - Median counts per 10 party hours for species that showed significant increases in count numbers over the five decades of the Halstead-Newton Christmas Bird Count by Kruskal-Wallis analysis of variance. Critical value of H at the 5% level of significance is 9.488 (7.819 for Rock Dove). Significant differences in the medians tested by Turkey-type nonparametric multiple comparison of rank sums are indicated by superscript letters. A significant difference in pair-wise comparisons between two successive medians by the Mann-Whitney U test is indicated by an asterisk between them. Number of counts on which the species was found is listed in parentheses.

Species	1949-58	1959-68	1969-78	1979-88	1989-98	H
Canada Goose	0 ^a (1)	0 ^a * (1)	5.2 ^{ab} (7)	2.6 ^{ab} * (7)	26.0 ^b (9)	19.766
Red-tailed Hawk	5.1 ^a (7)	6.4 ^{ab} (10)	6.2 ^a (10)	6.0 ^a * (10)	14.8 ^b (10)	20.626
Rock Dove	---	8.6 ^a * (10)	12.0 ^{ab} (10)	19.7 ^b (10)	25.4 ^b (10)	16.490
Mourning Dove	1.6 ^a (8)	2.5 ^{ab} (7)	6.4 ^{ab} (10)	6.4 ^{ab} * (10)	13.7 ^b (10)	13.703
Red-bellied Woodpecker	3.4 ^a (10)	4.1 ^{ab} (10)	3.0 ^a * (10)	4.3 ^{ab} (10)	7.3 ^b (10)	14.871
Northern Flicker	4.7 ^a (10)	7.8 ^{ab} (10)	5.6 ^a * (10)	8.8 ^{ab} (10)	13.2 ^b (10)	16.452
Blue Jay	1.1 ^a (8)	7.0 ^{ab} * (10)	18.7 ^{bc} (10)	25.7 ^c (10)	24.3 ^c (10)	28.864
White-breasted Nuthatch	0 ^a (1)	0 ^{ab} * (3)	1.2 ^{bc} * (10)	2.0 ^c (10)	1.8 ^c (10)	29.314
Eastern Bluebird	0.2 ^a (5)	1.0 ^{ab} (6)	1.2 ^{ab} (7)	0.7 ^{ab} * (7)	3.2 ^b (9)	12.871
American Robin	5.3 ^{ab} (9)	2.0 ^a (8)	5.2 ^{ab} (10)	5.9 ^{ab} (10)	22.5 ^b (10)	11.876
Northern Mockingbird	0 ^a (4)	0.4 ^{ab} (6)	0.2 ^{ab} (6)	0.2 ^{ab} (6)	0.4 ^b (8)	9.710
Cedar Waxwing	0 ^{ab} (4)	0 ^a (1)	0.3 ^{ab} (6)	1.8 ^{ab} (7)	3.6 ^b (10)	13.572
European Starling	132.8 ^a (10)	142.2 ^a * (10)	342.6 ^b (10)	502.9 ^b (10)	593.4 ^b (10)	30.128
Red-winged Blackbird	66.7 ^a (7)	14.6 ^a * (6)	217.2 ^{ab} (10)	182.8 ^{ab} (10)	505.0 ^b (10)	16.424

sp., Downy Woodpecker, and Dark-eyed Junco, showed significant decreases between the second and third decades when party hours increased and the count date was moved up. The decreases in median count numbers were probably not the result of these changes in the count since the low numbers did not continue in the fourth and fifth decades. Also the Downy Woodpecker is a resident species, and the migration of the other two taxa usually occurs in late September and October. On the counts in the 1920s and 1930s, the Downy Woodpecker (median of 8.6/10 party hours) and Dark-eyed Junco (111.5/10 party hours) had similar medians to the Halstead-Newton count data, but the Northern Cardinal (68.1/10 party hours) had much higher counts.

Fourteen species had significant increases in the numbers counted over the five decades (Table 8). The earlier count date in the last three decades could have resulted in increases in summer residents and migrants if the fall migration was less complete at the time of the count. In table 8, only six species show significant increases between the second and third decades when the shift in count dates occurred (of the other eight species, four show small increases and four show declines at this time). Of these six species, only the Canada Goose, Blue Jay, White-breasted Nuthatch and Red-winged Blackbird would have been affected by the completeness of the fall migration. Increases could also be at least partly due to the larger number of party hours during the last three decades. For uncommon species, more party hours of effort can decrease the number of counts with zero values, and median values would

be biased by this result. Of the six species with significant increases between the second and third decades, only the Canada Goose, White-breasted Nuthatch and Red-winged Blackbird had enough zero counts in the first two decades to bias the medians. Although these two factors could have augmented the differences in the counts, there is other evidence that the wintering populations of these species have actually increased. The large flocks of Canada Geese are easily seen and would not likely to have been overlooked in earlier decades. Edna Ruth (1955) reported that Blue Jays were rare in winter in Halstead in the mid-1950s. Blue Jays were reported on only one of the six counts in the 1920s and 1930s (two individuals on the 1928 count). Two White-breasted Nuthatches seen in Harvey County in November and December

Table 9. - Median counts per 10 party hours for species that showed significant decreases in count numbers over the five decades of the Halstead-Newton Christmas Bird Count by the Kruskal-Wallis analysis of variance. Critical value of H at the 5% level of significance is 9.488. Significant differences in the medians tested by Turkey-type nonparametric multiple comparison of rank sums are indicated by superscript letters. A significant difference in pair-wise comparisons between two successive medians by the Mann-Whitney U test is indicated by an asterisk between them. Number of counts on which the species was found is listed in parentheses.

Species	1949-58	1959-68	1969-78	1979-88	1989-98	H
Northern Harrier	3.4 ^{ab} (10)	5.2 ^a (10)	3.5 ^{ab} *	1.3 ^b (10)	1.7 ^b (10)	16.642
Rough-legged Hawk	4.2 ^a (10)	2.6 ^{ab} (9)	1.8 ^{ab} *	1.3 ^{bc} *	0.4 ^c (7)	30.878
Great Horned Owl	2.4 ^{ab} (10)	3.4 ^a (9)	2.6 ^{ab} (10)	1.8 ^{ab} (10)	1.8 ^b (10)	14.169
American Crow	154.4 ^{ab} *	429.8 ^a *	202.4 ^{ab} *	117.2 ^b (10)	74.0 ^b (10)	22.525
Tufted Titmouse	7.2 ^a *	2.4 ^{ab} *	1.6 ^b (10)	1.9 ^b (10)	2.4 ^{ab} (10)	17.726

of 1956 were the first that had been seen since 1944, indicating that they were very uncommon (Ruth 1956). No Canada Geese, White-breasted Nuthatches or Red-winged Blackbirds were reported on the six Hesston counts in the 1920s and 1930s. Nininger (1927), on the basis of observations in the winters of 1909-14 and 1920-27, reported that the Canada Goose was "rare most seasons," the Blue Jay was only a "summer resident," the White-breasted Nuthatch was a "rather rare resident," and the Red-winged Blackbird was a "summer resident" that "sometimes winters" in central Kansas.

Five species had significant decreases in the numbers observed over the five decades (Table 9). The Tufted Titmouse was not observed on the counts in the 1920s and 1930s, whereas the American Crow was seen on all six counts (median of 85.8/10 party hours). Of the two species showing a significant decrease between the second and third decades, only the American Crow could have been affected by the completeness of the fall migration at the time of the count. Although most northern crows arrive during October, maximum numbers may not be present until late December (Platt 1954). The Burrowing Owl (seen on two counts but last seen in the county in 1963) has been extirpated from the county during this period.

Twenty-seven species have been seen on five or more counts but less than 25. Table 10 lists the number of counts on which each species was found in each of the five decades. The total of the counts on which each of these species have been found has increased each decade; 69% from the first to second, 68% from the second to third, 26% from the third to fourth and 48% from the fourth to fifth decade. An important factor in these increased observations is the increase in number of party hours (Table 4). In addition, there are two species that have recently entered the county. The Wild Turkey and the House Finch were first seen on the 1989 count and have been seen on every count since (Table 10). They are now seen in large numbers, as the median counts per 10 party hours for the last decade were 36.1 and 29.3

Table 10. - Species seen on 5 or more counts but less than 25 in the five decades of the Halstead-Newton Christmas Bird Count. The number of counts on which they were observed in each decade is listed.

Species	1949-58	1959-68	1969-78	1979-88	1989-98
Great Blue Heron	0	0	1	7	9
Green-winged Teal	1	3	2	1	2
Lesser Scaup	1	0	0	2	3
Merlin	0	1	2	0	5
Prairie Falcon	2	1	5	5	7
Wild Turkey	0	0	0	0	10
Killdeer	2	0	4	7	5
Wilson's Snipe	1	0	3	8	5
Ring-billed Gull	0	0	0	1	6
Screech Owl	1	6	4	3	6
Barred Owl	1	5	0	0	3
Short-eared Owl	1	0	3	1	1
Yellow-bellied Sapsucker	0	2	1	6	5
Ruby-crowned Kinglet	1	1*	6	5	2
Townsend's Solitaire	3	4	3	5	3
Brown Thrasher	2	2	7	5	4
Yellow-rumped Warbler	0	0*	0	2	6
Field Sparrow	0	4	6	6	5
Fox Sparrow	0	0	2	3	1
Swamp Sparrow	0	2	1	0	2
White-throat. Sparrow	0	1	3	5	5
White-crown. Sparrow	2	1	4	5	9
Rusty Blackbird	2	4	4	5	5
Brewer's Blackbird	2	4	4	2	8
Purple Finch	1	0	5	3	3
House Finch	0	0	0	0	10
Pine Siskin	3	3	4	6	8
TOTAL	26	44	74	93	138
<i>*Species listed for 1962 count in KOS Bulletin but actually seen during count week and not count day.</i>					

respectively.

In the later decades, and particularly in the fifth decade, there has been an increased number of wintering waterbirds—see Canada Goose (Table 8), Great Blue Heron, Lesser Scaup, Killdeer, Wilson's Snipe, and Ring-billed Gull (Table 10). The Great Blue Heron was first seen on the 1977 count but has been seen on 16 of the subsequent 21 counts. Also, 14 additional species of ducks, geese, gulls, and grebes (not listed in Table 10) have been seen on less than five counts. The total of the number of counts on which each of these 14 species was seen in the first four decades is 7 and in the last decade is 17.

Some of the species (Yellow-rumped Warbler, White-throated Sparrow and White-crowned Sparrow) have increased their early winter populations in recent years (Table 10). The White-crowned Sparrow not only increased in the number of counts on which it was seen but the mean number seen per 10 party hours increased from 0.2 in the first decade to 3.4 in the fifth decade.

The Barred Owl is at the edge of its range in south central Kansas (Root 1988) and may enter and retreat from Harvey County. It was seen on counts in the first two decades (mean count of 0.4 in the second decade), was not observed during the third and fourth decades, and was then observed again on the last three counts of the fifth decade.

Three species were irregular winter visitors. The Ruby-crowned Kinglet was seen most often in the third and fourth decades. The Purple Finch was abundant on the 1957 count in the first decade (9.7/10 party hours on that count). It was again seen on half of the counts in the third decade (mean count was 0.5/10 party hours

for the decade) and on six counts in the last two decades but has not been seen since 1992. The Pine Siskin was abundant in the third and fourth decades (mean counts of 7.0 and 4.1/10 party hours respectively) and was seen on most counts in the fifth decade but in lower numbers (mean count of 1.7/10 party hours).

DISCUSSION

The species that were found on 25 or more of the counts can be classified into five categories: 1) winter resident only; 2) summer residents and migrants, some of which stay to winter in south central Kansas; 3) year-round residents, with summer populations replaced or augmented by many migrants from the north; 4) permanent residents with little or no migration; and 5) exotic species that have spread into Kansas after introductions elsewhere.

Winter residents: Of the 13 species that are resident only in the winter, 10 show no significant change over the five decades (Red-breasted Nuthatch, Brown Creeper, Winter Wren, Golden-crowned Kinglet, Spotted Towhee, American Tree Sparrow, Song Sparrow, Harris's Sparrow and Lapland Longspur - Table 6) or made a significant fluctuation in count numbers but showed no significant trend over the five decades (Dark-eyed Junco - Table 7). The American Tree Sparrow did have a consistent but nonsignificant decrease in counts and much higher numbers in the early Hesston counts. Species like the American Tree Sparrow, Harris's Sparrow, Song Sparrow, and Dark-eyed Junco are common, observed on all counts, and widely distributed in the county in small flocks. These species are efficiently counted in a survey like the Christmas Bird Count. Counts of the Lapland Longspur, on the other hand, were extremely variable from year to year. The variability is partly real but is partly due to inefficient counting, since they were sometimes not distinguished in large flocks of Horned Larks. This variability obscures differences even though counts were much larger in the last two decades. The Brown Creeper and Winter Wren were seen in small numbers in all decades but have shown a consistent but nonsignificant decrease in the last three decades. The count of Brown Creepers is significantly lower in the last decade when the fourth and fifth decades are compared.

The Cedar Waxwing (Table 8), an irregular winter visitor, showed a significant increase in counts. Its population has increased in eastern North America in the last 30 years (Witmer, *et al.* 1997). However, the apparent increase in our count data may partly result from the increase in party hours in the last three decades, since the waxwing was not reported on 15 of the first 20 counts. The two winter residents that have significant declines (Northern Harrier and Rough-legged Hawk - Table 9) are hawks, one of which (Northern Harrier) is declining as a breeding population continent-wide, especially in parts of the West and Midwest (Peterjohn and Sauer 1999; MacWhirter and Bildstein 1996). Nininger (1927) reported that Northern Harriers were "common summer and winter" in central Kansas but rated all *Buteo* hawks as rare in the period from 1909 to 1927.

Summer residents and migrants: Of the 12 summer residents or migrants that may winter in Harvey County, seven (Canada Goose, Mourning Dove, Blue Jay, Eastern Bluebird, American Robin, Northern Mockingbird, and Red-winged Blackbird - Table 8) showed increases in counts of their wintering populations, four (Mallard, Belted Kingfisher, Loggerhead Shrike, and Common Grackle - Table 6) showed no significant differences among the five decades, and one (Brown-headed Cowbird - Table 7) showed significant fluctuations but no obvious trend. Eight of these 12 species (Canada Goose, Mallard, Belted Kingfisher, Eastern Bluebird, Northern Mockingbird, Red-winged Blackbird, Common Grackle, and Brown-headed Cowbird) were not seen on the Hesston counts in the 1920s and 1930s, and the other four were only seen on one to three of the six counts.

The Red-winged Blackbird, Common Grackle, and Brown-headed Cowbird are usually found in winter in very large mixed flocks (often with Starlings and other blackbirds) that move over a wide area. As noted by Root (1988), these gregarious birds are prone to errors of estimation. Numbers in these large flocks are difficult to estimate, the proportionate numbers of the various species are difficult to deter-

mine, and finding or missing one of these flocks, or double counting one as it moves to different areas of the count circle, can produce a large difference in count numbers. The counts of all three of these species were inefficient and had large variations from year to year. The increases in Red-winged Blackbirds in the last three decades are very large and significant. The counts of the less common species, Common Grackle and Brown-headed Cowbird, were especially inefficient since they may sometimes have been overlooked among the abundant Red-winged Blackbirds. All three of these wintering populations have probably increased over the five decades.

The Loggerhead Shrike has decreased over much of the eastern part of its range and is listed as endangered in some Midwestern states (Ehrlich, et al. 1992; Yosef 1996). The winter population is small in Harvey County, but has shown no statistically significant change in count numbers over the 50 years. Although the trend has been negative for the last three decades, the counts are not much different than those on the earlier Hesston counts when it was seen on only three of the six counts (0.8 to 1.7/10 party hours in those three counts). Nininger (1927) reported the Loggerhead Shrike as a "rare winter sojourner" in central Kansas on the basis of his observations between 1909 and 1927. This shrike has had very small winter populations in Harvey County for most of the last century.

The Mallard has remained here in winter in small numbers throughout the 50 years, often being found along rivers and creeks as well as in ponds. Although count numbers have not changed significantly, the median count in the last decade was much larger than in any previous decade (Table 6). The small wintering population of the Belted Kingfisher in Harvey County has shown no significant change although the trend is positive in both numbers of counts and of birds counted (Table 6). This positive trend could partly result from the increased party hours in the last decades, since there were many counts without kingfishers in the first two decades.

Some of these summer residents and migrants may remain for a period in late fall and early winter before migrating further south. A confounding factor in comparing data from the five decades is the ten days later count date in the first and second decades, possibly allowing a more complete migration. This is unlikely to be a major factor. For most species that have shown significant increases, the major increases have occurred between the fourth and fifth decades rather than the second and third (see Canada Goose, Mourning Dove, Eastern Bluebird, American Robin, Northern Mockingbird - Table 8). Evidence for increased wintering populations of Blue Jays and Red-winged Blackbirds was discussed previously.

Some individuals of these 12 summer residents or migrants have wintered in Harvey County in most of the 50 years, although larger numbers have migrated further south. To the degree that migration is under genetic control, it would be subject to natural selection. Any change in the environment that increased the survivability of individuals of these species in the winter in south central Kansas would increase their fitness. Natural selection might then favor an increase of individuals that stop in south central Kansas rather than those that face the hazards and stresses of further migration. There are a number of changes that may have been favorable to the wintering of these species. The increased maturity of riparian woodland along creeks in the county, of shelterbelts and windbreaks, and of trees in towns and parks, all in areas that were grasslands a little more than 100 years ago, provide more favorable habitat and better winter cover for many of these species. Climate change or global warming, to the degree it has resulted in less severe winters, allows birds to winter farther north. There is evidence of earlier nesting of birds due to global warming (Dhondt and Hochachko 2000) and the range of many species has been expanding north possibly due to climate change. Winter bird feeding, which began increasing in popularity in the 1970s (DeGraaf and Thomas 1974), could be important for some of these species.

The increased counts of waterbirds in the last 10 to 15 years, discussed previously, could also be the result of some of the above factors. In addition, the development of the 235-acre Harvey County East Lake in 1972, although east of the count

circle, has attracted more waterbirds to Harvey County. Many small ponds have been constructed within the count circle in the last 50 years which are providing water habitat to supplement the rivers and streams of the county and the natural ponds and marshes in the sandhills. However, the numbers of waterbirds within this count circle have always been small because of the small and variable nature of the wetlands.

Year-round residents: There were nine year-round resident taxa that were migratory, and the breeding populations were augmented or replaced in winter by many migrants from the north. Five of these species showed no significant variation (American Kestrel, Horned Lark, and American Goldfinch - Table 6) or showed a significant fluctuation but no overall trend in numbers (*Accipiter* sp. and meadowlark sp. - Table 7). The American Goldfinch was seen in larger numbers in the last decade, and this change is significant when compared to the fourth decade. *Accipiter* sp. had low counts in the third decade while meadowlarks had lowest counts in the first decade, but there is no significant trend in numbers.

Three of these year-round residents had significant increases in numbers observed over the five decades (Red-tailed Hawk, Northern Flicker and White-breasted Nuthatch - Table 8) and one species (American Crow - Table 9) had decreased numbers. *Buteo* hawks are more abundant now than they were in the first half of the twentieth century when they were not legally protected and many were shot on sight (Nininger 1927). Most of this increase has been observed in the Red-tailed Hawk, and, as it has increased, the Rough-legged Hawk has declined in the county. As woody habitat increased and matured, the Red-tailed Hawk was probably the better competitor. The Northern Flicker is found in more open habitat than the Red-bellied Woodpecker, but these two large woodpeckers have probably increased in numbers with increases in the amount and maturity of riparian woodland.

The American Crow had lower count numbers in the later decades (Table 9), but this resulted from its move to the cities in the 1970s. In the early decades of the Halstead-Newton count, the roosts of large populations of wintering crows were in groves of catalpa trees in the sandhills, and the crows spent much time flying back and forth across the western part of the count circle. Their roosts then moved, mostly to urban woodlands, and fewer were observed in the Halstead-Newton count circle. There are still large populations of wintering crows in south central Kansas (Langley 2000).

Permanent residents: Of the nine permanent residents with very limited migration, six showed no significant variation over the five decades (Hairy Woodpecker and Black-capped Chickadee - Table 6) or showed significant fluctuation but no overall trend in numbers (Northern Bobwhite, Downy Woodpecker, Carolina Wren, and Northern Cardinal - Table 7). The Hairy Woodpecker did have a consistent negative trend and had higher numbers in the earlier Hesston counts (median of 3.3/10 party hours), while the chickadee had higher counts in the last two decades. Three species (Downy Woodpecker, Carolina Wren and Northern Cardinal) of the four which fluctuated significantly, had low numbers in the third decade while the fourth (Northern Bobwhite) had its highest counts then. The Northern Cardinal had much higher count numbers on the earlier Hesston counts (median of 69.1/10 party hours). The Carolina Wren was seen more often in the first and last decades, with low numbers of observations in the middle three decades. Harvey County is near the northwestern edge of the range of this species (Root 1988) and during stressful cold winters this range contracts southward (Thompson and Ely 1992) and numbers in Harvey County decline.

One permanent resident (Red-bellied Woodpecker - Table 8) increased significantly over the five decades, particularly between the fourth and fifth decades. This species has increased in numbers and spread westward through Kansas as riparian woodlands have matured (Thompson and Ely 1989).

Two permanent residents (Great Horned Owl and Tufted Titmouse - Table 9) showed significant decreases over the five decades. The counts of the Great Horned Owl were inefficient since no owling was done at night. The Tufted Titmouse had very high numbers in the first decade, which accounted for most of its significant

variation. However, the extreme difference between count numbers for the first decade and the last four may have resulted in part from greater coverage of riparian woodland (especially the more mature woodland along the Little Arkansas River) in counts in the first decade, since prime habitat for the titmouse is woodland. It was not reported on the Hesston counts in the 1920s and 1930s and was not included on ten lists of birds observed by Hesston Audubon Society members in the spring of 1928. Nininger (1927) reported that the titmouse was a "rather rare resident, in timber" between 1909 and 1927 in central Kansas. In Harvey County, the titmouse is near the western edge of the range where it is common (Root 1988), and it may only have become common here after the 1930s as riparian woodland increased and matured. As with many species near the edge of their range, titmouse numbers may fluctuate in Harvey County in response to limiting weather conditions, but it is probably not on a declining trend.

Exotic species: Of the five exotic species recorded on the counts, four had entered the county before the Halstead-Newton counts began and were seen on most or all counts (Rock Dove was not included as a species to be counted on the first seven counts). The Rock Dove and European Starling have been observed in increasing numbers in each succeeding decade and some of these differences are statistically significant (Table 8). The House Sparrow made a significant increase between the first and second decades and then declined in the last two decades (Table 7). The Ring-necked Pheasant showed no significant differences over the five decades, but the numbers in the fifth decade are significantly lower when compared only to the fourth decade (Table 6). Peterjohn and Sauer (1999) reported a 1% per year decline in the pheasant overall but said there were increasing populations in the Great Plains. The first report of a House Finch in Harvey County was in 1984 (unpublished data). House Finches were first observed on the Christmas Bird Count in 1989 and were seen on all 10 counts in the fifth decade (Table 10). Of these exotic species, only the House Sparrow was reported on the counts in the 1920s and early 1930s. The House Finch and probably the European Starling had not yet entered Harvey County at that time. The European Starling first arrived in Kansas in 1926 (Thompson and Ely 1992). Nininger (1927) included the House Sparrow ("very abundant") and the Ring-necked Pheasant ("becoming more common") in his list of birds in central Kansas but did not mention other exotic species.

Conclusions: The Halstead-Newton Christmas Bird Count has monitored early winter bird populations in Harvey County for more than 50 years. Conclusions from the first 50 counts include:

- 1) Many early winter bird populations made very limited changes in numbers in the five decades of counts. Two-fifths of the species that were found on at least half of the counts showed no significant changes in median count numbers by Kruskal-Wallis analysis of variance, and another one-fifth fluctuated significantly but had no long-term positive or negative trend.
- 2) Most of the summer resident and migratory species that remain in the county in smaller numbers in winter have increased wintering populations, especially in the last decade or two. Waterbird populations have especially increased. At least one of the species (Loggerhead Shrike) that did not increase has declining populations over part of its range.
- 3) Most of the permanent resident species, year-round resident species, and winter resident species have shown no significant change in counts over the five decades or have made significant fluctuations but without a long-term trend. The Tufted Titmouse has decreased from high counts in the first decade but does not show evidence of decline in the last four decades. However, the Red-bellied Woodpecker, Northern Flicker, White-breasted Nuthatch, and Cedar Waxwing have increased in count numbers, and the Great Horned Owl has decreased. The Hairy Woodpecker and American Tree Sparrow have made rather consistent but nonsignificant decreases. These two species and the Northern Cardinal were seen in larger numbers on counts in the 1920s and 1930s. The Brown Creeper and Winter Wren showed consistent small decreases in the last three decades.

- 4) The Northern Harrier and Rough-legged Hawk have decreased wintering populations while the Red-tailed Hawk has increased. *Accipiter* sp. has shown significant fluctuations but no long-term trend.
- 5) The exotic European Starling and Rock Dove counts have increased over the 50 years, while the Ring-necked Pheasant and House Sparrow numbers have changed less and have declined recently. The House Finch spread into the county in the 1980s and is increasing.
- 6) Decreases in bird count numbers can occur through a shifting of winter sites used rather actual declines of population, as occurred with the American Crow in Harvey County.

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LITERATURE CITED

- DeGraaf, R. M., and J. W. Thomas. 1974. A banquet for the birds. *Natural History* 83(1):40-45.
- Dhondt, A. A., and W. Hochachka. 2000. Global warming and citizen science. *Birdscope* 14(2):1-3.
- Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1992. *Birds in Jeopardy*. Stanford Univ. Press, Stanford, CA.
- Hoffman, B. R., and L. W. Dowd. 1974. *Soil Survey of Harvey County, Kansas*. USDA Soil Conservation Service.
- Klaassen, V. L. 1979. A study of the tree-life in Harvey County, Kansas. Unpublished paper in Bethel College Biology Department files.
- Langley, W.. 2000. Changes in wintering crow populations in Kansas. *Kansas Ornith. Soc. Bull.* 51(2):21-22.
- Link, W. A., and J. R. Sauer. 1999. Controlling for varying effort in count surveys – An analysis of Christmas Bird Count data. *Jour. Agricult. Biol. Environ. Stat.* 4:116-125.
- MacWhirter, R. B., and K. L. Bildstein. 1996. Northern Harrier (*Circus cyaneus*). In: *The Birds of North America*, No. 210 (A. Poole, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences.
- Nininger, H. H. 1927. A field guide to the birds of central Kansas. McPherson, KS: Democrat-Opinion Print.
- Peterjohn, B. G., and J. R. Sauer. 1999. Population status of North American grass land birds from the North American Breeding Bird Survey, 1966-1996. *Studies in Avian Biology* 19:27-44.
- Platt, D. R. 1954. Ecology and behavior of the crow *Corvus brachyrhynchos* Brehm in Harvey and Reno counties, Kansas. Master's thesis, University of Kansas.
- Root, T. 1988. *Atlas of Wintering North American Birds*. Univ. Chicago Press, Chicago, IL.
- Ruth, E. L. 1955. Halstead area news. *Kans. Ornith. Soc. Bull.* 6(3):17.
- Ruth, E. L. 1956. Halstead notes. *Kans. Ornith. Soc. Bull.* 7(4):19-20.
- Thompson, M. C., and C. Ely. 1989. *Birds in Kansas*, Vol. 1. Lawrence, KS: Univ. Kansas Mus. Nat. Hist.

- Thompson, M. C., and C. Ely. 1992. Birds in Kansas, Vol. 2. Lawrence, KS: Univ. Kansas Mus. Nat. Hist.
- Witmer, M. C., D. J. Mountjoy, and L. Elliot. 1997. Cedar Waxwing (*Bombycilla cedrorum*). In: The Birds of North America, No. 309 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences.
- Yosef, R. 1996. Loggerhead Shrike (*Lanius ludovicianus*). In: The Birds of North America, No. 231. (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences.
- Zar, J. H. 1984. Biostatistical Analysis (second edition). Prentice Hall, Englewood Cliffs, NJ.

Appendix. Scientific names* of species analyzed in paper.

Great Blue Heron <i>Ardea herodias</i>	Red-breasted Nuthatch <i>Sitta canadensis</i>
Canada Goose <i>Branta canadensis</i>	White-breasted Nuthatch <i>Sitta carolinensis</i>
Mallard <i>Anas platyrhynchos</i>	Brown Creeper <i>Certhia americana</i>
Green-winged Teal <i>Anas crecca</i>	Carolina Wren <i>Thryothorus ludovicianus</i>
Lesser Scaup <i>Aythya affinis</i>	Winter Wren <i>Troglodytes troglodytes</i>
Northern Harrier <i>Circus cyaneus</i>	Golden-crowned Kinglet <i>Regulus satrapa</i>
Red-tailed Hawk <i>Buteo jamaicensis</i>	Ruby-crowned Kinglet <i>Regulus calendula</i>
Rough-legged Hawk <i>Buteo lagopus</i>	Eastern Bluebird <i>Sialia sialis</i>
American Kestrel <i>Falco sparverius</i>	Townsend's Solitaire <i>Myadestes townsendi</i>
Merlin <i>Falco columbarius</i>	American Robin <i>Turdus migratorius</i>
Prairie Falcon <i>Falco mexicanus</i>	Brown Thrasher <i>Toxostoma rufum</i>
Ring-necked Pheasant <i>Phasianus colchicus</i>	Yellow-rumped Warbler <i>Dendroica coronata</i>
Wild Turkey <i>Meleagris gallopavo</i>	Spotted Towhee <i>Pipilo maculatus</i>
Northern Bobwhite <i>Colinus virginianus</i>	Field Sparrow <i>Spizella pusilla</i>
Killdeer <i>Charadrius vociferus</i>	Fox Sparrow <i>Passerella iliaca</i>
Wilson's Snipe <i>Gallinago delicta</i>	Song Sparrow <i>Melospiza melodia</i>
Ring-billed Gull <i>Larus delawarensis</i>	Swamp Sparrow <i>Melospiza georgiana</i>
Rock Dove <i>Columba livia</i>	White-throated Sparrow <i>Zonotrichia albicollis</i>
Mourning Dove <i>Zenaida macroura</i>	Harris's Sparrow <i>Zonotrichia querula</i>
Great Horned Owl <i>Bubo virginianus</i>	White-crowned Sparrow <i>Zonotrichia leucophrys</i>
Eastern Screech-Owl <i>Otus asio</i>	Dark-eyed Junco <i>Junco hyemalis</i>
Barred Owl <i>Strix varia</i>	Lapland Longspur <i>Calcarius lapponicus</i>
Short-eared Owl <i>Asio flammeus</i>	Northern Cardinal <i>Cardinalis cardinalis</i>
Belted Kingfisher <i>Ceryle alcyon</i>	Red-winged Blackbird <i>Agelaius phoeniceus</i>
Red-bellied Woodpecker <i>Melanerpes carolinus</i>	Meadowlark sp. <i>Sturnella sp.</i>
Yellow-bellied Sapsucker <i>Sphyrapicus varius</i>	Rusty Blackbird <i>Euphagus carolinus</i>
Downy Woodpecker <i>Picoides pubescens</i>	Brewer's Blackbird <i>Euphagus cyanocephalus</i>
Hairy Woodpecker <i>Picoides villosus</i>	Common Grackle <i>Quiscalus quiscula</i>
Northern Flicker <i>Colaptes auratus</i>	Brown-headed Cowbird <i>Molothrus ater</i>
Loggerhead Shrike <i>Lanius ludovicianus</i>	Purple Finch <i>Carpodacus purpureus</i>
Blue Jay <i>Cyanocitta cristata</i>	House Finch <i>Carpodacus mexicanus</i>
American Crow <i>Corvus brachyrhynchos</i>	Pine Siskin <i>Carduelis pinus</i>
Horned Lark <i>Eremophila alpestris</i>	American Goldfinch <i>Carduelis tristis</i>
Black-capped Chickadee <i>Poecile atricapilla</i>	House Sparrow <i>Passer domesticus</i>
Tufted Titmouse <i>Baeolophus bicolor</i>	Burrowing Owl <i>Athene cunicularia</i>
Northern Mockingbird <i>Mimus polyglottos</i>	Cedar Waxwing <i>Bombycilla cedrorum</i>
European Starling <i>Sturnus vulgaris</i>	American Tree Sparrow <i>Spizella arborea</i>

*American Ornithologists' Union. 1998. Check-list of North American Birds. 7th ed. American Ornithologists' Union, Washington, D.C.