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Interspecific Association among the Common Birds of Oak-Hickory Stands in Southwestern Michigan

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INTERSPECIFIC ASSOCIATION AMONG THE
COMMON BIRDS OF OAK-HICKORY STANDS
IN SOUTHWESTERN MICHIGAN

by

Michaline Slomka

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan
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Michaline Slomka

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INTRODUCTION

The spatial distribution of any species of plant or animal is determined by factors in the environment. These factors may be either physical features, such as soil, topography, or microclimate, or biotic factors. If an organism's distribution is largely controlled by a certain factor in the environment, the organism will not be randomly distributed throughout a particular area unless this factor, too, is randomly distributed. Any factor which affects the distribution of one organism may also affect the distribution of another organism of a different species. The presence of the first species itself may influence the distribution of the second species. If organisms of two different species are attracted by the same environmental factor, or are attracted to each other, they will be found together more often than would be expected by chance. In such an instance, these two species would show a positive association when appropriate analyses are made. If, on the other hand, one species is attracted by some factor in the environment, while another is repelled by that same factor, or if the two species, for some reason, avoid each other, they will show a negative association.

Such relationships are frequently elucidated by means of presence/absence data. Forbes (1911) was apparently

the first to suggest doing this. Most commonly, such data are put in the form of a 2 x 2 contingency table, as suggested by Gleason (1925). This table, as well as the standard form of notation used in describing and utilizing the data, is depicted as follows:

		<u>Species 1</u>		
		+	-	
<u>Species 2</u>	+	a	b	= a+b
	-	c	d	= c+d
		-----	-----	-----
		a+c	b+d	N

The information so obtained can be treated in various ways. Frequently a chi-square test for significance is calculated directly from the table, as described by Fisher (1970). Yates' correction for continuity, used with small sample sizes, can also be calculated directly from the table, as described by Snedecor (1940).

The use of presence/absence data to elucidate associations between species has been used most extensively by plant ecologists (Jones, 1945; Greig-Smith, 1952). The method has also been used with insects (Macan, 1954), and with insect ectoparasites on a mammalian host (Cole, 1949; Evans and Freeman, 1950). Very few such studies have been done with vertebrates. Nash (1950) used significant associations to determine community structure of fishes in three different habitats.

Only one such study has been done with birds. Caswell (1956), using census data from the literature, computed coefficients of association for species/species and species/environmental factor pairs for each individual census. This matrix of coefficients was then subjected to multiple factor analysis and ranking methods to measure the ecological communality or similarity between two species.

Apparently there has never been any attempt to determine associations between bird species based on spatial distribution within a single area. Birds present unique problems not encountered with plants, insects, or even fish. Owing to the nature of bird census data, time becomes a factor. Birds are, of course, highly mobile. The fact that two birds are both found in a particular quadrat does not necessarily indicate that they were there at the same time. This is because the data from several censuses are consolidated and treated as a unit for the particular period of time under consideration. Bearing this in mind, this paper will use presence/absence data in an attempt to detect association between various species of birds breeding in two oak-hickory stands in southwestern Michigan. An attempt will then be made to explain any associations found.

METHODS AND MATERIALS

This study is based on census data collected over a period of five years, from 1966 to 1970, by several different observers. The census areas are located in the Allegan State Game Area, in Allegan County, Michigan. The primary source of data is an area known as the Large Oak area, located in section 30, R 14 W, T 2 N. Data from the so-called Greenbrier area, section 25, R 15 W, T 2 N, is also utilized to a lesser extent. The vegetation of both areas has been described by Brewer, et al. (unpublished manuscript). The canopy of the Large Oak area is dominated by black oaks (Quercus velutina) with a diameter breast height (dbh) greater than 10 inches, although white oaks (Quercus alba) are equally common in the 5-10 inch dbh class. Dogwood (Cornus florida) is prominent in the understory. The Greenbrier area is more heterogeneous in vegetational composition. This area can be roughly divided into three vegetational subtypes:

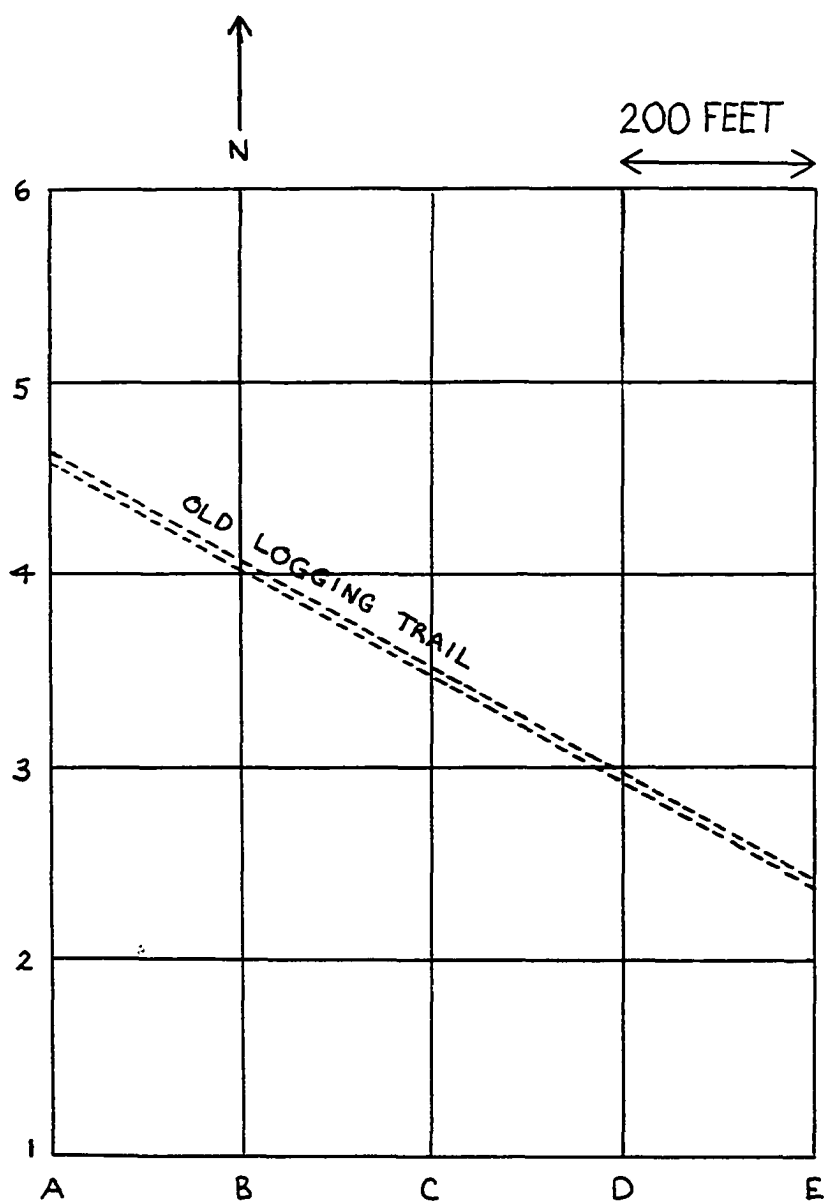
(1) areas of large trees, 73-85 feet tall, having a general resemblance to the Large Oak area; (2) a discontinuous strip of open patches running east-west near the center of the plot; and (3) smaller oaks having a canopy height of 31-50 feet. Diversity among the non-canopy species is greater in this area, and dogwood is scarcer.

The study plots (each 18.4 acres in size) were marked out into twenty quadrats measuring 200 feet on a side, or

40,000 square feet. Censusing was done by the spot-map method as described by Williams (1936). An observer traversed an area and plotted on a map all birds seen or heard. In addition to the map, an observer carried a standardized observation sheet on which to record pertinent information on position, location, activity, and other factors of birds wherever feasible. Figure 1 illustrates a sample map, and Figure 2 illustrates a standardized observation sheet. Wenger (1970) made a year-round study of the organization of the bird community of the Large Oak area.

A reusable transparent acetate grid was made to fit over the census maps. Each 40,000-square-foot quadrat was divided into four 10,000-square-foot quadrats. Every other quadrat was then blacked out on the grid, and only sightings in the remaining quadrats were counted. This arrangement, rather than using the twenty 40,000-square-foot quadrats, was devised primarily to avoid having quadrats with common boundaries. Enough observations occurred on boundary lines that the use of some convention designed to assign the observations to a particular quadrat seemed likely to obscure possible relationships. Treatment of the data to secure non-contiguous quadrats eliminated this problem. Samples need not be random when determining association. The null hypothesis tested is that there is no correlation between the occurrence of one species and another species. If this is the case, then all samples are statistically independent of one another (Grieg-Smith, 1964). A particular

Fig. 1. Sample map of Large Oak area censusing plot.



species was included in the analysis only if it occurred in ten or more quadrats in any one year.

Quadrats of 10,000 square feet appeared to be the best size for several reasons. In determining size, it was necessary to consider the size and mobility of the birds. The sampling area had to be large enough to have some records. At the same time, it had to be small enough to allow for restricted environmental variables, if such were to be found. Also taken into consideration was the average size of territories among the perching birds. The sampling area had to be small enough that any pattern based on interspecific territoriality would show up.

For each pair of species, a 2 x 2 contingency table was set up. A computer program was devised to determine chi-square, and chi-square with Yates' correction for continuity, for each contingency table. These were calculated directly from the table using the following formulas:

$$\text{Chi-square} = \frac{(ad-bc)^2 N}{(a+b)(b+d)(b+c)(a+c)}$$

$$\text{Chi-square with Yates' Correction} = \frac{(|ad-bd|-N/2)^2 N}{(a+b)(b+d)(b+c)(a+c)}$$

In instances where three species appeared to form a positive grouping based on the chi-square values, the three species were tested together for association. This was done using the method described by Greig-Smith (1964). The quadrat values are divided into eight classes, and each class is separately tested for significance. Then the eight

values are added together and the table as a whole can be judged for significance. The eight classes are quadrats containing:

1. None of the three species.
2. All of the three species.
3. Species 1 and Species 2, but not Species 3.
4. Species 1 and Species 3, but not Species 2.
5. Species 2 and Species 3, but not Species 1.
6. Species 1 only.
7. Species 2 only.
8. Species 3 only.

The resulting table has four degrees of freedom, hence there is no need to correct for continuity (Greig-Smith, 1964). It was possible to test four species in the same way. This table has eight degrees of freedom.

Only May and June data are used in computations, except for 1967. These months presumably encompass most of the breeding season for the majority of the birds in this area. The chi-square values were added together for each pair of species from 1966 to 1970.

In 1967, the area was censused far more frequently than in any other year, in connection with a study of the organization of the bird community by Wenger (1970). Wenger censused the area at least three times a week during the breeding season, then summarized the data at two-week intervals to determine population fluctuations. These intervals proved to be convenient units to use for this study. As the number of census trips increases, the likelihood of finding a bird in a particular quadrat likewise increases. Hence it was possible that a particularly active or abundant

bird could have been found in most of the sample quadrats when the May and June data from 1967 were summarized. This would tend to obscure any interspecific associations which involved such birds. By using the two-week summary data, this problem was believed to be minimized. It was further presumed that using such units would make it possible to determine whether there were changes in associations throughout the course of a season.

RESULTS

Table 1 lists all the species present in the Large Oak area and the Greenbrier area in any appreciable number. In all, 1079 chi-square tests for significance were done on these species (Appendix 1 and Appendix 2). Overall, there were few significant results. Only 71 tests were significant at the 0.05 level. Presumably, the majority of these (5% of 1079, or about 54) are meaningless. This leaves a residue of some twenty or fewer cases of significant association which are valid.

When the chi-square values were added together for the five years, the values from only four species pairs were significant at the 0.05 level. These pairs were: Great Crested Flycatcher/Tufted Titmouse, Robin/Scarlet Tanager, Robin/Rose-breasted Grosbeak, and Baltimore Oriole/Scarlet Tanager (Table 2). Of these, the first two associations were not consistent, in that they varied from positive to negative from year to year. It is not possible, from the data available, to determine what underlying factors caused these fluctuating values. Hence, these pairs will not be considered further in the present study. In the case of the robin and the grosbeak, the significant association is due only to exceptionally high chi-square values in the Large Oak area in 1968 and in 1970. This did not seem to be enough evidence to warrant further consideration of this species pair. Only one species pair

Table 1. Birds found in the Allegan study areas in sufficient numbers for analysis.

Great Crested Flycatcher	<u>Myiarchus crinitus</u>
Eastern Wood Pewee	<u>Contopus virens</u>
Blue Jay	<u>Cyanocitta cristata</u>
Black-capped Chickadee	<u>Parus atricapillus</u>
Tufted Titmouse	<u>Parus bicolor</u>
White-breasted Nuthatch	<u>Sitta carolinensis</u>
Robin	<u>Turdus migratorius</u>
Yellow-throated Vireo	<u>Vireo flavifrons</u>
Red-eyed Vireo	<u>Vireo olivaceus</u>
Ovenbird	<u>Seiurus aurocapillus</u>
Baltimore Oriole	<u>Icterus galbula</u>
Brown-headed Cowbird	<u>Molothrus ater</u>
Scarlet Tanager	<u>Piranga olivacea</u>
Rose-breasted Grosbeak	<u>Pheucticus ludovicianus</u>
Rufous-sided Towhee	<u>Pipilo erythrophthalmus</u>

Table 2. Chi-square values for species showing significant additive chi-square values for the Large Oak (LO) and Greenbrier (G) areas, 1966-1970. Positive and negative tendencies toward association are indicated by (+) and (-).

	LO 1966	LO 1967	LO 1968	LO 1969	LO 1970
Flycatcher/ Titmouse	2.9767 1.6162 ⁺	3.2516 2.1212 ⁻	0.9854 0.2704	3.8009 2.2064 ⁻	2.0165 0.8497 ⁺
Robin/ Tanager	2.1622 0.7357 ⁺	4.2236 2.4699 ⁺	0.2302 0.0064	0.0275 0.0618	6.9299 5.1725 ⁻
Robin/ Grosbeak	2.3269 0.6384 ⁺	0.7581 0.0236	6.3866 4.3422 ⁺	0.4167 0.0586	10.8524 8.3526 ⁺
Oriole/ Tanager	0.2337 0.0157	2.8283 1.443 ⁺	2.8161 0.9586 ⁺	7.1795 5.2747 ⁺	0.1307 0.0082

	G 1966	G 1967	G 1969*	G 1970
Flycatcher/ Titmouse	2.0493 0.8124 ⁻	8.9751 1.7728 ⁺	6.7903 3.1161 ⁺	0.1139 1.8234
Robin/ Tanager		4.6083 2.4782 ⁺		
Robin/ Grosbeak		0.4633 0.0515		
Oriole/ Tanager	0.1612 0.0179	5.8397 3.6798 ⁺	1.6858 0.5016 ⁻	1.0037 0.2872

* Due to insufficient data from the area in 1968, the Greenbrier data from this year was not included in the analysis.

showed a consistent, significant association throughout the five-year period. The Baltimore Oriole showed a significant positive association with the Scarlet Tanager in the Large Oak area in 1969, and in the Greenbrier area in 1967. In addition, these two species showed a tendency, though not significant, towards positive association in 1967 and in 1968 in the Large Oak area, and in 1970 in the Greenbrier area.

Most of the biweekly data from the Large Oak area in 1967 did not prove to be very informative. However, one group of species did appear to merit further consideration. From June 11 to June 24, the White-breasted Nuthatch showed a significant positive association with both the Eastern Wood Pewee and the Tufted Titmouse. In addition, the Wood Pewee and the Tufted Titmouse showed a tendency, though not significant, towards positive association. Again, from June 25 to July 8, these last two species showed a significant positive association with each other, and both the pewee/nuthatch and the titmouse/nuthatch pairs showed a tendency, though not a significant one, towards positive association (Table 3). It appeared, then, that these three species formed an ecological group during these two two-week intervals. To determine whether this was the case, the three species were tested together for the interval from June 11 to July 8. The resulting table (Table 4) is significant at the 0.01 level, with the greatest contribution to significance being made by the class containing all of the

Table 3. Seasonal chi-square values for the pewee, titmouse, nuthatch, and grosbeak, 1967.

	Pewee/ Titmouse	Pewee/ Nuthatch	Pewee/ Grosbeak	Titmouse/ Nuthatch
May 2- 12				2.3269 0.6384
May 15- 20	0.0263 9.4938	1.7094 0.0684	0.5523 0.1014	0.6154 0.0684
May 22- 26		0.4396 0.0868	0.3175 0.0446	
May 29- June 9	3.6470 2.4703 ⁺	3.8721 2.6024 ⁺	0.0668 0.0042	1.1607 0.4891 ⁺
June 12- 24	1.9277 0.8846 ⁺	8.1890 6.3135 ⁺	1.4396 0.7084 ⁺	16.4706 12.7824 ⁺
June 26- July 8	5.0863 3.0769 ⁺	1.6954 0.8844 ⁺	1.8286 0.8392 ⁺	3.0273 1.4509 ⁺
July 10- 22	0.0628 0.0628	3.0946 2.0369 ⁺	0.2302 0.0019	1.7329 0.7018 ⁺
July 23- August 5	1.0256 0	0.9023 0.4010	1.5584 0.6926 ⁻	1.0256 0
August 9- September 20		4.1771 ⁺ 2.9474 ⁺		

Table 3. Continued.

	Titmouse/ Grosbeak	Nuthatch/ Grosbeak
May 2- 12	0.5263 0.0329	2.0301 1.0589 ⁺
May 15- 20	0.5523 0.1014	0.7326 0.2637
May 22- 26		2.2982 ⁺ 1.3723 ⁺
May 29- June 9	2.2982 ⁺ 1.3723 ⁺	0.0836 0.0052
June 12- 24	1.7924 ⁺ 0.7106 ⁺	1.7256 ⁺ 0.8598 ⁺
June 26- July 8	2.0037 ⁺ 0.6184 ⁺	1.0037 ⁺ 0.2872 ⁺
July 10- 22	0.0247 0.2226	0.0733 0.0213
July 23- August 5	4.8352 ⁺ 0.7504 ⁺	0.1732 0
August 9- September 20		

Table 4. Association of the Wood Pewee, the Tufted Titmouse, and the White-breasted Nuthatch in the Large Oak area from June 11 to July 8, 1967.

Quadrats Containing	Observed	Expected	Chi-square
None of the three	10	5.18	4.48
All of the three	8	3.34	6.50
Pewee only	10	10.67	.05
Titmouse only	0	1.96	1.96
Nuthatch only	2	4.24	1.18
Pewee/Titmouse	2	4.08	1.06
Pewee/Nuthatch	7	8.08	.36
Titmouse/Nuthatch	1	1.60	.22
Total			15.81

species and the class containing none of the species.

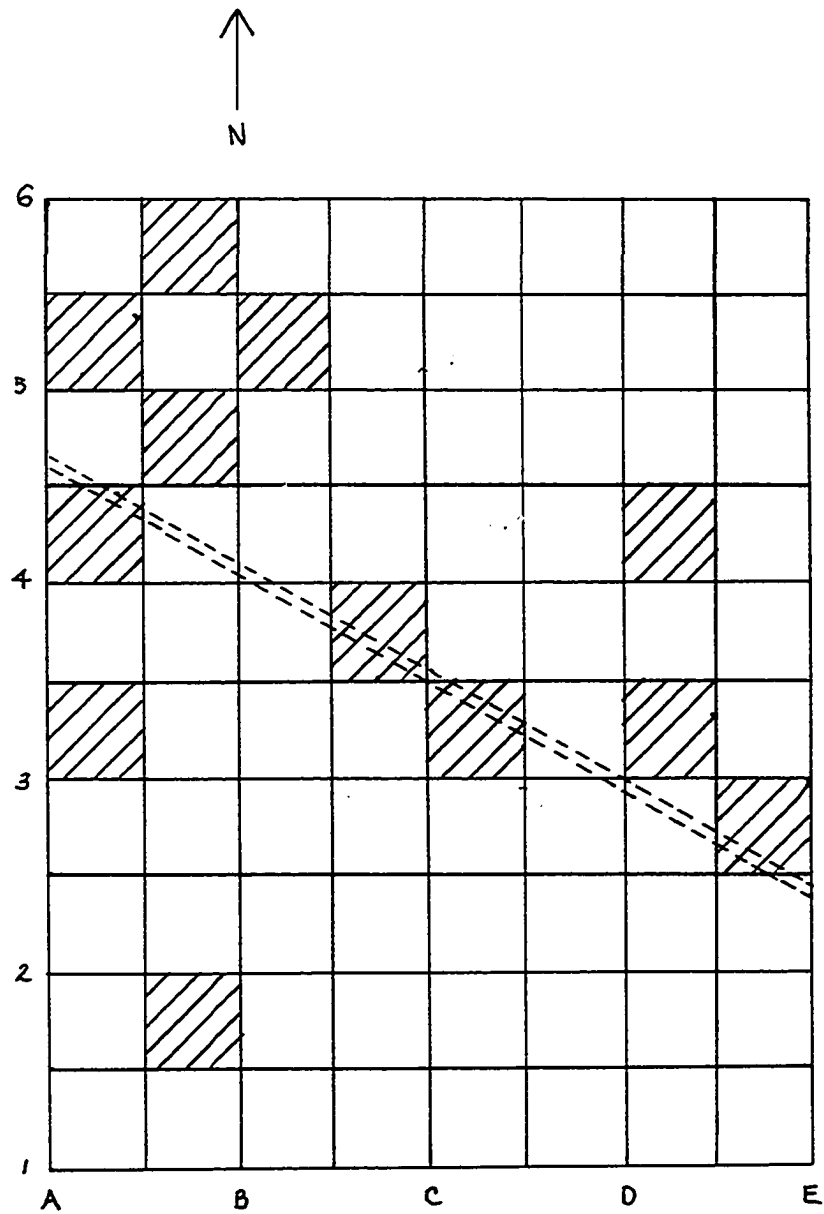
It was also noticed that there was a tendency, though not a significant one, for the Rose-breasted Grosbeak to be positively associated with these three species during this particular time period (Table 3). These four species were tested together for this time interval. The resulting table (Table 5) is significant at the 0.01 level, with the greatest contribution to significance coming from the classes containing all four and none of the four species. The quadrats in which three or four of these species appear together are mapped out in Figure 3.

—

Table 5. Association of the Wood Pewee, the Tufted Titmouse, the White-breasted Nuthatch, and the Rose-breasted Grosbeak in the Large Oak area from June 11 to July 8, 1967.

Quadrats Containing	Observed	Expected	Chi-square
None of the four	8	3.23	7.04
Pewee only	7	6.72	0.01
Titmouse only	0	1.22	1.22
Nuthatch only	2	2.65	0.15
Grosbeak only	2	1.94	0
Pewee/Titmouse	0	2.55	2.55
Pewee/Nuthatch	4	5.50	0.40
Pewee/Grosbeak	3	4.03	0.26
Titmouse/Nuthatch	1	1.00	0
Titmouse/Grosbeak	0	0.73	0.73
Nuthatch/Grosbeak	0	1.59	1.59
Pewee/Titmouse/ Nuthatch	3	2.08	0.40
Pewee/Titmouse/ Grosbeak	2	1.53	0.14
Pewee/Nuthatch/ Grosbeak	3	3.30	0.02
Titmouse/Nuthatch/ Grosbeak	0	0.60	0.60
All of the four	5	1.25	<u>11.25</u>
		Total	26.36

Figure 3. Sample quadrats in the large Oak area where three or four of the following species were found together from June 11 to July 8, 1967: Wood Pewee, Tufted Titmouse, White-breasted Nuthatch, Rose-breasted Grosbeak.



DISCUSSION

Very few significant associations were found in the census data from the Large Oak area. This may be due to the relative homogeneity of the area. Evidence from several sources (Miller, 1942; Peterson, 1948; MacArthur and MacArthur, 1961; Hilden, 1965) indicates that psychological factors play an important part in habitat selection in birds. Apparently the aspect of the vegetation, as perceived by the birds, is more important than the actual species composition. Therefore, in a homogeneous area, there is an increased likelihood that selection of territories and nest sites will be random throughout the area.

As expected in mature stands such as this, there is much variation among the birds in height of canopy utilization and in area of vegetation used for nest and perching sites (Wenger, 1970). To a lesser extent, there is also a variation in types of food utilized. In 1967, at least, there was an abundance of food available and, hence, this was not a limiting factor. This was probably true of other years as well (Faulkner, 1970). It appears, then, that the various species of birds divide up the habitat in complementary fashion. This suggests that there was a minimum amount of interspecific competition among the birds breeding in these areas. This, in turn, would tend to reduce the number of significant interspecific associations.

It is possible that in an area of this size (18.4

acres), factors affecting the distribution of bird species will be constant throughout. Hence, there will be no subdivision of utilization based on microhabitat differences. Birds would thus tend to be randomly distributed throughout the area. It is more likely, though, that there are variations in microhabitat within the Large Oak area.

However, these variations may not have an important effect on the distribution of birds because they are on a small scale relative to the size of the areas occupied or utilized by the birds. Such small scale changes may not be perceived by the birds and hence do not affect their distribution. It is equally possible that some factors to which they are responding are on a large scale relative to the size of the census area. The oak stand itself may be perceived as a whole and responded to accordingly.

There is another factor which may contribute to the lack of significant association among the birds of this area. Birds are highly mobile. As the number of census trips increases, so does the likelihood that a bird will be found in a particular quadrat. Thus, even though a bird spends the majority of its time within a certain area, it may, on occasion, stray outside its home range. These stray occurrences would tend to obscure interspecific associations or, at least, would tend to decrease the strength of any associations which may be evident. This suggests that, in future studies, it would be well to take the factor of abundance into consideration. This will be discussed at greater

length in another part of this paper.

The only clear-cut exception to the lack of associations among the birds of these oak stands was the positive association between the Baltimore Oriole and the Scarlet Tanager. It is not immediately apparent why such an association would be shown. Life history data would seem to indicate that these two species are not directly competitive or cooperative in their habits. The nest of the oriole is generally a purse-shaped nest which is fastened to several drooping twigs on a hanging branch of a large tree. The tanager's nest is flat and loosely constructed, and placed well out from the trunk of a tree on a horizontal branch. Both species are insectivores, and there is probably an overlap in the kinds of food eaten (Bent, 1965). However, it is apparent from comparison of height utilization data (Table 6) calculated from the standardized observation sheets, that such overlap would not result in direct competition, since they utilize different strata for foraging. The oriole tends to select foraging and singing sites in the uppermost part of the canopy, while the tanager is generally found at considerably lower levels. The only area of overlap in height utilization is in selection of perching sites. Both species appear to arrive in the early part of May, judging from what data are available (Table 7). In both species, nesting takes place almost immediately, the incubation period for eggs is 13-14 days, and the young are fledged in approximately two weeks (Bent, 1965).

Table 6. Height of forest utilization in the Baltimore Oriole and the Scarlet Tanager.

Baltimore Oriole				
	Large Oak		Large Oak and Greenbrier	
	Median	Mean	Median	Mean
Total	65	56	65	57
Perch	40	40	---	---
Forage	67	62	67	61
Sing	69	61	70	61

Scarlet Tanager				
	Large Oak		Large Oak and Greenbrier	
	Median	Mean	Median	Mean
Total	40	40	40	39
Perch	40	36	37	35
Forage	40	40	37	39
Sing	50	49	50	49

The male orioles, however, arrive before the females. This may account for the fact that the orioles appear to be slightly behind the tanagers in time of fledging young. In 1967, the only year in which data are complete enough to allow for comparisons, fledged young of the tanager were seen as early as June 30, while young of the oriole were not seen until July 5. At any rate, the apparent association between these two species appears to take place before young are fledged.

It may be that both species are responding to some environmental gradient which is not detectable in the data that have thus far been collected. It is not possible to draw any definite conclusions about the association between these two species without further study of niche parameters within this particular area.

An environmental gradient may occur in time as well as in space. An example of this would be some seasonally changing factor such as climate or available food supply. This could be the case with the apparent association of the Wood Pewee, the Tufted Titmouse, the White-breasted Nuthatch, and the Rose-breasted Grosbeak during the two, two-week periods from June 11 to July 8, 1967. Some knowledge of life history data of these species may shed some light on this association. Where helpful to the discussion, data from the Greenbrier area, and from three other Allegan study areas, the Large Pine area, the Small Pine area, and the Small Oak area will be utilized. These areas were also described by

Table 7. Approximate arrival dates of the Baltimore Oriole and the Scarlet Tanager in the Large Oak area and in the Greenbrier area. Parentheses indicate date of previous census.

Large Oak area	
Baltimore Oriole	Scarlet Tanager
May 21, 1966 (May 17)	May 17, 1966 (May 11)
May 10, 1967 (May 9)	May 16, 1967 (May 15)
May 9, 1968 (May 3)	May 9, 1968 (May 3)
May 3, 1969 (April 3)	May 6, 1969 (May 3)
May 8, 1970 (May 1)	May 14, 1970 (May 8)

Greenbrier area	
Baltimore Oriole	Scarlet Tanager
May 17, 1966 (May 16)	May 17, 1966 (May 16)
May 21, 1967 (May 9)	May 21, 1967 (May 9)
May 6, 1969 (April 23)	May 6, 1969 (April 23)
May 22, 1970 (May 11)	May 11, 1970 (May 8)

Brewer, et al. (unpublished manuscript).

The pewee was first seen in the Large Oak area on May 23 in 1967. In the Small Oak area it was first heard May 25, a pair was seen in the Large Pine area on May 24, and it was seen in the Greenbrier area on May 31. On June 8 it was seen building a nest on the Large Oak area, and was on the nest until July 7. The nest of this species is usually located on a small, often dead, limb (Bent, 1963). In this instance, a nest was being built in the crotch of a dead branch. On July 12, the nest was empty. The incubation period of the eggs of the pewee is 12-13 days. The young leave the nest in 15-18 days. (Bent, 1963). During the second two weeks of the four-week period under discussion, therefore, the pewee was probably feeding young in the nest. The food of the pewee consists largely of insects taken on the wing. (Bent, 1963).

The data for the titmouse, a year-round resident in this area, were very scarce. The birds do not appear to be very numerous in this area, probably because they are at the northern limits of their range (Wood, 1951). According to Bent (1964a), these birds begin nest building in late April, and accompany each other to and from the nest site with building materials. As early as April 21, a pair was seen in the Large Oak area. This species breeds inside cavities of trees, both live and dead. No nests were found directly on the study plot in 1967. The incubation period is approximately 12 days, and the young re-

remain in the cavity for 15-16 days. The young follow the parents for many months (Bent, 1964a). Although there is no direct evidence from the Large Oak data, it is probable that young were present by late May. Two "or more" were seen in the Small Oak area as early as May 11. On June 30, a group of titmice was seen on the Large Oak plot. The most important food item of these species consists of caterpillars, although a large share of its diet consists of wasps, other insects, and insect eggs.

The White-breasted Nuthatch is also a permanent resident in the Allegan area. These birds were seen mating in late May in the Large Oak area. Their nests are usually located in a cavity, and a nuthatch was seen going into such a cavity on June 1. The male feeds the female on the nest, and both feed the young. The incubation period is 12 days. It is not known how long a time the young remain in the nest. The families stay together until the end of November (Bent, 1964b). Such family groups were seen as early as June 21, and throughout the latter part of June in the Large Oak area. On the Small Pine area, such a family group was seen on June 20. The food of this species consists chiefly of insects, and eggs and larvae of insects. These are taken from crevices in the bark of trees (Bent, 1964b).

The Rose-breasted Grosbeak was first seen on May 10 in the Large Oak area. Comparable dates for the Large Pine

area and for the Small Oak area were May 12 and May 11. A pair was seen on the Greenbrier area on May 21. On May 29, a female in the Large Oak area was seen on a nest, and a male was seen on a nest on June 2. Although Bent (1968) indicates that the nest is ordinarily placed in a bush or sapling 5-10 feet from the ground, a nest was seen on the Large Oak plot 65 feet up in the crotch of a small branch in the canopy. The incubation period of the eggs of these birds is 12-14 days, and the young leave the nest in 9-12 days. Young were not observed until July 19 in the Large Oak area, but it seems probable that they were fledged some time before this. These birds have a varied diet which includes plant matter, such as buds, as well as animal matter, such as beetles (Bent, 1968).

It is apparent, then, that during the period of time from June 11 to July 8, 1967, each of these species was under increased feeding pressure due to young either in the nest or fledged. The standardized observations for this period consist largely of foraging and, in the case of the pewee, of flycatching activities. However, judging from the discussion of their food habits, it appears unlikely that these four were directly competing for the same food items. This is further borne out by a comparison of their height utilization at this time (Table 8). No overt competition is evident from the data available. It is, therefore, possible only to conjecture why they are all drawn to certain parts of the stand.

It may be that they are all responding to some slight difference in microhabitat which are not apparent from the available data. They might be avoiding some other group of birds but, if so, these negative associations did not show up. Possibly the most significant feature of the group is that it is ecologically diverse, consisting of birds occupying several of the major forest niches; a fly-catcher, a tree-trunk feeder, a small generalized feeder of the lower strata, and a large generalized feeder of the upper strata. Whatever the reasons for the lack of other associations, positive or negative, it is clear that these birds can afford to occur together because they can almost totally avoid competition.

It is unfortunate that comparable data from other years is not available. Owing to this, it is not possible to draw any definite conclusions as to whether this was a unique chance association, or whether this grouping was a recurring phenomenon.

As stated before, the Greenbrier area is far more heterogeneous in vegetational structure than the Large Oak area. It is worth giving separate attention to the lack of significant associations in this area. One reason for this lack is that the forest-edge species added by the inclusion of openings and accompanying factors did not provide enough records to be used in the analyses. These species, occurring on the Greenbrier area but not on the Large

Oak area (Gottshall, 1969), included the Least Flycatcher (Empidonax minimus) and the Catbird (Dumetella carolinensis). Another species, the Rufous-sided Towhee (Pipilo erythrophthalmus), occurred in sufficient numbers for analysis only in 1970. In this year, however, few other species showed ten or more occurrences. Analysis of the Greenbrier data in general was hampered by lack of sufficient data owing to the fact that the area was censused so infrequently throughout the course of a season. It seems likely that these species would have shown a significant negative association with some of the forest species had it been possible to test the relationship.

This does not account for the lack of significant interspecific associations among the forest species when presented with an area that is heterogeneous on a large scale. The explanation for this phenomenon is uncertain. It is worth indicating, however, that the lack of associations does not seem to support the continuum concept of communities (Curtis, 1959), because in a diverse area of this sort, the species adjacent to one another in the continua should be positively associated. It is worth indicating, also, that James (1971), in a study of habitat relationships of birds in Arkansas, was unable to separate the cluster of "forest birds" by an ordination technique, even when using fifteen variables.

Table 8. Height utilization in the Wood Pewee, the White-breasted Nuthatch, the Tufted Titmouse, and the Rose-breasted Grosbeak from June 11 to July 8, 1967, in the Large Oak area. Numbers indicate feet.

Wood Pewee		
	Median	Mean
Total	30	32
Perch	32	32
Forage	30	33
Sing	30	29

Tufted Titmouse		
	Median	Mean
Total	17	21
Perch	--	--
Forage	17	21
Sing	20	20

White-breasted Nuthatch		
	Median	Mean
Total	40	42
Perch	--	--
Forage	40	42
Sing	--	--

Rose-breasted Grosbeak		
	Median	Mean
Total	55	46
Perch	--	--
Forage	61	55
Sing	47	40

CONCLUSIONS

This study was undertaken long after the original data had been collected. The original data were collected by several different observers who were frequently censusing with some particular goal in mind. If this kind of a study were to be undertaken again, several changes could improve the amount of ecological information to be derived from it.

Dice (1945) has stated that the most ecological information can be derived from such a study if the number of observations is ten or greater, but does not exceed half of the sampling units. Since this particular study utilized forty quadrats, this would mean that the most information could be derived when a particular species is found in ten to twenty quadrats for the period of time one wishes to study. As indicated before, as the number of census trips increases, the possibility that a bird will be found in a particular quadrat likewise increases. The species of birds in this area differ widely in absolute numbers, in density, in activity level, and in feeding range. These factors influence how many quadrats will show the presence of each species. The number of census trips which will result in ten to twenty occurrences will therefore vary with the species. Before undertaking such a study again, pilot studies should be made to determine the number of census trips required to encompass the majority of birds of such an area.

It would equally be possible to tailor the number of census trips so as to study a particular species at optimum numbers. This particular study indicated some species pairs which would warrant such investigation. In order to study seasonal relationships, censusing would have to be fairly intensive, and would have to be done over a period of several years, to determine whether relationships shown were recurring phenomena. In addition, greater attention should be paid to collecting life history data in the course of censusing. This could include stomach analyses and intensive study of habitat parameters for each individual species.

The factor of abundance should also be taken into consideration in future analyses. A cursory glance at monthly summary maps for a particular species indicates that they tend to be found in certain areas far more frequently than in others. Presence/absence data gives as much weight to the single occurrence of a species in a particular quadrat as it does to numerous occurrences in another quadrat. This may obscure significant associations, or it may indicate associations when none are actually present. The contingency table method may bring to light interesting associations, but for organisms as mobile as birds, further analyses are necessary to draw more than tentative conclusions. The data presented in this paper indicate that the use of presence/absence data can provide meaning-

ful information about relationships between the birds of small forest stands. With the improvements in techniques discussed above, this method could prove to be a useful tool in ecological studies of population interactions among birds.

SUMMARY

Presence/absence data for birds in two oak-hickory stands in the Allegan Forest area in southwestern Michigan were put in the form of 2 x 2 contingency tables. Chi-square tests were calculated for each of these tables to study interspecific association.

Overall, there were few significant results. Only two species showed a significant positive association for the five-year period from 1966 to 1970. These were the Baltimore Oriole and the Scarlet Tanager. In addition, four species, the Wood Pewee, the Tufted Titmouse, the White-breasted Nuthatch, and the Rose-breasted Grosbeak showed a positive association from June 11 to July 8, 1967, the only year for which seasonal data were available.

It was postulated that the lack of significant associations was due primarily to the homogeneity of the Large Oak area. This apparent lack may also be partly accounted for by the failure to consider the factor of abundance in determining association. The apparent association between the oriole and the tanager may be due to an environmental gradient that is not detectable in the data thus far collected. The basis of the association of the pewee, titmouse, nuthatch, and grosbeak is unclear, but it is evident that these species can occur together with little or no competition, owing to their totally different foraging patterns. More study is needed to determine whether this grouping is a recurring phenomenon.

It was concluded that, with improvements in data collection techniques, and with corrections made for abundance, this technique could prove to be a useful tool for population studies of birds.

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APPENDIX 1

Chi-square values for bird species found in the Large Oak (LO) area and the Greenbrier (G) area in May and June, 1966-1970. See Table 1 for species names.

Species pair	LO 1966	LO 1967	LO 1968	LO 1969
Flycatcher-Pewee	0.6349 0.1587	1.1538 0.4369 ⁺	1.5759 0.8392	0.8252 0.3342
Flycatcher-Blue Jay	0.1515 0.0013	0.7535 0.2564	3.265 2.0465 ⁺	0.1705 0.0068
Flycatcher-Chickadee	0.0263 0.0393	0.0907 0.0057	5.8771 3.663 ⁺	1.0429 0.3103 ⁻
Flycatcher-Titmouse	2.9767 1.6162 ⁺	3.2516 2.1212 ⁻	0.9854 0.2704	3.8009 2.2064 ⁻
Flycatcher-Nuthatch	3.6364 2.1109 ⁻	1.1538 0.4369 ⁺	0.0209 0.0471	1.5038 0.8087 ⁻
Flycatcher-Robin	0.4010 0.0251	0.3946 0.0779	0.5976 0.0840	0.6667 0.1667
Flycatcher-Red-eyed Vireo	1.9048 0.6481 ⁻	0.8068 0.3055	0.7535 0.2564	0.0076 0.0684
Flycatcher-Ovenbird	0.6679 0.1319	1.3445 0.4575 ⁺	0.1465 0.0163	0.8889 0.32
Flycatcher-Oriole	1.0091 0.3821 ⁻	0.1732 0.0048	0.2564 0.0071	0.0356 0.0356
Flycatcher-Cowbird	1.1607 0.4891 ⁺	0.2926 0.0239	1.2832 0.4741 ⁻	0.6981 0.1379
Flycatcher-Tanager	1.5759 0.8392 ⁺	0.2721 0	0.8068 0.3055	0.0293 0.0293
Flycatcher-Grosbeak	0.6089 0.1945	0.4396 0.1954	3.4801 2.3105 ⁺	0.4444 0.111
Pewee-Blue Jay	0.1465 0	0.0142 0.0772	0.9428 0.3896	0.6282 0.2200
Pewee-Chickadee	2.88 1.7422 ⁺	0.0614 0.0273	0.5195 0.0577	0.3882 0.0317
Pewee-Titmouse	0.5195 0.0577	0.0014 0.1173	2.2896 1.1408 ⁺	0.3882 0.0317

APPENDIX 1

Chi-square values for bird species found in the Large Oak (LO) area and the Greenbrier (G) area in May and June, 1966-1970. See Table 1 for species names.

Species pair	LO 1966	LO 1967	LO 1968	LO 1969
Pewee- Nuthatch	2.8283 1.443 -	0.7816 0.1855	0.7504 0.2842	6.3199 4.8123 +
Pewee- Robin	0.1201 0.1201	0.3993 0.0619	1.6162 0.7639 +	0.2273 0.0063
Pewee- Red-eyed Vireo	0 0.3704	0.9346 0.3453	0.6061 0.2062	1.085 0.4899 +
Pewee- Ovenbird	4.6753 2.8283 +	3.0614 1.4871 +	1.443 0.5195 +	0.8525 0.3069
Pewee- Oriole	3.3856 2.0481 +	0.6386 0.1752	1.2374 0.5114 -	0.0341 0.0341
Pewee- Cowbird	0.1982 0.0004	0.1622 0.0004	1.5584 0.6926 -	1.9277 0.8846 -
Pewee- Tanager	2.2222 1.25 -	1.6589 0.5120 -	0.0506 0.0093	4.1831 2.9240 +
Pewee- Grosbeak	0.8525 0.3069	0.2978 0.4448	0.0506 0.0093	0.0171 0.0384
Blue Jay- Chickadee	1.0532 0.4521	0.7535 0.2564	2.4489 1.0884 +	1.9277 0.8846 +
Blue Jay- Nuthatch	1.8286 0.8392 +	0.0142 0.0772	0.7535 0.2564	0.4741 0.1356
Blue Jay- Robin	0.0039 0.3208	3.9133 2.6992 +	0.2679 0.0074	1.2532 0.5179 +
Blue Jay- Red-eyed Vireo	0.4396 0.0122	0.8031 0.3184	1.6954 0.8844 +	0.1052 0.0003
Blue Jay- Ovenbird	1.6003 0.6869 -	0.6981 0.1379	0.2721 0	1.6709 0.8525 -
Blue Jay- Oriole	0.0124 0.0675	3.2368 2.1489 +	1.4583 0.6027 -	0.0341 0.0341
Blue Jay- Cowbird	0.7289 0.2329	4.4769 3.0438 +	0.9977 0.2968	1.6869 0.7241 -

APPENDIX 1

Chi-square values for bird species found in the Large Oak (LO) area and the Greenbrier (G) area in May and June, 1966-1970. See Table 1 for species names.

Species pair	LO 1966	LO 1967	LO 1968	LO 1969
Blue Jay-Tanager	0.7504 0.2842	0.0628 0.0628	0.0429 0.0191	1.7099 ⁻ 0.9454 ⁻
Blue Jay-Grosbeak	2.3488 1.4386 ⁻	0.5523 0.1014	1.3796 ⁺ 0.6874 ⁺	0.0171 0.0384
Blue Jay-Towhee	-- --	-- --	-- --	-- --
Chickadee-Titmouse	2.3488 1.1845 ⁺	0.9428 0.3896	0.4633 0.0515	0.0154 0.2461
Chickadee-Nuthatch	0.2886 0.0115	7.4347 5.3524 ⁺	0.0628 0.0628	0.0177 0.0963
Chickadee-Robin	0.0240 0.2162	1.7586 0.9548	0 0.3571	3.9706 2.0711
Chickadee-Yellow throated Vireo	-- --	0.7535 0.2564 ⁻	0.3008 0.3008	0.1809 0.9854 ⁺
Chickadee-Ovenbird	0.1039 0.0115	1.3445 0.4575 ⁺	0.8163 0.0327	2.3529 1.0458 ⁻
Chickadee-Oriole	2.5477 1.5005 ⁺	1.2121 0.5387 ⁺	0.6879 0.0001	2.3529 1.0458 ⁻
Chickadee-Cowbird	0.1032 0.0032	0.2926 0.0239	0.0247 0.2226	0.0154 0.2461
Chickadee-Tanager	3.9133 2.6991 ⁺	0.0761 0.0761	0.2610 0.0081	3.1114 1.6893 ⁻
Chickadee-Grosbeak	0.0104 0.0564	2.3932 0.1954 ⁺	4.2236 2.4699	0.1307 0.0082
Titmouse-Nuthatch	1.7998 0.6304	0.5228 0.1173	-- --	0.0614 0.0273
Titmouse-Robin	1.5402 0.0820 ⁺	0.0506 0.0093	1.0084 0.1120 ⁻	1.7647 0.6005 ⁻
Titmouse-Red-eyed Vireo	0.9428 0.0769	0.1225 0.0010	0.1307 0.0082	0.0022 0.1809

APPENDIX 1

Chi-square values for bird species found in the Large Oak (LO) area and the Greenbrier (G) area in May and June, 1966-1970. See Table 1 for species names.

Species pair	LO 1966	LO 1967	LO 1968	LO 1969
Titmouse- Ovenbird	1.7998 0.6304 ⁻	0.3882 0.0317	2.8011 1.0084 ⁺	0.2614 0
Titmouse- Oriole	0.5195 0.0577	1.4733 0.7999 ⁻	0.0247 0.2226	0.2614 0
Titmouse- Cowbird	0.0049 0.1569	0.4572 0.1026	0.0247 0.2226	0.0154 0.2461
Titmouse- Tanager	0.4618 0.0649	0.0577 0.0577	0.1625 0.0020	0.0086 0.1379
Titmouse- Grosbeak	0.6736 0.1599	0.8392 0.0104	0.1625 0.0020	2.0915 0.9886 ⁺
Nuthatch- Robin	0.6879 0.0016	0.3993 0.0619	0.0275 0.0618	0.4010 0.0564
Nuthatch-Yellow- throated Vireo	-- --	0.8334 0.2663	1.1336 0.0925 ⁻	1.1336 0.0026 ⁻
Nuthatch- Red-eyed Vireo	0.1732 0.0769	0.9346 0.3453	2.1302 1.2366 ⁺	0.6309 0.2082
Nuthatch- Ovenbird	0.0607 0.0907	3.0614 1.4871 ⁺	1.5699 0.5651 ⁺	0.3008 0.0334
Nuthatch- Oriole	3.7395 2.1545 ⁺	0.5228 0.1173	0.0275 0.0618	0.0334 0.0334
Nuthatch- Cowbird	1.0037 0.2872 ⁺	0.1982 0.0004	0.0082 0.1319	0.5681 0.0963
Nuthatch- Tanager	1.0389 0.3535 ⁻	0.0205 0.1843	0.8031 0.3184	0.1862 0.0099
Nuthatch- Grosbeak	0.0004 0.1599	3.5328 0.4448 ⁺	3.095 2.0370 ⁺	5.414 4.0142 ⁺
Robin- Red-eyed Vireo	0.3604 0.1602	1.7663 1.0176 ⁺	0.9375 0.3190	0.2564 0.0071
Robin- Ovenbird	0.5632 0.0016	0.1625 0.0020	1.4286 0.3571	0.8333 0.0283
Robin- Oriole	0.7018 0	0.1746 0.0093	1.2257 0.2750 ⁺	0.8333 0.2083

APPENDIX 1

Chi-square values for bird species found in the Large Oak (LO) area and the Greenbrier (G) area in May and June, 1966-1970. See Table 1 for species names.

Species pair	LO 1966	LO 1967	LO 1968	LO 1969
Robin-Cowbird	5.5502 ⁺ 2.3824 ⁺	1.4396 ⁻ 0.7084 ⁻	0.0034 0.2750	0.0490 0.1103
Robin-Tanager	2.1622 ⁺ 0.7357 ⁺	4.2236 ⁺ 2.4699 ⁺	0.2302 0.0064	0.0275 0.0618
Robin-Grosbeak	2.3269 ⁺ 0.6384 ⁺	0.7581 0.0236	6.3866 ⁺ 4.3422 ⁺	0.4167 0.0586
Yellow-throated Vireo-Ovenbird	- - - -	0.0086 0.1379	0.3008 0.3008	0.3419 0.3419
Yellow-throated Vireo-Oriole	- - - -	3.2368 ⁺ 2.489 ⁺	1.1842 ⁺ 0.0329 ⁺	3.0769 ⁺ 0.3419 ⁺
Yellow-throated Vireo-Grosbeak	- - - -	0.5523 0.1014	0.0485 0.2638	0.6838 0.0427
Red-eyed Vireo-Ovenbird	0.1732 0.0769	0.0177 0.0963	3.8095 ⁺ 2.1429 ⁺	1.8614 ⁺ 0.9497 ⁺
Red-eyed Vireo-Oriole	0.0139 0.2229	0.9731 0.4466	0.0260 0.0586	0.9497 0.3419
Red-eyed Vireo-Tanager	0.4167 0.0116	0.1289 0.0143	1.1997 0.5828 ⁻	0.1014 0.0013
Red-eyed Vireo-Grosbeak	0.1023 0.0455	1.1336 ⁺ 0.0026 ⁺	3.0946 ⁺ 2.0370 ⁺	0.6838 0.2327
Ovenbird-Oriole	1.0037 0.2872 ⁺	0.0713 0.0317	1.4286 0.3571 ⁻	0.1778 0
Ovenbird-Cowbird	0.0049 0.1569	0.4155 0.0221	1.2121 0.2226 ⁻	0.2613 0
Ovenbird-Tanager	3.4921 2.0851 ⁻	0.1120 0.1120	0.7161 0.1315	0.1465 0
Ovenbird-Grosbeak	2.9056 1.6479 ⁺	0.1809 0.9854	0.7161 0.1315	0.5556 0.1389
Ovenbird Towhee	- - - -	- - - -	- - - -	- - - -
Oriole-Cowbird	0.0418 0.0418	0.4572 0.1026	0.7204 0.0907	6.5359 ⁺ 4.1830 ⁺

APPENDIX 1

Chi-square values for bird species found in the Large Oak (LO) area and the Greenbrier (G) area in May and June, 1966-1970. See Table 1 for species names.

Species pair	LO 1966	LO 1967	LO 1968	LO 1969
Oriole- Tanager	0.2337 0.0157	2.8283 1.443 ⁺	2.8161 0.9586 ⁺	7.1795 5.2747 ⁺
Oriole- Grosbeak	0.9008 0.3492	0.8392 0.0104	0.1023 0.0064	0 0.1389
Cowbird- Tanager	4.4089 3.0411 ⁺	0.4478 0.0179	0.6736 0.1599	1.0429 0.3103 ⁺
Cowbird- Grosbeak	0.0013 0.1026	2.7039 0.2604 ⁻	0.6736 0.1599	2.0915 0.9886 ⁺
Cowbird- Towhee	- - - -	- - - -	- - - -	- - - -
Oriole- Grosbeak	0.0041 0.0653	0.1465 1.3187	1.6485 0.9349 ⁺	0.8974 0.3709
Oriole- Towhee	- - - -	- - - -	- - - -	- - - -

APPENDIX 1

Species pair	LO 1970	G 1966	G 1967	G 1969
Flycatcher-Pewee	1.2191 0.4726 ⁻	2.6775 1.3006 ⁻	1.1842 0.0329 ⁺	0.3486 0.0218
Flycatcher-Blue Jay	0.0157 0.0857	0.7843 0.0218	0.1108 1.7728	3.9706 2.0711 ⁺
Flycatcher-Chickadee	0.4466 0.0820	0.3486 0.0218	0.2339 0.5263	0.0490 0.1103
Flycatcher-Titmouise	2.0165 0.8497 ⁺	2.0493 0.8124 ⁻	8.9751 1.7728 ⁺	6.7903 3.1161 ⁺
Flycatcher-Nuthatch	3.6364 2.1109 ⁻	0.3486 0.0218	0.2339 0.5263	0.0154 0.2461
Flycatcher-Robin	0.0597 0.0399	- - - -	2.7068 0.3008 ⁺	- - - -
Flycatcher-Red-eyed Vireo	0.0034 0.2750	- - - -	- - - -	- - - -
Flycatcher-Ovenbird	1.9482 0.9587 ⁻	5.7754 3.8344 ⁻	0.7018 0	1.0429 0.3103 ⁻
Flycatcher-Oriole	1.4973 0.4108 ⁻	2.8011 1.0084 ⁺	1.5402 0.0820 ⁺	0.3486 0.0218
Flycatcher-Cowbird	2.1212 0.8766 ⁻	0.3715 0.1651	2.0227 0.1651 ⁺	12.549 7.8649 ⁺
Flycatcher-Tanager	2.3377 1.2193 ⁻	0.1205 0.0221	0.9130 0.0075	0.4155 0.0221
Flycatcher-Grosbeak	0.3283 0.0056	2.0493 0.8124 ⁻	0.1707 0.9294	0.5723 0.0071
Pewee-Blue Jay	0.8516 0.3656	- - - -	- - - -	- - - -
Pewee-Chickadee	0.0053 0.4274	1.6858 0.5016 ⁻	1.1111 0.1562 ⁻	1.1111 0.1562 ⁻
Pewee-Titmouise	4.269 2.8462 ⁺	0.1982 0.0004	0.5263 0.0329	0.3604 0.1602
Pewee-Nuthatch	0.0429 0.0191	0.0139 0.2229	2.5 0.8507 ⁺	0.3486 0.0218
Pewee-Robin	0.3020 0.0380	- - - -	0 0.3571	- - - -

APPENDIX 1

Species pair	L0 1970	G 1966	G 1967	G 1969
Pewee- Red-eyed Vireo	0.5681 0.0963	0.1982 0.0004	3.9706 2.0711 ⁺	0.1732 0.0769
Pewee- Ovenbird	0.0003 0.0907	0.0013 0.1026	0 0.2083	3.1258 1.4774 ⁺
Pewee- Oriole	0.0177 0.0963	0.1612 0.0179	2.7706 1.3095 ⁺	1.1111 0.0309 ⁺
Pewee- Cowbird	0.0251 0.0564	0.4010 0.0251	0.0490 0.1103	0.4938 0.0309
Pewee- Tanager	1.7663 1.0176 ⁻	2.4532 1.3683 ⁺	1.2903 0.4391 ⁺	1.1285 0.2229 ⁺
Pewee- Grosbeak	0.0435 0.0291	0.1622 0.0004	0.3604 0.0225	0.3604 0.1602
Blue Jay- Chickadee	2.5731 0.7656 ⁻	0.4938 0.0309	0.2339 0.5263	2.5 1.1816 ⁻
Blue Jay- Nuthatch	0.0769 0.0048	0.4938 0.0309	0.2339 0.5263	1.7647 0.6005 ⁻
Blue Jay- Robin	1.9265 1.0652 ⁺	- - - -	0.3008 0.3008	- - - -
Blue Jay- Red-eyed Vireo	1.3389 0.5070	- - - -	- - - -	- - - -
Blue Jay- Ovenbird	0.1225 0.0010	0.0449 0.1010	0.7018 0	0.0275 0.0618
Blue Jay- Oriole	0.3882 0.0317	0.6349 0	0.4466 0.0820	0.0694 0.1562
Blue Jay- Cowbird	0.1010 0.0063	3.7427 0.5263 ⁺	0.3715 0.1651	0.0694 0.1562
Blue Jay- Tanager	4.6387 3.3574 ⁻	0.0139 0.2229	0.9130 0.0075	1.1285 0.3840 ⁻
Blue Jay- Grosbeak	0.0014 0.1173	0.0159 0.2549	5.4813 0.9294 ⁺	0.3604 0.0225
Blue Jay- Towhee	0.8392 0.0104	- - - -	- - - -	- - - -
Chickadee- Titmouse	0.6112 0.0075	1.6858 0.5016 ⁻	0.2339 0.5263	0.0694 0.1562

APPENDIX 1

Species pair	L0 1970	G 1966	G 1967	G 1969
Chickadee- Nuthatch	0.4010 0.0251	1.1111 0.0309 ⁺	0.4938 0.0309	0.0490 0.1130
Chickadee- Robin	0.9023 0.0251	- - - -	0.6349 0	- - - -
Chickadee-Yellow throated Vireo	- - - -	- - - -	- - - -	- - - -
Chickadee- Ovenbird	0.0053 0.4274	0.7183 0.1010	0 0.3704	0.4396 0.0618
Chickadee- Oriole	11.9298 5.9443 ⁺	0.6349 0	0.1732 0.0769	1.1111 0.1562 ⁻
Chickadee- Cowbird	0.5263 0.0329	3.7427 0.5263 ⁺	0.7843 0.0218	2.5 0.8507 ⁺
Chickadee- Tanager	0.0877 0.1974	0.0139 0.2229	1.2903 0.2549 ⁻	2.5392 1.3244 ⁺
Chickadee- Grosbeak	0.9130 0.0075	0.0159 0.2549	0.3604 0.1602	0.8108 0.0225
Titmouse- Nuthatch	0.0159 0.2549	0.2339 0.5263	0.5723 0.0071	0.9428 0.0769
Titmouse- Tobin	0.0037 0.1180	- - - -	0.3008 0.3008	- - - -
Titmouse- Red-eyed Vireo	0.4751 0.0253	- - - -	- - - -	- - - -
Titmouse- Ovenbird	0.3022 0.2910	0.0014 0.1173	0.7018 0	1.7464 0.4792 ⁻
Titmouse- Oriole	2.0493 0.8124 ⁺	0.1612 0.0179	0.4466 0.0820	1.1111 0.0309 ⁻
Titmouse- Cowbird	1.2903 0.4391 ⁺	0.5346 0.0066	2.0227 0.1651 ⁺	1.1111 0.0309 ⁺
Titmouse- Tanager	0.2151 0.0059	1.5645 0.6836 ⁻	0.6112 0.0075	1.6858 0.5016 ⁻
Titmouse- Grosbeak	0.0005 0.1855	0.0005 0.1855	0.1707 0.9294	3.1199 0.3928 ⁺

APPENDIX 1

Species pair	L0 1970	G 1966	G 1967	G 1969
Nuthatch-Robin	1.7256 0.8598 ⁺	- - - -	0.6349 0	- - - -
Nuthatch-Yellow-throated Vireo	- - - -	0.1612 0.0179	1.9619 0.1602 ⁺	0.1809 0.9854
Nuthatch-Red eyed Vireo	1.3445 0.4575 ⁺	7.0251 4.0781 ⁺	0.3486 0.0218	0.0034 0.2750
Nuthatch-Ovenbird	0.2339 0.0191	3.6364 1.8968 ⁻	1.4815 0.3704 ⁻	1.0429 0.3103 ⁻
Nuthatch-Oriole	1.3445 0.4575 ⁺	0.6349 0	0.1732 0.0769	0.7843 0.0218
Nuthatch-Cowbird	0.1190 0.0074	0.3008 0.3008	0.3486 0.0218	0.7843 0.0218
Nuthatch-Tanager	0.3946 0.0779	1.1285 0.2229	0.0159 0.2549	1.7924 0.7106 ⁺
Nuthatch-Grosbeak	0.3345 0.0273	1.2903 0.2549 ⁻	0.3604 0.1602	0.5723 0.0071
Robin-Red-eyed Vireo	3.0252 1.5779 ⁻	- - - -	0.1120 0.1120	- - - -
Robin-Ovenbird	0.7546 0.2643	- - - -	- - - -	- - - -
Robin-Oriole	0.0022 0.1809	- - - -	7.1490 4.1806 ⁺	- - - -
Robin-Cowbird	0.2564 0.0071	- - - -	1.0084 0.1120 ⁻	- - - -
Robin-Tanager	6.9299 5.1725 ⁻	- - - -	4.6083 2.4782 ⁺	- - - -
Robin-Grosbeak	10.8524 8.3526 ⁺	- - - -	0.4633 0.0515	- - - -
Yellow-throated Vireo-Ovenbird	- - - -	2.1291 1.2172 ⁺	1.0811 0.1201 ⁻	0.5523 0.1014
Yellow-throated Vireo-Oriole	- - - -	0.4478 0.0179	0.6879 0.0016	0.1139 1.8234

APPENDIX 1

Species pair	L0 1970	G 1966	G 1967	G 1969
Yellow-throated Vireo-Grosbeak - -	- -	5.0575 3.3856 ⁻	0.2629 0.3928	0.0832 2.6704
Red-eyed Vireo-Ovenbird	1.0398 0.3322 ⁻	0.6386 0.1752	0.2614 0	1.6003 0.6869 ⁻
Red-eyed Vireo-Oriole	1.2457 0.2461 ⁻	- - - -	- - - -	3.2516 1.2314 ⁺
Red-eyed Vireo-Tanager	2.0915 0.9886 ⁺	0.1982 0.0004	0.1377 0.0253	0.7431 0.1569
Red-eyed Vireo-Grosbeak	0.1377 0.0253	0.8638 0.2266	0.5723 0.0071	0.5632 0.0016
Ovenbird-Oriole	0.5681 0.0963	0.0577 0.0577	1.443 0.5195 ⁺	0.4396 0.0122
Ovenbird-Cowbird	2.0301 1.0589 ⁺	0.0213 0.3402	2.3529 1.0458 ⁻	0.4396 0.0122
Ovenbird-Tanager	1.5202 0.8330 ⁻	0.4572 0.1026	0.1778 0	0.3982 0.0675
Ovenbird-Grosbeak	2.9755 1.8113 ⁺	1.2121 0.5387 ⁻	1.0811 0.1201 ⁻	1.7464 0.4792 ⁻
Ovenbird-Towhee	0.9279 0.0026	- - - -	- - - -	- - - -
Oriole-Cowbird	0.7843 0.1103	0.3008 0.3008	1.4973 0.4108 ⁻	0.4938 0.0309
Oriole-Tanager	0.1307 0.0082	0.1612 0.0179	5.8397 ⁺ 3.6798 ⁺	1.6858 0.5016
Oriole-Grosbeak	0.4751 0.0253	0.0205 0.1843	0.6879 0.0016	1.9619 ⁺ 0.1602 ⁺
Cowbird-Tanager	0.4167 0.0586	0.7985 0.0066	0.1377 0.0253	0.0139 0.2229
Cowbird-Grosbeak	1.2903 0.4391 ⁺	0.6112 0.0075	0.5723 0.0071	0.3604 0.1602
Cowbird-Towhee	4.1026 0.5769 ⁺	- - - -	0.3486 0.0218	0.1732 0.0769

APPENDIX 1

Species pair	LO 1970	G 1966	G 1967	G 1969
Oriole-	4.0382	0.1622	0.9416	1.2302 ⁺
Grosbeak	2.6344 ⁻	0.0004	0.0633	0.1909 ⁺
Oriole-	0.6838	- -	- -	- -
Towhee	0.0427	- -	- -	- -

APPENDIX 1

Species pair	G 1970
Flycatcher- Pewee	0.1809 0.9854
Flycatcher- Blue Jay	0.3419 0.3419
Flycatcher- Chickadee	0.2978 0.4448
Flycatcher Titmouse	0.1139 1.8234
Flycatcher Nuthatch	0.2176 0.7504
Flycatcher- Robin	- - - -
Flycatcher- Red-eyed Vireo	- - - -
Flycatcher- Ovenbird	0.7581 0.0236
Flycatcher- Oriole	0.2176 0.7504
Flycatcher- Cowbird	0.6154 0.0684
Flycatcher- Tanager	2.7039 0.2604 ⁺
Flycatcher- Grosbeak	0.2176 0.7504
Pewee- Blue Jay	- - - -
Pewee- Chickadee	2.0493 0.8124 ⁻
Pewee- Titmouse	0.3486 0.0218
Pewee- Nuthatch	1.2257 ⁺ 0.2750 ⁺
Pewee- Robin	- - - -

APPENDIX 1

Species pair	G 1970
Pewee- Red-eyed Vireo	- - - -
Pewee- Ovenbird	0.1625 0.0020
Pewee- Oriole	0.0034 0.2750
Pewee- Cowbird	2.5621 1.3072 ⁺
Pewee- Tanager	0.1205 0.0221
Pewee- Grosbeak	1.2257 0.2750 ⁺
Blue Jay- Chickadee	3.8709 2.3417 ⁻
Blue Jay- Nuthatch	2.8283 1.443 ⁻
Blue Jay- Robin	- - - -
Blue Jay- Red-eyed Vireo	- - - -
Blue Jay- Ovenbird	1.6709 0.8525 ⁻
Blue Jay- Oriole	4.6753 2.8283 ⁺
Blue Jay- Cowbird	0.0356 0.0356
Blue Jay- Tanager	0.0418 0.0418
Blue Jay- Grosbeak	1.443 0.5195 ⁺
Blue Jay- Towhee	0.0418 0.0418
Chickadee- Titmouse	0.0159 0.2549

APPENDIX 1

Species pair	G 1970
Chickadee- Nuthatch	2.0165 0.8497 ⁺
Chickadee- Robin	- - - -
Chickadee-Yellow throated Vireo	- - - -
Chickadee- Ovenbird	0.8099 0.2673
Chickadee Oriole	0.3283 0.0056
Chickadee- Cowbird	0.0860 0.0096
Chickadee- Tanager	1.6723 ⁺ 0.7555 ⁺
Chickadee- Grosbeak	0.3283 0.0056
Titmouse- Nuthatch	0.5228 0.1173
Titmouse- Robin	- - - -
Titmouse- Red-eyed Vireo	- - - -
Titmouse- Ovenbird	1.921 0.7275 ⁻
Titmouse- Oriole	0.1732 0.0769
Titmouse- Cowbird	0.2963 0
Titmouse- Tanager	1.1285 0.2229
Titmouse- Grosbeak	0.9428 0.0769
Nuthatch Robin	- - - -

APPENDIX 1

Species pair	G 1970
Nuthatch-Yellow-throated Vireo	0.4466 0.0820
Nuthatch-Red-eyed Vireo	- - - -
Nuthatch-Ovenbird	0.0004 0.1599
Nuthatch-Oriole	1.7998 0.6304 ⁻
Nuthatch-Cowbird	0.1039 0.0115
Nuthatch-Tanager	3.2184 1.7636 ⁻
Nuthatch-Grosbeak	0.0607 0.0907
Robin-Red-eyed Vireo	- - - -
Robin-Ovenbird	- - - -
Robin-Oriole	- - - -
Robin-Cowbird	- - - -
Robin-Tanager	- - - -
Robin-Grosbeak	- - - -
Yellow-throated Vireo-Ovenbird	2.8483 0.9099
Yellow-throated Vireo-Oriole	1.5402 0.0820 ⁺
Yellow-throated Vireo-Grosbeak	0.4466 0.0820
Red-eyed Vireo-Ovenbird	- - - -

APPENDIX 1

Species pair	G 1970
Red-eyed Vireo	- -
Oriole	- -
Red-eyed Vireo	- -
Tanager	- -
Red-eyed Vireo	- -
Grosbeak	- -
Ovenbird-	0.7445
Oriole	0.1953
Ovenbird-	0.1705
Cowbird	0.0068
Ovenbird-	0.9008
Tanager	0.3492
Ovenbird-	0.0004
Grosbeak	0.1599
Ovenbird-	0.9008
Towhee	0.3492
Oriole-	1.3968
Cowbird	0.5657 ⁺
Oriole-	1.0037
Tanager	0.2872 ⁺
Oriole-	0.7204
Grosbeak	0.0907
Cowbird-	0.0084
Tanager	0.0752
Cowbird-	0.1039
Grosbeak	0.0115
Cowbird-	0.4096
Towhee	0.0752
Oriole	0.7431
Grosbeak	0.1569
Oriole-	0.5979
Towhee	0.1419

APPENDIX 2

Chi-square values for bird species found in the Large Oak area from May 2 to September 20, 1967. See Table 1 for species names.

Species pair	May 2- May 12	May 15- May 20	May 22- May 26	May 29- June 9
Flycatcher- Pewee	- - - -	0.2564 0.5769	2.1483 1.2471	0.8068 0.3055
Flycatcher- Blue Jay	1.9048 0.1041 ⁺	0.0490 0.1103	2.3945 1.2751 ⁺	3.2052 1.5775 -
Flycatcher- Chickadee	0.3419 0.3419	0.2302 0.0064	0.0213 0.3402	0.9023 0.0251
Flycatcher- Titmouse	0.0539 4.3725	0.2564 0.5769	- - - -	0.4396 0.0868
Flycatcher- Nuthatch	0.2979 0.0026	0 0.1667	2.8566 1.8189 +	0.2926 0.0239
Flycatcher- Red-eyed Vireo	- - - -	- - - -	- - - -	0.7143 0.2431
Flycatcher- Ovenbird	2.7039 0.2604 ⁺	0.0251 0.0564	0.2514 0.0317	2.5254 ⁺ 1.5467 ⁺
Flycatcher- Oriole	0.0263 9.4938	0.8333 0.2083	0.6138 0.2089	0.4396 0.0868
Flycatcher- Cowbird	0.0263 9.4938	0.2564 0.5769	0.0449 0.1010	1.3899 0.2746 -
Flycatcher Tanager	- - - -	0.3516 0.0098	0.1746 0.0093	0.6566 0.1954
Flycatcher- Grosbeak	0.2564 0.5769	0.4396 0.0618	1.3811 0.7204 ⁺	1.6071 ⁺ 0.8383 ⁺
Pewee- Chickadee	- - - -	1.3876 0.0236 ⁺	0.4010 0.0251	0.0213 0.3402
Pewee- Titmouse	- - - -	0.0263 9.4938	- - - -	3.6470 ⁺ 2.4703 ⁺
Pewee- Nuthatch	- - - -	1.7094 0.0684 ⁺	0.4396 0.0868	3.8721 ⁺ 2.6024 ⁺

APPENDIX 2

Species pair	May 2- May 12	May 15- May 20	May 22- May 26	May 29- June 9
Pewee- Robin	- - - -	0.1465 1.3187	0.0373 0.0840	0.6152 0.0328
Pewee- Red-eyed Vireo	- - - -	0.0263 9.4938	0.9023 0.0251	5.4135 4.0142-
Pewee- Ovenbird	- - - -	0.9279 0.0026	0.0049 0.0794	1.5681 0.8746+
Pewee- Oriole	- - - -	0.3419 0.3419	1.6071 0.8383-	0.3327 0.0564
Pewee- Tanager	- - - -	0.2564 0.5769	0.1732 0.0048	0.0139 0.0483
Pewee- Grosbeak	- - - -	0.5523 0.1014	0.3175 0.0446	0.0668 0.0042
Blue Jay- Chickadee	0.1465 0	0.2427 0.0020	0.4466 0.0820	0.3715 0.1651
Blue Jay- Nuthatch	2.3488 1.4386	0.4706 0.0523	0.0597 0.0399	0.4155 0.0221
Blue Jay- Robin	0.4396 0.0122	0.1120 0.1120	1.2257+ 0.2750+	0.8549 0.0071
Blue Jay- Ovenbird	2.5478 1.5006+	3.7735 2.2971+	0.7445 0.1953	0.5681 0.0963
Blue Jay- Oriole	0.5523 0.1014	0.2614 0	0.0289 0.0649	0.9854 0.2704
Blue Jay- Cowbird	1.9048 0.1014+	5.8119 0.9854+	0.9428 0.0769	0.5723 0.0071
Blue Jay- Tanager	- - - -	1.7647 0.6005-	0.9253 0.2956	0.0373 0.0840
Blue Jay- Grosbeak	0.0275 0.0618	1.0429 0.3103+	0.4618 0.0649	2.0915 0.9886-
Chickadee- Nuthatch	0.1347 0	0.1705 0.0068	0.2939 0.0539	0.5346 0.0066
Chickadee Robin	0 0.3704	1.1838 0.3644-	0.3715 0.1651	0.1707 0.9294

APPENDIX 2

Species pair	May 2- May 12	May 15- May 20	May 22- May 26	May 29- June 9
Chickadee-Yellow-throated Vireo	- - - -	0.2728 0.0384	- - - -	- - - -
Chickadee-Ovenbird	0.3762 0.0418	0.4744 0.1356	1.5561 0.2638-	0.0053 0.4274
Chickadee-Oriole	0.3419 0.3419	4.1262 2.7622+	0.0877 0.1974	0.2939 0.0539
Chickadee-Tanager	- - - -	1.6368 0.7737+	2.5731 0.7656-	0.4010 0.0251
Chickadee-Grosbeak	0 0.2083	0.0011 0.0911	0.0877 0.1974	0.0877 0.1974
Titmouse-Nuthatch	2.3269 0.6384-	0.6154 0.0684	- - - -	1.1607 0.4891+
Titmouse-Robin	- - - -	- - - -	- - - -	- - - -
Titmouse-Red-eyed Vireo	- - - -	- - - -	- - - -	0.6838 0.2327
Titmouse-Ovenbird	0.7985 0.0066	0.9279 0.0026	- - - -	0.3110 0.0483
Titmouse-Tanager	- - - -	- - - -	- - - -	0.7795 0.2730
Titmouse-Grosbeak	0.5263 0.0329	0.5523 0.1014	- - - -	2.2982 1.3723+
Nuthatch-Robin	- - - -	- - - -	- - - -	- - - -
Nuthatch-Yellow-throated Vireo	2.4203 1.1600-	0.4444 0.1111	0.0037 0.1180	0.1205 0.0221
Nuthatch-Red-eyed Vireo	- - - -	0.6154 0.0684	1.0136 0.0539-	0.0836 0.0052
Nuthatch-Ovenbird	0.0013 0.1026	0.5414 0.1671	0.1285 0.0003	0.7546 0.2643
Nuthatch-Oriole	0.9279 0.0026	0.0356 0.0356	1.5385 0.8025+	0.1889 0.0032

APPENDIX 2

Species pair	May 2- May 12	May 15- May 20	May 22- May 26	May 29- June 9
Nuthatch- Tanager	- - - -	2.6667 1.5	0.6089 0.1945	0.1032 0.0032
Nuthatch- Grosbeak	2.0301 1.0589 +	0.7326 0.2637	2.2982 1.3723 ⁺	0.0836 0.0052
Robin- Red-eyed Vireo	- - - -	0.1465 1.3187	0.3715 0.1651	0.0601 0.1351
Robin- Oriole	- - - -	0.6857 0.0762	0.1307 0.0082	- - - -
Robin- Tanager	- - - -	0 0.3571	0.0713 0.0317	1.3899 0.2746 ⁻
Robin- Grosbeak	- - - -	0.7467 0.1371	0.1307 0.0082	- - - -
Yellow-throated Vireo-Ovenbird	0.4478 0.0179	2.8237 1.8421 ⁻	0.3993 0.0619	1.0398 0.3322 ⁺
Yellow-throated Vireo-Oriole	0.1465 1.3187	2.2222 1.25 ⁻	0.0956 0.0059	0.9854 0.2704
Yellow-throated Vireo-Grosbeak	0 0.3571	0.1648 0.0046	3.4409 2.1565 ⁻	0.2941 0.0082
Red-eyed Vireo Ovenbird	- - - -	1.1336 0.0026 ⁺	1.5561 0.2638 ⁻	0.0668 0.0042
Red-eyed Vireo Tanager	- - - -	0.2564 0.5769	0.0213 0.3402	0.3039 0.0427
Red-eyed Vireo Grosbeak	- - - -	0.5523 0.1014	3.1579 1.0746 ⁻	0.0694 0.0043
Ovenbird- Oriole	2.7039 0.2604 ⁺	4.0434 2.7068 ⁻	0.6138 0.2087	3.6470 2.4703 ⁺
Ovenbird- Cowbird	0.3890 0.2604	1.1336 0.0026 ⁺	0.1023 0.0455	0.4778 0.0081
Ovenbird- Tanager	- - - -	0.4010 0.0564	1.1253 0.5466 ⁺	1.5220 0.8023 ⁺
Ovenbird- Grosbeak	1.1285 0.3840 ⁻	0.8031 0.3184	0.6138 0.2089	0.0668 0.0042

APPENDIX 2

Species pair	May 2- May 12	May 15- May 20	May 22- May 26	May 29 June 9
Oriole-	- -	0.8333	0.0168	5.2150
Tanager	- -	0.2083	0.0379	3.6684 ⁺
Oriole-	0.2564	1.3187	0.1562	10.9402
Grosbeak	0.5769	0.5861 ⁺	0.0043	8.7797 ⁻
Cowbird	- -	0.2564	1.6162	1.3899
Tanager	- -	0.5769	0.5499 ⁻	0.2746 ⁻
Cowbird-	0.2564	0.5523	2.9629	0.9609
Grosbeak	0.5769	0.1014	1.4005 ⁺	0.1351
Tanager-	- -	7.0329	0.0168	6.8566
Grosbeak	- -	5.0069 ⁻	0.0379	5.1709 ⁻

APPENDIX 2

Species pair	June 12- June 24	June 26- July 8	July 10- July 22	July 23- August 5
Flycatcher- Pewee	0.5569 0.0455	0.5651 0.0628	1.5699 0.5651 ⁺	1.1111 0.2778 ⁻
Flycatcher- Blue Jay	1.9275 0.5735 ⁺	0.6349 0	0.8163 0.0327	0.6349 0
Flycatcher- Chicadee	0.3604 0.1602	1.287 0.0515 ⁺	0.3008 0.3008	1.4815 0.3704 ⁺
Flycatcher- Titmouse	0.7843 0.0218	0.8163 0.0327	0.2939 0.0327	0.1139 1.8234
Flycatcher- Nuthatch	1.9048 0.6481 ⁻	0.4478 0.0179	1.7329 0.7018 ⁺	1.1111 0.2778 ⁻
Flycatcher- Red-eyed Vireo	- - - -	- - - -	- - - -	- - - -
Flycatcher- Ovenbird	0.4396 0.0122	0.6857 0.0762	1.2121 0.2226	- - - -
Flycatcher- Oriole	- - - -	- - - -	8.7001 4.1699 ⁺	- - - -
Flycatcher- Cowbird	0.2339 0.5263	- - - -	- - - -	- - - -
Flycatcher- Tanager	0.1852 0.0116	0.0152 0.1371	2.8283 1.443 ⁻	3.6594 1.8234 ⁺
Flycatcher- Grosbeak	0.0139 0.2229	0.0247 0.2226	0.0247 0.2226	0.1732 0.0769
Pewee- Chickadee	0.7751 0.0747	1.4296 0.3208 ⁺	0.2082 0.0925	0.8354 0.3008
Pewee- Titmouse	1.9277 0.8846 ⁺	5.0863 3.0769 ⁺	0.0628 0.0628	1.0256 0
Pewee- Nuthatch	8.8190 6.3135 ⁺	1.6954 0.8844 ⁺	3.0946 2.0369 ⁺	0.9023 0.4010
Pewee- Robin	0.1115 0.0747	0.0142 0.0772	0.8974 0.3709	2.4893 1.4962 ⁻
Pewee- Red-eyed Vireo	1.5561 0.2638 ⁺	0.2082 0.0925	3.0952 2.0192 ⁻	5.625 3.9062 ⁺

APPENDIX 2

Species pair	June 12- June 24	June 26- July 8 -	July 10- July 22	July 23- August 5
Pewee- Ovenbird	0.4058 0.0911	5.4690 3.8706	0.1541 0.0019	- - - -
Pewee- Oriole	- - - -	- - - -	1.4296 0.3208 ⁺	- - - -
Pewee- Tanager	0.2728 0.0384	0.3913 0.0773	0.0012 0.0911	0.3110 0.0483
Pewee- Grosbeak	1.4396 0.7084 ⁺	1.8286 0.8392 ⁺	0.2302 0.0019	1.5584 0.6926 ⁻
Blue Jay- Chickadee	3.6281 1.4066 ⁺	0.3604 0.1602	0.3008 0.3008	0.0762 0.0762
Blue Jay- Nuthatch	3.6115 2.2119 ⁺	0.0139 0.2229	0.1289 0.0143	0.2286 0
Blue Jay- Robin	0.2183 0.0633	0.0159 0.2549	0.9524 0.2381	0.4478 0.0179
Blue Jay- Ovenbird	0.0142 0.0772	1.4815 0.3704	1.2121 0.2226 ⁻	- - - -
Blue Jay- Oriole	- - - -	- - - -	0.4633 0.0515	- - - -
Blue Jay- Cowbird	0.9130 0.0075	- - - -	- - - -	- - - -
Blue Jay- Tanager	0.2151 0.0059	0.2963 0	1.443 0.5195 ⁺	0.407 0.0163
Blue Jay- Grosbeak	1.6723 0.7555 ⁺	0.9428 0.0769	0.0247 0.2226	1.2121 0.2226 ⁻
Chickadee- Nuthatch	2.0764 0.6178	0.0554 0.1909	0.0053 0.4274	0.5333 0.1333
Chickadee- Robin	0.2629 0.3928	0.2183 0.0633	0.0877 0.1974	0.3762 0.0418
Chickadee- Yellow- throated Vireo	- - - -	- - - -	- - - -	- - - -
Chickadee- Ovenbird	1.7464 0.4792 ⁻	3.003 1.0811 ⁺	0.4466 0.0820	- - - -

APPENDIX 2

Species pair	June 12- June 24	June 26- July 8	July 10- July 22	July 23- August 5
Chickadee	- -	- -	5.4813	- -
Oriole	- -	- -	0.9294 ⁺	- -
Chickadee- Tanager	0.0601 0.1351	1.9459 0.6006 ⁻	0.0213 0.3402	0.3419 0.0379
Chickadee- Grosbeak	2.4954 0.8235 ⁺	0.5632 0.0016	0.4466 0.0820	0.5195 0.0577
Titmouse- Nuthatch	16.4706 12.7824 ⁺	3.0273 1.4509 ⁺	1.7329 0.7018 ⁺	1.0256 ⁺ 0
Titmouse- Robin	- - - -	0.0205 0.1843	0 0.2381	- - - -
Titmouse- Red-eyed Vireo	- - - -	- - - -	- - - -	- - - -
Titmouse- Ovenbird	0.0086 0.1379	0.6857 0.0762	1.2121 0.2226 ⁻	- - - -
Titmouse- Tanager	- - - -	- - - -	- - - -	- - - -
Titmouse- Grosbeak	1.7924 0.7106 ⁺	2.0037 0.6184 ⁺	0.0247 0.2226	4.8352 0.7504 ⁺
Nuthatch- Robin	- - - -	- - - -	0.1504 0.0042	0.1254 0
Nuthatch-Yellow- throated Vireo	0.5976 0.0840	2.4954 0.8235 ⁺	0.4778 0.0081	1.0256 ⁺ 0
Nuthatch- Red-eyed Vireo	4.1923 2.0301 ⁺	0.5346 0.0066	0.1504 0.0042	0 0.1562
Nuthatch- Ovenbird	0.0209 0.0471	1.7256 0.8598 ⁺	1.9482 0.9587 ⁻	- - - -
Nuthatch- Oriole	- - - -	- - - -	0.4778 0.0081	- - - -
Nuthatch- Tanager	0.7143 0.2431	0.3349 0.0471	0.3510 0.0741	1.0256 0.4558 ⁻
Nuthatch- Grosbeak	1.7256 0.8598 ⁺	1.0037 0.2872 ⁺	0.0733 0.0213	0.1732 0

APPENDIX 2

Species pair	June 12- June 24	June 26- July 8	July 10- July 22	July 23- August 5
Robin- Red-eyed Vireo	0.1707 0.9294	0.6112 0.0075	0.8507 0.3516	1.1285 0.3840 -
Robin- Oriole	- - - -	- - - -	- - - -	- - - -
Robin- Tanager	0.9609 0.1351	3.4504 2.1505-	0.2728 0.0384	0.1889 0.0032
Robin Grosbeak	- - - -	- - - -	- - - -	- - - -
Yellow-throated Vireo-Ovenbird	0.0086 0.1379	0.1201 0.1201	0.6879 0.0016	- - - -
Yellow-throated Vireo-Oriole	- - - -	- - - -	0.2629 0.3928	- - - -
Yellow-throated Vireo-Grosbeak	0.1205 0.0221	0.5632 0.0016	0.5632 0.0016	0.2176 0.7504
Red-eyed Vireo- Ovenbird	0.2082 0.0925	0.7018 0	0.0289 0.0649	- - - -
Red-eyed Vireo Tanager	3.1579 1.0746 ⁺	3.5088 1.2632 ⁺	0.0171 0.0384	4.1026 2.5712 ⁺
Red-eyed Vireo Grosbeak	5.5502 2.3824 ⁺	1.5402 0.0820 ⁺	0.4618 0.0649	0.1732 0.0108
Ovenbird- Oriole	- - - -	- - - -	0.6879 0.0016	- - - -
Ovenbird- Cowbird	0.2082 0.0925	- - - -	- - - -	- - - -
Ovenbird- Tanager	2.6374 1.6529 ⁺	0.7535 0.2564	0.9253 0.2956	- - - -
Ovenbird- Grosbeak	0.0124 0.0675	1.443 0.5195 ⁺	3.7788 1.9497 ⁺	- - - -
Oriole- Tanager	- - - -	- - - -	3.9639 1.9256	- - - -
Oriole- Grosbeak	- - - -	- - - -	0.5632 0.0016	- - - -

APPENDIX 2

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Species pair	June 12 June 24	June 26- July 8	July 10 July 22	July 23- August 5
Cowbird- Tanager	1.4035 0.1974	- - - -	- - - -	- - - -
Cowbird- Grosbeak	0.7985 0.0066	- - - -	- - - -	- - - -
Tanager- Grosbeak	0.1881 0.0052	1.9509 0.9351-	0.0157 0.0857	1.2832 0.4741-

APPENDIX 2

Species pair	August 9- September 20
Flycatcher- Pewee	- - - -
Flycatcher- Blue Jay	- - - -
Flycatcher- Chickadee	- - - -
Flycatcher- Titmouse	- - - -
Flycatcher- Nuthatch	- - - -
Flycatcher- Red-eyed Vireo	- - - -
Flycatcher- Ovenbird	- - - -
Flycatcher- Oriole	- - - -
Flycatcher- Cowbird	- - - -
Flycatcher- Tanager	- - - -
Flycatcher- Grosbeak	- - - -
Pewee- Chickadee	2.4893 1.4962 ⁺
Pewee- Titmouse	- - - -
Pewee- Nuthatch	4.1771 2.9474 ⁺
Pewee- Robin	- - - -
Pewee- Red-eyed Vireo	0.9023 0.1782

APPENDIX 2

Species pair	August 9- September 20
Pewee- Ovenbird	- - - -
Pewee- Oriole	- - - -
Pewee- Tanager	0.9346 0.3453
Pewee- Grosbeak	- - - -
Blue Jay- Chickadee	0.1982 0.0004
Blue Jay- Nuthatch	0.2389 0.0096
Blue Jay- Robin	- - - -
Blue Jay- Ovenbird	- - - -
Blue Jay- Oriole	- - - -
Blue Jay- Cowbird	- - - -
Blue Jay- Tanager	3.3715 1.9121 -
Blue Jay Grosbeak	- - - -
Chickadee- Nuthatch	1.8809 1.0115 ⁺
Chickadee- Robin	- - - -
Chickadee-Yellow- throated Vireo	- - - -
Chickadee- Ovenbird	- - - -

APPENDIX 2

Species pair	August 9- September 20
Chickadee- Oriole	- - - -
Chickadee- Tanager	0.1622 0.0004
Chickadee- Grosbeak	- - - -
Titmouse- Nuthatch	- - - -
Titmouse- Robin	- - - -
Titmouse- Red-eyed Vireo	- - - -
Titmouse- Ovenbird	- - - -
Titmouse- Tanager	- - - -
Titmouse- Grosbeak	- - - -
Nuthatch- Robin	- - - -
Nuthatch-Yellow throated Vireo	- - - -
Nuthatch- Red-eyed Vireo	2.6667 1.1852 ⁺
Nuthatch- Ovenbird	- - - -
Nuthatch- Oriole	- - - -
Nuthatch- Tanager	0.0860 0.0096
Nuthatch- Grosbeak	- - - -

APPENDIX 2

Species pair	August 9- September 20
Robin- Red-eyed Vireo	- - - -
Robin- Oriole	- - - -
Robin- Tanager	- - - -
Robin- Grosbeak	- - - -
Yellow-throated Vireo-Ovenbird	- - - -
Yellow-throated Vireo-Oriole	- - - -
Yellow-throated Vireo-Grosbeak	- - - -
Red-eyed Vireo- Ovenbird	- - - -
Red-eyed Vireo Tanager	0.0159 0.2549
Red-eyed Vireo- Grosbeak	- - - -
Ovenbird- Oriole	- - - -
Ovenbird- Cowbird	- - - -
Ovenbird- Tanager	- - - -
Ovenbird- Grosbeak	- - - -
Oriole- Tanager	- - - -
Oriole- Grosbeak	- - - -

APPENDIX 2

<u>Species pair</u>	<u>August 9- September 20</u>
Cowbird- Tanager	- - - -
Cowbird- Grosbeak	- - - -
Tanager- Grosbeak	- - - -

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