THE DISTRIBUTION OF BIRDS ON A PENINSULA IN LAKE NORMAN ACCORDING TO FLORISTIC COMMUNITIES

A Thesis

by

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Submitted to the Graduate Faculty of
Appalachian State University in
partial fulfillment of the requirement
for the degree of
MASTER OF SCIENCE
in
Biology

April, 1980

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This thesis is dedicated to the memory of my Grandmother, Gladys V. Kennard, who first introduced me to birds and kindled a love for them within me.

ACKNOWLEDGEMENTS

The Author would like to express thanks and appreciation to the following people for their kind help in the preparation of this thesis.

Dr. J. Frank Randall directed this study and offered much time and assistance in the preparation of this work.

I would also like to express my appreciation to Dr. Marie Hicks and Dr. John Bond for their critical review of this thesis.

The help of Dr. Mary Connell in the preparation of the plant data is deeply appreciated.

Mrs. Janice Ashley's help in typing this thesis was also invaluable.

My wife, Sandy, gave me moral support as well as physical help in collecting data. Her patience during this difficult time was greatly appreciated.

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INTRODUCTION

It is well known that avian species are not distributed at random in forest and marginal communities (Odum, 1971). Their distribution patterns are the result of various factors. Certain species, and in some cases genera, families or orders are often found in specific habitats. These habitats are difficult to determine because birds fly. In this study, specific habitats were determined by quantitative floristic analysis. Avian species were identified through both visual and audio methods.

Because of man's increased disruption of natural communities habitat gradients are continually changing, resulting in changes in avian species composition. Some major disruptive factors causing habitat gradient and species composition changes are logging, farming, noise associated with the onslaught of mans' transportational and recreational needs, and the amount of human population pressure on an area. These factors, as well as many others, play an important role in avian distribution.

The objectives of this study were to:

1. Identify all avian species inhabitating Duke Power State Park, a peninsula in Lake Norman, from March 15 - October 15, 1979.
2. Determine the range of habitats occupied by each species and identify some factors which influence habitat selection.
3. Determine species associations within each major habitat type.
4. Establish an avian species record for the North Carolina State Park system as a standard of comparison for future distributional changes.

REVIEW OF THE LITERATURE

There is little agreement concerning the factors determining diversity of bird communities within a given area. Birds may be distributed within forest communities according to their ancestral instincts (Lack, 1933). Lack also noted that distinct adjoining habitats suggest separation of habitat by a common ancestor but differential specialization tends to increase the longer the forms have been separated. Although this ancestral habitat idea may be true and is the prime initiator of distribution, there are environmental factors which help determine distribution.

Birds respond to environmental factors either positively or negatively. Anderson and Shugart (1974), state that selection of habitat may be based on certain factors such as food, protection and nest site availability. Each of these factors is represented by "sign stimuli" that lend themselves to measurable species responses.

Beal (1960), states that these "sign stimuli" are so variable that it is impossible to identify all stimuli for a given species. This may account for the wide range of bird community usage. The "sign stimuli" therefore may come from many communities.

Some observers believe that bird distribution within a community can be more sharply delimited. MacArthur and MacArthur (1961), state that bird species diversity in temperate regions is correlated with diversity of foliage height. They also state that avian diversity increases with the number of layers in the vegetation and with the evenness of foliage apportionment among the layers. Thus, species diversity can be related to the ecological succession of the community in which a species occurs. Early successional stage forests, therefore, would have more bird species diversity because they have a greater number of layers. According to Odum (1950), and Adams (1908), ecological succession of birds has a positive correlation with the ecological succession of plants. Population diversity would, therefore, decrease as stands approach climax.

Distribution of birds can be seen as a function of many variables. All of these variables are influenced by the instincts of birds.

DESCRIPTION OF THE STUDY AREA

Duke Power State Recreation Area lies twelve miles south of Statesville, North Carolina, in Iredell County. It is a peninsula of Lake Norman, the largest man-made lake in the state. The Park covers 1399 acres of which ten percent adjoins the northwest shore of this 32,510 acre lake (N. C. Department of Economic and Natural Resources, 1978). The Park contains a man-made, multi-recreational, 33 acre lake. The Park was established in 1962 by a grant given to the State of North Carolina by the Duke Power Company (N. C. Department of Economic and Natural Resources, 1976).

Much of the land was either farmed or logged, with the last major disruption occurring around 1960, two years before the Park was established. As a result, the Park contains many successional community types varying from oak-hickory forest to marginal swamp areas.

The Park is bordered on the north by Lake Norman. Lake Norman is a multiuse hydroelectric, recreational lake. It was established in 1961 by the flooding of the Cowan's Ford Dam in 1960 (N. C. Department of Economic and Natural Resources, 1978).

The Park lies completely within the Piedmont Province of North Carolina at an elevation of about 700 feet with variations less than 200 feet and has an average yearly rainfall of fifty inches and an average annual temperature of fifty-nine degrees (U. S. Department of Agriculture, 1941).

The topography of the Park is a result of it being within the Catawba River drainage basin. The Park viewed as a whole contains many forest coves and hills running from the center of the peninsula to the lake. The hills and coves are a result of the drainage of water into the Catawba River.

MATERIALS AND METHODS

The names of all birds sighted along a transect were recorded according to the habitats they were occupying. The transect was a 6 mile swath following natural observation routes starting at the Park Office and finishing at a cove of Lake Norman. The transect represented examples of all major community types within the Park, the 33 acre lake and part of the Lake Norman shoreline. As a result, most variables as to habitat and physical barriers were included.

Observations were made between 5:30 and 9:00 A.M. on the average of two times per week starting on March 3, 1979, and ending on September 19, 1979. Ten observations were also made at night from 9:00 to 2:00 P.M. to identify nocturnal avian species in the study area.

Birds were identified using direct audio and visual recognition. Common songs and sightings were immediately recognized but problem birds were checked using the following sources: (Peterson, 1947; Pearson, 1959; Ball and Farrand, 1977; American Ornithologists' Union, 1957; and Peterson, 1949).

After the birds were identified and given an area identification number, the areas were analyzed using the "Plotless Method" (Gottam and Curtis, 1955), which gave botanical frequency, density and importance values.

EXPERIMENTAL RESULTS

Forested areas were quantified using the "Plotless Method", (Gottam and Curtis, 1955). Using this method, relative density, relative frequency, relative coverage and importance values were recorded for the tree species within six of the seven habitats sampled. These habitats were named according to the dominant tree associations or consociations (Oosting, 1956). The results are listed in Table I.

Habitat number one is a *Pinus echinata* forest that borders a lake cove. This area is not natural and was planted in monoculture form.

Habitat number two is a *Pinus virginiana* forest. Further observation of this area reveals obsolete farm terraces which indicates that this area was farmed.

At both ends of the *Pinus virginiana* forest are what can best be described as "old fields" with dominants of *Andropogon* sp. and *Pinus virginiana*. Observations indicate the pines are from three to five years of age and widely stratified.

Habitat number three is a *Quercus alba - Carya ovata* association but contains variations. The distributional data shows that *Pinus echinata* still

exists here and is of relative importance in this habitat. This area was situated on top of a hill and is relatively xeric when compared to lower areas closer to the lake.

Habitat four is also a *Quercus - Carya* association but the data indicates a greater relative diversity of *Quercus* sp. The presence of *Liriodendron tulipifera* indicates a hydric condition while *Pinus echinata* indicates a sub climax condition.

Habitat number five is relatively xeric because it is not adjacent to the lake and is elevated. This area is termed a *Quercus alba* consociation due to the lack of comparable dominance of *Carya* sp. In addition to the dominant *Quercus alba,* several other tree species were present. However, no *Pinus echinata* was present. The area has a slight northern aspect.

A *Quercus - Carya* association exists in area number six. This area is adjacent to the lake and has a northern aspect. The area is relatively hydric and contains a few freshwater springs. *Acer rubrum, Fagus grandifolia* and *Nyssa sylvatica* also occur. There is a lack of *Pinus echinata* in the area.

The final sampling area was not quantitatively analyzed because its diversity ranges from open water to marshland. This area consists of *Salix nigra* - *Cephalanthus occidentalis* associations; *Alnus serrulata* consociations; *Carex* sp. - *Typha latifolia* associations and barren shore. All of these habitats were grouped under one heading as open water to marshland habitats.

Table I. Quantitative Habitat Description

Habitat Number 1. (*Pinus echinata* forest)

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Pinus echinata Miller	114	.919	.795	.909	2.623
Liriodendron tulipifera L.	4	.032	.052	.006	.090
Liquidambar styraciflua L.	1	.008	.025	.004	.044
Juniperus virginiana L.	1	.008	.025	.002	.042
Cornus florida L.	1	.008	.025	.015	.055
Prunus serotina Ehrhart	1	.008	.025	.001	.041
Oxydendrum arboreum DC.	2	.016	.052	.063	.144

Habitat Number 2. (*Pinus virginiana* forest)

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Pinus virgininiana Miller	124	1.00	1.0	1	3

Habitat Number 3. (*Quercus alba* - *Carya ovata* association)

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Cornus florida L.	20	.172	.168	.026	.366
Carya ovata K. Koch	5	.043	.042	.013	.098
Fagus grandifolia Ehrhart	2	.017	.021	.029	.067
Pinus echinata Miller	12	.103	.095	.169	.367
Quercus rubra var. *borealis* Farwell	5	.043	.052	.047	.142
Oxydendrum arboreum DC.	10	.086	.073	.016	.175
Gleditsia triacanthos L.	1	.009	.011	.026	.046

Habitat Number 3. (*Quercus alba* - *Carya ovata* association) Cont.

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Fraxinus americana L.	6	.052	.063	.021	.136
Carya tomentosa Nuttall	4	.034	.043	.008	.085
Quercus marilandica Muenchh.	2	.017	.021	.012	.050
Quercus alba L.	20	.172	.137	.088	.397
Illex opaca Aiton	1	.009	.011	.0004	.020
Liriodendron tulipifera L.	9	.078	.073	.071	.222
Quercus falcata Michaux	2	.017	.021	.028	.066

Habitat Number 3. (*Quercus alba* - *Carya ovata* association) Cont.

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Carpinus caroliniana Walter	5	.043	.042	.002	.087
Prunus serotina Ehrhart	1	.009	.011	.0002	.020
Nyssa sylvatica Marshall	7	.060	.073	.0120	.145
Acer rubrum L.	3	.026	.032	.0120	.070
Pinus virginiana Miller	1	.009	.011	.004	.024
Quercus coccinea Muenchh.	1	.009	.011	.435	.455

Habitat Number 4. (*Quercus* - *Carya* association)

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Carya glabra Sweet	13	.105	.110	.032	.247
Quercus falcata Michaux	6	.048	.055	.016	.119
Quercus velutina Lam.	7	.056	.066	.033	.155
Cornus florida L.	27	.218	.198	.068	.484
Illex opaca Aiton	2	.016	.022	.019	.057
Quercus rubra var. *borealis* Farwell	7	.056	.055	.076	.187
Liriodendron tulipifera L.	9	.075	.077	.101	.253

Habitat Number 4. (*Quercus* - *Carya* association) Cont.

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Quercus alba L.	4	.032	.033	.011	.076
Fraxinus americana L.	1	.008	.011	.003	.022
Nyssa sylvatica Marshall	5	.040	.044	.008	.092
Pinus echinata Miller	20	.161	.154	.505	.820
Oxydendrum arboreum DC.	10	.08	.066	.008	.154
Carya ovata K. Koch	13	.105	.110	.119	.334

Habitat Number 5. (*Quercus alba* consociation)

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Prunus serotina Ehrhart	3	.024	.024	.004	.052
Quercus alba L.	39	.315	.247	.554	1.116
Acer rubrum L.	11	.089	.118	.008	.215
Liriodendron tulipifera L.	11	.089	.129	.146	.364
Carya ovata K. Koch	1	.008	.012	.025	.045
Oxydendrum arboreum DC.	37	.298	.235	.059	.592
Quercus coccinea Muenchh.	2	.016	.024	.017	.057

Habitat Number 5. (*Quercus alba* consociation) Cont.

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Quercus falcata Michaux	7	.056	.059	.122	.237
Pinus echinata Miller	1	.008	.012	.042	.062
Nyssa sylvatica Marshall	1	.008	.012	.002	.022
Carpinus caroliniana Walter	1	.008	.012	.009	.029
Juniperus virginiana L.	2	.016	.024	.001	.041
Cornus florida L.	4	.032	.047	.003	.082
Quercus rubra var. *borealis* Farwell	2	.016	.024	.004	.044

Habitat Number 5. (*Quercus alba* consociation) Cont.

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Ilex opaca Aiton	1	.008	.012	.003	.023
Fagus grandifolia Ehrhart	1	.008	.012	.0005	.021

Habitat Number 6. (*Quercus* - *Carya* association)

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Cornus florida L.	12	.098	.092	.104	.294
Carya ovata K. Koch	8	.065	.070	.019	.154
Fraxinus americana L.	2	.016	.020	.038	.074
Carya glabra Sweet	4	.032	.041	.002	.075
Liriodendron tulipifera L.	20	.161	.174	.094	.429
Nyssa sylvatica Marshall	12	.098	.082	.142	.322
Quercus rubra var. *borealis* Farwell	18	.145	.123	.324	.592

Habitat Number 6. (*Quercus - Carya* association) Cont.

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Quercus alba L.	11	.089	.092	.060	.241
Fagus grandifolia Ehrhart	10	.081	.092	.057	.230
Carpinus caroliniana Walter	2	.016	.020	.0003	.036
Acer rubrum L.	15	.121	.102	.035	.258
Oxydendrum arboreum DC.	6	.048	.051	.013	.112
Diospyros virginiana L.	1	.008	.317	.0002	.325
Prunus serotina Ehrhart	1	.008	.317	.013	.338

Habitat Number 6. (*Quercus* - *Carya* association) Cont.

Species	Number of Individuals	Relative Density	Relative Frequency	Relative Coverage	Importance Value
Carya tomentosa Nuttall	1	.008	.317	.019	.344
Quercus coccinea Muenchh.	1	.008	.317	.082	.407

The distribution of birds within each habitat consisted of all birds sighted in the area throughout the study period. The summation of these sightings is called the "total individual occurrence." Some of these individual birds were sighted more than once. This observation is quantified under the heading of "total individual occurrence less repeats." The summation of each column of values was computed from which came the "individual % occurrence" and "individual % occurrence less repeats." These results are in Table II.

Table II. Distribution of Birds Within Each Habitat

Habitat Number 1. (*Pinus echinata* forest)

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Agelaius phoeniceus	1	1	.559	.637
Ardea herodias	1	1	.559	.637
Bubo virginianus	1	1	.559	.637
Buteo lineatus	3	2	1.68	1.27
Buteo platypterus	1	1	.559	.637
Caprimulgus vociferus	2	2	1.12	1.27
Carpodacus purpureus	1	1	.559	.637
Coccyzus americanus	9	7	5.03	4.46
Colaptes auratus	4	4	2.23	2.55

Habitat Number 1. (*Pinus echinata* forest) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Contopus virens	1	1	.559	.637
Corvus brachyrhynochos	8	8	4.47	5.10
Cyanocitta cristata	7	7	3.91	4.46
Dendrocopos villosus	2	2	1.12	1.27
Dumetella carolinensis	1	1	.559	.637
Geothlypis trichas	2	2	1.12	1.27
Hylocichla guttata	2	2	1.12	1.27
Hylocichla mustelina	1	1	.559	.637
Icteria virens	2	2	1.12	1.27

Habitat Number 1. (*Pinus echinata* forest) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Megaceryle alcyon	1	1	.559	.637
Melospiza melodia	1	1	.559	.637
Mimus polyglottos	1	1	.559	.637
Pandion haliaetus	2	1	1.12	.637
Parus bicolor	10	10	5.59	6.37
Parus carolinensis	20	19	11.17	12.10
Pheucticus ludovicianus	1	1	.559	.637
Quiscalus quiscula	1	1	.559	.637
Richmondena cardinalis	3	3	1.68	1.91
Seiurus aurocapillus	1	1	.559	.637

Habitat Number 1. (*Pinus echinata* forest) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Sitta pusilla	7	7	3.91	4.46
Spinus tristis	33	22	18.44	14.01
Spizella passerina	17	15	9.50	9.55
Spizella pusilla	1	1	.559	.637
Strix varia	1	1	.559	.637
Thryothorus ludovicianus	10	10	5.59	6.37
Toxostoma rufum	6	3	3.35	1.19
Turdus migratorius	1	1	.559	.637

Habitat Number 1. (*Pinus echinata* forest) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Vireo olivaceus	11	10	6.15	6.37
Zenaidura macroura	2	2	1.12	1.27

Habitat Number 2. (*Pinus virginiana* forest)

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Buteo platypterus	4	2	5.71	2.94
Caprimulgus carolinensis	1	1	1.43	1.47
Caprimulgus vociferus	1	1	1.43	1.47
Coccyzus americanus	2	2	2.86	2.94
Colinus virginianus	4	4	5.71	5.88
Corvus brachyrhynchos	1	1	1.43	1.47
Cyanocitta cristata	1	1	1.43	1.47
Dumetella carolinensis	3	3	4.29	4.41
Hylocicla mustelina	1	1	1.43	1.47

Habitat Number 2. (*Pinus virginiana* forest) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Mimus polyglottos	1	1	1.43	1.47
Parus bicolor	2	2	2.86	2.94
Parus carolinensis	8	8	11.43	11.76
Richmondena cardinalis	7	7	10.00	10.29
Seiurus aurocapillus	2	2	2.86	2.94
Spinus tristis	7	7	10.00	10.29
Spizella passerina	1	1	1.43	1.47
Thryothorus ludovicianus	3	3	4.29	4.41
Toxostoma rufum	3	3	4.29	4.41
Vireo olivaceus	2	2	2.86	2.94

Habitat Number 2. (*Pinus virginiana* forest) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Zenaidura macroura	16	16	22.86	23.53

Habitat Number 2a. (Old Field)

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Archilochus colubris	2	2	6.45	7.41
Cathartes aura	1	1	3.23	3.70
Colinus virginianus	2	2	6.45	7.41
Passerina cyanea	1	1	3.23	3.70
Pipilo erythrophthalmus	3	3	9.68	11.11
Richmondena cardinalis	2	2	6.45	7.41
Spinus tristis	14	10	45.16	37.04
Sturnella magna	1	1	3.23	3.70
Zenaidura macroura	5	5	16.13	18.52

Habitat Number 3. (*Quercus alba* - *Carya ovata* association)

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Buteo lineatus	6	2	33.33	14.29
Corvus brachyrhynochos	4	4	22.22	28.57
Cyanocitta cristata	2	2	11.11	14.29
Iridoprocne bicolor	2	2	11.11	14.29
Parus carolinensis	3	3	16.67	21.43
Vireo olivaceis	1	1	5.56	7.14

Habitat Number 4. (*Quercus - Carya* association)

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Caprimulgus vociferus	2	1	2.78	1.89
Coccyzus americanus	2	2	2.78	3.77
Colaptes auratus	9	8	12.50	15.09
Corvus brachyrhynochos	1	1	1.39	1.89
Cyanocitta cristata	5	5	6.94	9.43
Dendrocopos pubescens	4	4	5.56	7.55
Dryocopus pileatus	6	4	8.33	7.55
Hylocichla guttata	2	2	2.78	3.77
Hylocichla mustelina	16	6	22.22	11.32
Parus bicolor	3	3	4.17	5.66

Habitat Number 4. (*Quercus* - *Carya* association) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Parus carolinensis	4	4	5.56	7.55
Richmondena cardinalis	7	4	9.72	7.55
Spinus tristis	1	1	1.39	1.89
Strix varia	3	2	4.17	3.77
Thryothorus ludovicianus	1	1	1.39	1.89
Toxostoma rufum	2	2	2.78	3.77
Vireo olivaceus	4	3	5.56	5.66

Habitat Number 5. (*Quercus alba* consociation)

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Centurus carolinus	3	3	14.29	16.67
Colinus virginianus	1	1	4.76	5.56
Cyanocitta cristata	3	3	14.29	16.67
Dendrocopos pubescens	1	1	4.76	5.56
Parus bicolor	2	2	9.52	11.11
Parus carolinensis	2	2	9.52	11.11
Turdus migratorius	1	1	4.76	5.56
Vireo olivaceus	8	5	38.10	27.78

Habitat Number 6. (*Quercus* - *Carya* association)

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Centurus carolinus	5	3	14.71	10.00
Coccyzus americanus	1	1	2.94	3.33
Corvus brachyrhynochos	1	1	2.94	3.33
Cyanocitta cristata	2	2	5.88	6.67
Dendrocopos pubescens	10	8	29.41	26.67
Dendrocopos villosus	4	4	11.76	13.33
Dryocopus pileatus	1	1	2.94	3.33
Parus bicolor	4	4	11.76	13.33
Parus carolinensis	1	1	2.94	3.33
Richmondena cardinalis	5	5	14.71	16.67

Habitat Number 7. (Freshwater Marsh to Open Water Community)

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Agelaius phoeniceus	27	15	14.59	17.24
Aix sponsa	29	8	15.68	9.20
Actitis macularia	15	10	8.11	11.49
Anas platyrhynochos	3	3	1.62	3.45
Anas rubripes	2	1	1.08	1.15
Ardea herodias	8	4	4.32	4.60
Aythya valisineria	1	1	.541	1.15
Botaurus lentiginosus	1	1	.541	1.15
Buteo lineatus	2	1	1.08	1.15
Butorides virescens	14	2	7.57	2.30

Habitat Number 7. (Freshwater Marsh to Open Water Community) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Casmerodius albus	8	4	4.32	4.60
Carthartes aura	1	1	.541	1.15
Charadius vociferus	2	1	1.08	1.15
Corvus brachyrhynchos	10	6	5.41	6.90
Cyanocitta cristata	3	3	1.62	3.45
Dendroica pensylvanica	2	1	1.08	1.15
Florida caerulea	1	1	.541	1.15
Geothlypis trichas	12	4	6.49	4.60
Iridoprocne bicolor	3	3	1.62	3.45

Habitat Number 7. (Freshwater Marsh to Open Water Community) Cont.

Species	Total Individual Occurrence	Total Individual Occurrence Less Repeats	Individual % Occurrence	Individual % Occurrence Less Repeats
Megaceryle alcyon	16	4	8.65	4.60
Pandion haliaetus	5	2	2.70	2.30
Parus bicolor	1	1	.541	1.15
Pipilo erythrophthalmus	2	1	1.08	1.15
Sayornis phoebe	9	5	4.86	5.75
Seiurus aurocapillus	1	1	.541	1.15
Spinus tristis	5	1	2.70	1.15
Wilsonia citrina	2	2	1.08	2.30

To perceive the importance of this data, a comparison of all species with respect to all habitats must be made. This was done by listing all 64 species and noting the total representation of each in all habitats again noting the difference due to repeats. Of this total number, the percentage of this time that a species was found within one of the seven habitats was noted and given a percentage of total occurrence number. This information can afford a comparison of all species as to habitats. This information is tabulated in Table III.

Table III. Distribution of Birds Within the Total Study Area

Species	Total	Total Less Repeats	% H-1	% H-2	% H-2a	% H-3
Agelaius phoeniceus	28	16	6.25			
Actitis macularia	15	10				
Aix sponsa	29	8				
Anas platyrhynchos	3	3				
Anas rupripes	2	1				
Archilochus colubris	2	2			100	
Ardea herodias	9	5	20			
Aythya valisineria	1	1				
Botaurus lentiginosus	1	1				
Bubo virginianus	1	1	100			

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	% H-4	% H-5	% H-6	% H-7
Agelaius phoeniceus				93.75
Actitis macularia				100
Aix sponsa				100
Anas platyrhynchos				100
Anas rupripes				100
Archilochus colubris				
Ardea herodias				80
Aythya valisineria				100
Botaurus lentiginosus				100
Bubo virginianus				

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	Total	Total Less Repeats	% H-1	% H-2	% H-2a	% H-3
Buteo lineatus	11	5	40			40
Buteo platypterus	5	3	33	67		
Butorides virescens	14	2				
Caprimulgus carolinensis	1	1		100		
Caprimulgus vociferus	5	4	50	25		
Carpodacus purpureus	1	1	100			
Casmerodius albus	8	4				
Cathartes aura	2	2			50	
Centurus carolinus	8	6				
Charadrius vociferus	2	1				
Coccyzus americanus	14	12	58	17		

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	% H-4	% H-5	% H-6	% H-7
Buteo lineatus				20
Buteo platypterus				
Butorides virescens				100
Caprimulgus carolinensis				
Caprimulgus vociferus	25			
Carpodacus purpureus				
Casmerodius albus				100
Cathartes aura				50
Centurus carolinus		50	50	
Charadrius vociferus				100
Coccyzus americanus	17		8.33	

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	Total	Total Less Repeats	% H-1	% H-2	% H-2a	% H-3
Colaptes auratus	13	12	33.3			
Colinus virginianus	7	7		57	29	
Contopus virens	1	1	100			
Corvus brachyrhynchos	26	21	38.1	4.7		19
Cyanocitta cristata	23	23	30.4	4.3	8.7	
Dendrocopus pubescens	15	13				
Dendrocopus villosus	6	6	33.33			
Dendroica pensylvanica	2	1				
Dryocopus pileatus	7	5				
Dumetella carolinensis	4	4	25	75		
Empidonax virescens	1	1				

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	% H-4	% H-5	% H-6	% H-7
Colaptes auratus	66.7			
Colinus virginianus		14		
Contopus virens				
Corvus brachyrhynchos	4.7		4.7	28.6
Cyanocitta cristata	21.7	13	8.7	13
Dendrocopus pubescens	30.77	7.70	61.54	
Dendrocopus villosus			66.67	
Dendroica pensylvanica				100
Dryocopus pileatus	80		20	
Dumetella carolinensis				
Empidonax virescens				100

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	Total	Total Less Repeats	% H-1	% H-2	% H-2a	% H-3
Florida caerulea	1	1				
Geothlypis trichas	16	8	25			
Hylocichla guttata	4	4	50			
Hylocichla mustelina	18	8	12.5	12.5		
Icteria virens	2	2	100			
Iridoprocne bicolor	5	5				40
Megaceryle alcyon	18	6	16.67			
Melospiza melodia	1	1	100			
Mimus polyglottos	2	2	50	50		
Pandion haliaetus	7	3	33.3			
Parus bicolor	22	22	45.45	9.09		

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	% H-4	% H-5	% H-6	% H-7
Florida caerulea				100
Geothlypis trichas				75
Hylocichla guttata	50			
Hylocichla mustelina	75			
Icteria virens				
Iridoprocne bicolor				60
Megaceryle alcyon				83.33
Melospiza melodia				
Mimus polyglottos				
Pandion haliaetus				66.7
Parus bicolor	13.64	9.09	18.18	4.55

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	Total	Total Less Repeats	% H-1	% H-2	% H-3	% H-4
Parus carolinensis	38	37	51.35	21.62		8.11
Passerina cyanea	1	1	100			
Pheucticus ludovicianus	1	1	100			
Pipilo erythrophthalmus	5	4		75		
Quiscalus quiscula	1	1	100			
Richmondena cardinalis	24	21	14	33	9.6	
Sayornis phoebe	9	5				
Seiurus aurocapillus	4	4	25	75		
Sitta pusilla	7	7	100			
Spinus tristis	60	41	55.66	17	24.3	
Spizella passerina	18	16	93.75	6.25		

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	% H-4	% H-5	% H-6	% H-7
Parnus carolinensis	10.81	5.41	2.7	
Passerina cyanea				
Pheucticus ludovicianus				
Pipilo erythrophthalmus				25
Quiscalus quiscula				
Richmondena cardinalis	19.05		23.81	
Sayornis phoebe				100
Seiurus aurocapillus				25
Sitta pusilla				
Spinus tristis	2.44			2.44
Spizella passerina				

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	Total	Total Less Repeats	% H-1	% H-2	% H-2a	% H-4
Spizella pusilla	1	1	100			
Strix varia	4	3	33.33			
Sturnella magna	1	1			100	
Thryothorus ludovicianus	14	14	71.43	21.43		
Toxostoma rufum	11	8	37.5	37.5		
Turdus migratorius	2	2	50			
Vireo olivaceus	26	22	50	9.09		4.55
Wilsonia citrina	2	2				
Zenaidura macroura	23	23	8.70	69.6	21.7	
Zonotrichia albicollis	3	3	66.67			

Table III. Distribution of Birds Within the Total Study Area (Cont.)

Species	% H-4	% H-5	% H-6	% H-7
Spizella pusilla				
Strix varia	66.67			
Sturnella magna				
Thryothorus ludovicianus	7.14			
Toxostoma rufum	25			
Turdus migratorius		50		
Vireo olivaceus				
Wilsonia citrina				100
Zenaidura macroura				
Zonotrichia albicollis			33.33	

DISCUSSION

The experimental data collected from the study area can be organized, interpreted and discussed under three major concepts:

1. The relationship of all birds to each habitat.
2. Bird dominance in each habitat.
3. Bird associations within each habitat.

Species Distribution Within Each Habitat

Certain avian species are known to prefer specific habitat types (Odum, 1950). The "Theoretical Habitat Preference Table and Bird List," (See Table IV), follows the habitat information in the Audubon Society: Field Guide to North American Birds (Ball and Farrand, 1977). This table will be used as a standard for comparison. The avian species found in each habitat will be compared to this table to determine how a species fits the theoretical data. The birds will be classified as "well fitters," "marginal fitters" and "poor fitters."

Habitat Number 1, the *Pinus echinata* forest

This habitat, located along a cove of Lake Norman is dominated by a single tree species, *Pinus echinata*. Thirty-eight bird species were recorded for this area and can be categorized into three major groups.

The "well fitters" are birds that correspond most closely to the theoretical data. Two of the thirty-eight birds recorded in this habitat, *Carpodocus purpureus*, (Purple Finch), and *Sitta pusilla*, (Brown Headed Nuthatch), were found only here. These birds depend upon coniferous forest for their major food and nesting sites. *C. purpureus* was recorded only once during this study period and was found only in this area. *S. pusilla* was recorded seven times with 100% of its occurrence within this habitat, (See Table III).

The "marginal fitting" birds fell within six subgroups according to their habitat preference. These subgroups were entitled generalists, marginal areas, lakes-ponds-rivers, freshwater marsh, moist deciduous forest and second growth. These birds did not exactly fit the theoretical preference standard.

The generalist birds are those that are known to have wide habitat tolerance ranges most of which frequent all communities within the study area. The wide habitat tolerance birds and their % occurrence within this habitat with respect to all other habitats are, (See Table III):

Bubo virginianus	Great Horned Owl	100%
Colaptes auratus	Flicker	33%
Corvus brachyrhynochos	American Crow	38%

Cyanocitta cristata	Blue Jay	30%
Hylocichla guttata	Hermit Thrash	50%
Mimus polygottos	Mockingbird	50%
Quescalus quiscula	Purple Grackle	100%
Turdus migratorius	Robin	50%

Two of these birds, *Q. quiscula* and *B. virginianus*, were recorded only once, (See Table III). It is, therefore, invalid to draw any conclusions about these birds in relation to habitat. However, both birds are rather uncommon to this area of North Carolina (Pearson, 1959).

Marginal area birds tend to frequent forest edges with thick undergrowth. The ecotone between the lake and the *Pinus echinata* forest supplies good habitat for the following edge usage birds. Their % occurrences as found in Table III are:

Caprimulgus vociferus	Whip-Poor-Will	50%
Melospiza melodia	Song Sparrow	100%
Parus carolinensis	Carolina Chick-a-dee	51%
Pheucticus ludovicianus	Rose-Brested-Grosebeak	100%
Richmondena cardinalis	Cardinal	14%
Spinus tristis	Goldfinch	54%
Spizella passerina	Chipping Sparrow	94%
Spizella pusilla	Field Sparrow	100%
Toxostoma rufum	Brown Thrasher	38%

Three birds within this subgroup were recorded only once. Two of these birds, *M. melodia* and *P. ludovicianus*, are not common to the Piedmont of North Carolina (Pearson, 1959). Also *S. pusilla* tends to gravitate toward open country and old fields (Pearson, 1959).

Three birds recorded for this habitat were there because of its nearness to the lake. These birds were:

Ardea herodias	Great Blue Heron	20%
Megacreyle alcyon	Belted Kingfisher	17%
Pandion haliaetus	Osprey	33%

Two birds, *Agelius phonecius* found here 6% of the time and *Geothylpis trichas* 25% of the time, are termed freshwater marsh birds. These birds utilized the lake margin.

Certain birds, although moist deciduous forest birds, were recorded for this area not because of the dominant tree species but because of their affinities for lakes. Birds, along with their % occurrence in this habitat that are known to frequent deciduous forests are:

Buteo lineatus	Red Shoulder Hawk	40%
Hylocichla mustelina	Wood Thrush	13%
Parus bicolor	Tufted Titmouse	46%
Strix varia	Barred Owl	33%

One class of "marginal fitters" can be termed second growth utilizing birds. These birds prefer areas in later successional stages and are known to utilize coniferous forest margins. These birds and their % occurrence are:

Coccyzus americanus	Yellow-billed Cuckoo	58%
Icteria virens	Yellow-brested Chat	100%
Thryothorus ludovicianus	Carolina Wren	71%
Zenaidura macroura	Mourning Dove	9%

The third major group, "poor fitters", have birds which utilize two habitat types. The dry deciduous forest birds and their % occurrence are:

Buteo platypterus	Broad Winged Hawk	33%
Contopus virens	Eastern Wood Pewee	100%
Dendrocopos villosus	Hairy Woodpecker	33%
Seiurus aurocapillus	Ovenbird	25%
Vireo olivacius	Red-eyed Vireo	50%

All of these birds were probably attracted by the edge effect as created by the *Pinus echinata* forest adjoining the lake. Edge areas like this are known to attract quite a few insects and small mammals due to the cover derived from this edge area. All the above birds except *B. platypterus* are insectivores. *B. platypterus* prefers small mammals such as mice and shrews.

One bird, *Dumetella carolinensis*, (Catbird), was found here 25% of the time. The marginal effect of the lake may be the cause. This birds is known to frequent thickets. Lake edge areas supply this need.

Habitat Number 2, the *Pinus virginiana* forest

Habitat number two is a pure stand of *Pinus virginiana* vegetation (not uncommon to the Piedmont of North Carolina). These trees had an approximate age of from 10 to 20 years. This habitat, being in a phase of ecological succession affects bird species diversity.

No "well fitting" birds were noted for this area but "marginal" and "poor fitters" were recorded. Twenty bird species were recorded for this area.

The "marginal fitting" birds fell into four sub-groups; generalist birds, marginal area usage birds, second growth usage birds and old field usage birds.

Three generalist birds, as would be expected, were found here. These birds are *Cyanocitta cristata,* (Blue Jay), *Corvus brachrhynchos,* (Crow) and *Mimus polygottos,* (Mockingbird). The relatively low % occurrence, with respect to all habitats, should be noted for two of these birds; *C. cristata* and *C. brachyrhynchos* at 4 and 5% respectively. This low percent could be attributed to chance fly-through. The 50% occurrence data for *M. polygottos* can be considered inconclusive due to the lack of overall abundance for this species (See Table III).

Birds that are termed marginal area species can be dealt with more conclusively with the exception of *Caprimulgus carolinensis* (Chuck-will's widow), with a misleading occurrence according to all habitats of 100%. Only one *C. carolinensis* was recorded in the study area. The remaining marginal birds can however be grouped together and said to occur here due to the edge effect

created by this type area as well as the dense undergrowth afforded by greater light penetration. These marginal birds along with their % occurrence are as follows (See Table III):

Caprimulgus vociferus	Whip-poor-will	25%
Dumetella carolinensis	Catbird	75%
Parus carolinensis	Carolina Chick-a-dee	22%
Richmondena cardinalis	Cardinal	33%
Spinus tristis	Goldfinch	17%
Spizella passerina	Chipping Sparrow	6%
Toxostoma rufum	Brown Thrasher	38%

Other "marginal fitters" included three species which are collectively termed second growth utilizers. All three of these birds are known to utilize edges, thickets, and coniferous margins according to the theoretical habitat preference data. This area contains all of these habitat types. The birds according to this grouping are *Coccyzus americanus,* (Yellow-billed Cuckoo), 17%; *Thryothorus ludovicianus,* (Carolina Wren), 21% and *Zenaidura macroura,* (Mourning Dove), 70%.

The final "marginal fitter" is *Colinus virginianus,* (Bobwhite), with a % occurrence according to all habitats of 57%. This bird, preferring old fields, was found here due to the resemblance of areas along the forest edge to old field type habitat. It was noted in the habitat description section that this *Pinus*

virginiana forest was surrounded by old field habitats. It can therefore be concluded that *C. virginianus* was using this area as cover, hence their high percentage here.

The final group of birds known collectively as deciduous forest users "fit poorly" into this habitat but their presence here can be explained. The *Pinus virginiana* forest, although bordered on all sides by an old field type habitat for a narrow distance, was situated between two climax forest areas. As a result, these species were considered as transients between hardwood areas.

Buteo platypterus	Broad Winged Hawk	67%
Hylocichla mustelina	Wood Thrush	13%
Parus bicolor	Tufted Titmouse	9%
Seiurus aurocapillus	Ovenbird	75%
Vireo olivaceus	Red-eyed Vireo	9%

Habitat Number 2a, the Old Field

Habitat number 2a was unmeasurable by the transect method but site identification shows it to be the old field type habitat with dominants of *Andropogon* sp. and *Pinus virginiana* seedlings. This area was directly adjacent to the *Pinus virginiana* forest discussed in the previous section.

There were three "well fitting" birds. *Sturnella magna,* (Meadow Lark), with an occurrence according to all habitats of 100%, cannot be considered significant. This bird was only found once here as was *Passerina cyanea,* (Indigo Bunting), was an occurrence according to all habitats of 100%. The small occurrence of these two species can be attributed to the small amount of old field habitat within the Park as well as to its disjunct nature with respect to adjoining farmland. This area was surrounded by various forest types of many acres making it almost inaccessible to transient old field birds. One bird of old field character, *Colinus virginianus,* (Bobwhite), at 29% of its total occurrence within this habitat, is not as limited to this habitat and is more versatile in its preference. The greatest abundance of this species was noted in the *Pinus virginiana* forest which was used as cover.

"Marginal fitters" fell here into two subgroups, marginal area users and second growth users. All species in these two subgroups gravitate toward edge type areas with trees close by. Marginal area users along with their present occurrence according to all habitats were, (See Table III):

Archilochus colubris	Ruby-Throated Hummingbird	100%
Cathartes aura	Turkey Vulture	50%
Spinus tristis	Goldfinch	25%
Pipilo erythrophthalmus	Towhee	75%
Richmondena cardinalis	Cardinal	10%

One second growth user was noted. *Zenaidura macroura,* (Mourning Dove), 22%, has affinities for old fields as well as coniferous margins.

Habitat Number 3, the *Quercus alba-Carya ovata* association

Habitat number 3 was identified as a *Quercus alba-Carya ovata* association but this was a misleading classification. In the description of the habitats *Pinus echinata* was of relative importance, (See Table I). This area was noted to be xeric and was one of the major usage areas. This area is in the main Park picnic area. These two factors play an important role in the distribution of birds within this area. Although this area contains a great diversity of tree, subcanopy and herbal vegetation only six species of birds were recorded for this area. This low bird species diversity can be explained by the presence of humans in the adjacent swimming area.

Although few birds used this area two birds, *Buteo lineatus,* (Red Shouldered Hawk), at 40% occurrence; and *Iridoprocne bicolor,* (Tree Swallow), at 40% occurrence used this area avidly. These birds were "well fitting"

deciduous users and "poor fitting", freshwater marsh users respectively. *B. lineatus*, although wary of human intervention, utilized this area because of the large canopy trees and the thick *Cornus florida* subcanopy. It was also noted that they were at the extreme southern end of the picnic area which received the least usage. Rodents were abundant in this area due to the picnic debris which is another factor insuring the hawks presence here. It was also observed that one of these hawks was a female that had two young in this area.

The second most abundant bird in this area is *Iridoprocne bicolor*, (Tree Swallow). It is a "poor fitting" freshwater marsh user. Human population pressure forced the bird away from the lake into the tree cover. All other birds that were found in this area were marginal fitting birds. Two of these birds are termed generalists, *Cyanocitta cristata*, (Blue Jay), 9%, and *Corvus brachyrhynochos*, (Crow), 19%. Both of these species are known to be tolerant of human invaders as long as they are kept at a distance. These birds were observed frequenting the area in the early mornings and late afternoons when human activity was at its lowest point. They were often observed feeding on picnic debris.

The final bird found here was *Parus carolinensis*, (Carolina Chick-a-dee), at 8% occurrence in relationship to all habitats. This bird is a marginal area user that is known to gravitate toward deciduous forests. It frequents this type of habitat and is not wary of man. This bird is the only species that remained within this area during peak human presence. This bird, being small and inconspicuous, found it easy to hide among the plant layers.

Habitat Number 4, (*Quercus-Carya* association)

Habitat number 4 is a *Quercus-Carya* association as is habitat number 3. There are some major differences in this habitat which affect the distribution of avian species. Most of these differences are the result of this area being relatively hydric due to its proximity to the 33 acre lake.

One major difference in habitat noted here is the greater diversity of *Quercus* species; another being the greater number of *Pinus echinata*, (See Table I). This information, coupled with the fact that this area is disjunct from any well used area of the Park, explains why this area has 17 species of birds while its ecological equivalent, (Habitat Number 3), being nearer

populated areas, had only 6 avian species. The relatively greater moisture in this area had an obvious effect on bird users.

Six of the seventeen birds found within this area were attracted by the deciduous forest and are termed "well fitters." These birds with their % occurrence according to all habitats are:

Dendrocopos pubescens	Downy Woodpecker	31%
Dryocopus pileatus	Pileated Woodpecker	80%
Hylocichla mustelina	Wood Thrush	75%
Vireo olivaceus	Red-eyed Vireo	14%
Parus bicolor	Tufted Titmouse	14%
Strix varia	Barred Owl	67%

There were three classes of "marginal fitting" birds; generalists, marginal area users and second growth users. There were four generalists birds one of which, *Hylocichla guttata,* (Hermit Thrush), at 50%, is known to be a transient visitor that stops in North Carolina deciduous or coniferous forests on its way northward in spring. Pearson, (1959), states that although this species does not nest here, it still often sings on territory as it passes through.

The other three generalist birds were found here due to the open canopy found in this type area which is broken up by the existence of old *Pinus echinata*

individuals. These birds along with their % occurrence according to all habitats are:

Colaptes auratus	Flicker	67%
Corvus brachyrhynchos	Crow	5%
Cyanocitta cristata	Blue Jay	22%

There were four "marginal fitting", marginal area usage birds one of which, *Richmondena cardinalis*, (Cardinal), at 19% was attracted to this area for two reasons; its affinity for moist woodlands and its usage of edge habitat.

Three marginal area usage birds were found here due to the edge effect created by the lake which was adjacent to this area. The birds with edge affinities along with their % occurrence according to all habitats are:

Caprimulgus vociferus	Whip-or-will	25%
Parus carolinensis	Carolina Chick-a-dee	11%
Toxostoma rufum	Brown Thrasher	25%

Two "marginal fitting", second growth usage birds were also noted for this area. *Coccyzus americanus*, (Yellow-Billed Cuckoo), at 17% and *Thryothorus ludovicianus*, (Carolina Wren), at 7%. The former frequents moist forests and the latter, lake edges.

One bird was found in this area which is a "poor fitting", marginal usage bird. This bird species,

Spinus tristis, (Goldfinch), at 2% occurrence was transient to this area. This species is occasionally known to use thickets which can be found along the lake edge.

Habitats 5 and 6, the *Quercus alba* consociation and *Quercus-Carya* association, respectively

Habitat numbers 5 and 6, termed *Quercus alba* consociation and *Quercus-Carya* association respectively, are both areas at or near forest climax. Habitat five is the more xeric of the two thus giving rise to a consociation. Habitat number six is more hydric due to its proximity to the lake and its northern aspect which supports the *Quercus-Carya* association. The validity of this conclusion is enhanced by the occurrence of *Acer rubrum* and *Fagus grandifolia*, both well known climax species of moist areas with a northern aspect, (Oosting, 1956).

Both areas being at or near climax decrease bird species diversity. According to Odum (1950), and Adams (1908), population density in birds decreases as the forest stands mature. This is illustrated in Table II. Habitat 2, a *Pinus virginiana* forest of probable early successional nature, as shown by the

obsolete farm terraces, had 20 bird species. The number of bird species in Habitat 4, a *Quercus-Carya* association was 17. This diversity can be explained by the presence of coniferous trees in the habitat. Areas 5 and 6 had eight and ten species respectively.

Four "well fitting" birds were recorded in Habitat number 5. These birds along with their percent occurrence according to all habitats are:

Centurus carolinus	Red-Bellied Woodpecker	50%
Dendrocopos pubescens	Downy Woodpecker	8%
Parus bicolor	Tufted Titmouse	9%
Vireo olivaceus	Red-eyed Vireo	23%

Habitat number 6 had five "well fitting" birds. These birds are:

Centurus carolinus	Red-Bellied Woodpecker	50%
Dendrocopos pubescens	Downy Woodpecker	62%
Dendrocopos villosus	Hairy Woodpecker	67%
Dryocopus pileatus	Pileated Woodpecker	20%
Parus bicolor	Tufted Titmouse	18%

Information can be extrapolated here concerning the Picidea Family of Woodpeckers. It should be noted that 100% of the occurrence of *C. carolinus* occurs in these two areas. The relatively lower percentage occurrence of *D. pubescens* in Habitat 5 as compared to number 6 is also of importance. This difference was caused by the conifers existing in the *Quercus alba* consociation found

in Habitat number 6. Also it should be noted that another Woodpecker, *D. pileatus* was only in Habitat number 6 due again to the conifers and the xeric nature of the *Quercus alba* consociation.

Parus bicolor, another "well fitting" bird, was found in both habitats. Again because of the existence of conifers, half as many of this bird species were found in Habitat 5 as in Habitat 6.

Habitat 5 also had three "marginal fitting" birds; two which were generalists and one marginal usage bird. *Cyanocitta cristata,* (Blue Jay), at 13% was there as a generalist that likes Oak trees. Another generalist, *Turdus migratorius,* (Robin), at 50% was there due to its affinity for open woods. The marginal bird, *Parus carolinensis,* (Carolina Chick-a-dee), at 5% is known to prefer deciduous forests.

Habitat 6 either had or lacked the same "marginal fitting" birds as Habitat 5. *Cyanocitta cristata* at 8% and *Parus carolinensis* at 3% were both found here as deciduous forest frequenters.

Three "marginal fitting" birds were found here that were not found in Habitat 5. These birds are:

Coccyzus americanus	Yellow-Billed Cuckoo	8%
Corvus brachyrhynchos	Crow	8%
Richmondena cardinalis	Cardinal	24%

C. brachyrhynchos was there as an obvious generalist, while *R. cardinalis* and *C. americanus* were there due to their affinities for moist areas near the lake. The absence of the latter two species in Habitat 5 can be explained by the xeric nature of this area.

One "poor fitting", old field usage bird was recorded for this area. *Colinus virginianus*, (Bobwhite), at 14% was found here because this species is known to frequent roadsides. A road is directly adjacent to Habitat 5.

Habitat Number 7, the Marsh to Open Water Communities

Habitat 7 is termed marsh to open water habitat and includes many variable habitats as explained in the experimental results section. Not only did this habitat include various associations as well as consociations, it was touched at some point by almost all of the major habitat types discussed in the study area. This wide variety of possible habitats gives an indication why 27 species of birds were found within this area.

"Well fitting" birds fell into two subgroups; freshwater marsh birds and lake, river, and pond birds. The freshwater marsh birds were:

Agelaius phoeniceus	Red-Winged Blackbird	94%
Botaurus lentiginosus	American Bittern	100%
Casmerodius albus	Common Egrett	100%
Florida caerulea	Little Blue Heron	100%
Iridoprocne bicolor	Tree Swallow	60%
Wilsonia citrina	Hooded Warbler	100%

It should be noted here that *I. bicolor* was found here only 60% of the time for the reason explained in the discussion of Habitat 1. *W. citrina,* although rare to this area of North Carolina according to Pearson (1959), was found where expected.

Lake, pond, and river "well fitting" birds were:

Actitis macularia	Spotted Sandpiper	100%
Aix sponsa	Wood Duck	100%
Anas platyrhynchos	Mallard Duck	100%
Ardea herodias	Great Blue Heron	80%
Aythya valisineria	Canvasback	100%
Butorides virescens	Green Heron	100%
Megaceryle alcyon	King Fisher	83%
Pandion haliaetus	Osprey	67%

Three of these birds were also found in the *Pinus echinata* forest due to its proximity to the lake, but were found no where else.

Many of these birds were once considered to be common only to areas in the sandhills and coastal plain. With the increase of aquatic habitats around lakes formed by damming of the Catawba-Santee-Wateree drainage basin many of these birds have expanded their range. For instance a salt marsh "poor fitting" bird, *Anas rubripes,* (Black Duck), at 100%; was found in this area.

There were three generalist, "marginal fitting" birds, one of which *Sayornis phoebe,* at 100% was found nesting under a bridge in one instance and under the

diving platform in another. This bird is known to frequent areas such as this, making it not uncommon to be found in this habitat type.

Corvus brachyrhynchos, (Crow), although found here only 29% of the time, was recorded here more often than in any other habitat. The lake, being a hydro-electric lake, has a fluctuating character and therefore exposed much carion. As a result *C. brachyrhynchos*, a "marginal fitting" generalist was found here most often.

The final "marginal fitting" generalist, *Cyanocitta cristata*, (Blue Jay), at 13% was found here not much more frequently than in any other habitat. This bird seems to fit the generalist definition well.

Four "marginal fitting", marginal area usage birds were recorded for this area.

Carthartes aura	Vulture	50%
Geothlypis trichas	Yellowthroat	75%
Pipilo erythrophthalmus	Towhee	25%
Spinus tristis	Goldfinch	2%

G. trichas, (Yellowthroat), has affinities for lake margins. It was found here and on the lake margins of the *Pinus echinata* forest only. This bird could be termed a freshwater edge user.

Cathartes aura was found here, also attracted by the carion exposed by the fluctuating water level.

Pipilo erythrophthalmus likes edges and thickets which are abundant to this area as does *Spinus tristis*. It should be noted, however, that *S. tristis* was found here only sparingly due to its greater preference for dryer, old field areas.

One final "marginal fitting" bird, *Dendroica pensylvanica* at 100%, is a second growth user. Pearson (1959), states this bird is a transient to this area of North Carolina which explains its low number. It was attracted by the edge effect.

These birds although "poor fitting" birds, collectively known as deciduous forest users were found frequenting this area due to its proximity to deciduous forest and due to their affinity for lake margins. These birds are:

Buteo lineatus	Red Shoulder Hawk	20%
Parus bicolor	Tufted Titmouse	5%
Seiurus aurocapillus	Ovenbird	25%

The final bird in the area was *Charadrius vociferus*, (Killdeer), at 100%. Although considered here a "poor fitting", grassland or old field bird, this bird is common throughout the state in almost any open area according to Pearson (1959). This bird was found only once here and at a time when the lake was down because of hydroelectric usage, showing mud flat areas.

The Dominant Bird in Each Habitat

The data for this section was compiled based on Table II. It should be noted that the column entitled "Individual Percent Occurrence Less Repeats" was used for any conclusions drawn. This data is also based on other variables contained within the raw data which will be enumerated.

Habitat Number 1, the *Pinus echinata* forest

Spinus tristis, (Goldfinch), a marginal area user, seems at first glance to be the dominant bird for this area. This information is however inconclusive due to the fact that 15 of the 22 birds found here were recorded as a transient flock. The percentage occurrence therefore would be much lower indicating some other bird species must be the dominant.

Parus carolinensis at 12.10% would seem to be the next likely candidate. This bird is a marginal area user but cannot be considered the dominant due to its number of 19 being cut down by a transient flock of eight.

Spizella passerina at 9.55% is the true dominant here. This bird is a marginal area user known to frequent woodland edges and thickets which were abundant

in this habitat. The occurrences of this species involved less transient flocks and is therefore the dominant bird of this habitat.

Habitat Number 2, the *(Pinus virginiana* forest)

The dominant bird *Zenaidura macroura,* is a second growth bird according to the "Theoretical Habitat Preference Table and Bird List." It made up 23.53% of all the bird sightings in this area, (See Table II).

Habitat Number 2a, the Old Field

The old field type habitat contained a large number of the species *Spinus tristis.* At 37.04% of all the bird sightings, this is a far greater percentage than other birds in the area. This is due to its affinity as a marginal area bird that uses thickets and old fields.

Habitat Number 3, the *Quercus alba-Carya ovata* association

Corvus brachyrhynchos was the dominant bird. At 21.43% of all bird sightings in this area, this scavenger frequented this area due to human picnic debris on more occasions than any other species.

Habitat Number 4, the *Quercus-Carya* association

Colaptes auratus was recorded for this area more often than any other species. 15.09% of all bird sightings were attributed to this species. This bird is

known to frequent young deciduous forests mixed with old pines. The habitat data, (See Table I), indicates this is a suitable area for this bird.

Habitat Number 5, the *Quercus alba* consociation

The dominant bird, *Vireo olivaceus* at 27.78% of all the bird sightings, is a deciduous forest bird. This is not unexpected as Ball and Farrand (1977), list this bird as the most abundant bird in eastern North America.

Habitat Number 6, the *Quercus-Carya* association

An avid user of deciduous forests, *Dendrocopos pubescens* is the dominant bird of this climax forest habitat. At 26.67% of all the sightings, this bird was recorded almost twice as often as its next nearest competitor.

Habitat Number 7, the Marsh to Open Water Communities

The freshwater to marshland communities had a single dominant bird as could be expected from the "Theoretical Habitat Preference Chart." This bird is *Agelaius phoeniceus* at 17.24% of all the bird sightings in this area. This is not unexpected, considering its use of this type of area for nesting purposes.

Associations Within Each Habitat

Birds which frequent the same habitat can be considered in association. These associations may

involve nest site availability. Birds within this study area were known to associate within various habitats. The following conclusions about associations are not quantitative. If a bird was found within a habitat less than 10% of the time it was not considered in association with other birds in that habitat. The % value is obtained from Table III.

Habitat Number 1, the *Pinus echinata* forest

All thirty-eight species with the exception of four are considered in association. *Agelaius phoeniceus* for instance was only here by chance as explained in the section on species distribution in each habitat. *Geothlypis trichas* was also not found there often enough and can therefore not be considered in association.

Two birds *Carpodacus purpureus* and *Contopus virens* were transients and were recorded only once throughout the entire study area. No conclusion could be drawn due to this lack of examples.

Habitat Number 2, the *Pinus virginiana* forest

Two birds *Caprimulgus vociferus* and *Cathartes aura* were not found in any habitat frequently enough for inclusion in an association. *Vireo olivaceus* also did not occur here often enough to be considered an associate as should be expected for this deciduous forest bird.

Two of the 20 birds found here although not above the 10% cut off point should be considered in association. *Corvus brachyrhynchos* and *Cyanocitta cristata* were not found in any greater or lesser abundance in almost any habitat. This is due to their generalist attributes.

Habitat Number 2a, the Old Field

Two old field birds were not found in sufficient abundance to be considered in association. These birds, *Sturnella magna* and *Passerina cyanea* were recorded only once as explained in the section on species distribution within each habitat. Seven other birds fit well into the association scheme.

Habitat Number 3, the *Quercus alba-Carya ovata* association

Cyanocitta cristata appears again to be a bird that is not an associate in this habitat. Its low percentage is due to its generalist attribute. Two birds, *Parus carolinensis* and *Vireo olivaceus* could not be considered associates in this area.

Habitat Number 4, the *Quercus-Carya* association

Of the seventeen species recorded for this area only two seem to be non-associates. These two birds *Spinus*

tristis and *Thryothorus ludovicianus* both are not expected to be in great abundance here due to their affinity for coniferous margins.

Habitat Number 5, the *Quercus alba* consociation

Three of the eight birds recorded for this area can not be considered in association. These birds are *Dendrocopos pubescens*, *Parus bicolor*, and *Parus carolinensis*. These non-associates are few in number due to the uncharacteristic nature of this consociation as discussed in the section on species distribution within each habitat.

Habitat Number 6, the *Quercus-Carya* association

Only one bird in this habitat, *Coccyzus americanus*, does not fit the proposed association criteria. All nine other species are in association in this habitat.

Habitat Number 7, the Marsh to Open Water Communities

Spinus tristis, an old field bird is obviously not in association here. The remainder of the species here are however, considered in association.

Table IV. Theoretical Habitat Preference and Bird List

A. Deciduous Forest Birds

Species	Affinities
Dyrocopus pileatus pileatus (Linnaeus)	young deciduous forests
Centurus carolinus (Linnaeus)	swampy areas or moist deciduous forests
Dendrocopus villosus audubonii (Swainson)	climax forests
Dendrocopus pubescens pubescens (Linnaeus)	young deciduous forests
Buteo lineatus lineatus (Gemlin)	lowland and lake margins
Buteo platypterus platypterus (Vieillot)	highland, dry forest
Hylocichla mustelina (Gemlin)	lowland, moist forest
Parus bicolor (Linnaeus)	
Seiurus aurocapillus aurocapillus (Linnaeus)	dry forest
Contopus virens (Linnaeus)	young deciduous and mixed forests
Empidonax virescens (Vieillot)	mature deciduous forests
Strix varia varia (Barton)	lake shores

B. Coniferous Forest Birds

Species	Affinities
Zonotricha albicollis (Gemlin)	thick undergrowth
Carpodacus purpureus purpureus (Gemlin)	coniferous and mixed forests
Sitta pusilla pusilla (Latham)	coniferous and mixed forests

C. Marginal Area Birds

Archilochus colubris (Linnaeus)	woodland edges
Cathartes aura septentrionalis (Wied.)	deciduous forest and old fields
Caprimulgus carolinensis (Gemlin)	deciduous forest and old fields
Caprimulgus vociferus vociferus (Wilson)	deciduous forest and old fields
Dumetella carolinensis (Linnaeus)	old fields and thickets
Geothlypis trichas trichas (Linnaeus)	thickets, freshwater marshes
Melospiza melodia melodia (Wilson)	thickets, undergrowth
Parus carolinensis carolinensis (Audubon)	deciduous forests
Pheucticus ludoricianus (Linnaeus)	woodland edges
Pipilo erythrophthalmus erythrophthalmus (Linnaeus)	woodland edges
Richmondena cardinalis cardinalis (Linnaeus)	woodlands, swamp edges

Species	Affinities
Spinus tristis tristis (Linnaeus)	thickets, old fields
Spizella passerina passerina (Bechstein)	thickets, woodland edge
Spizella pusilla pusilla (Wilson)	old fields with scattered thickets
Toxostoma rufum rufum (Linnaeus)	deciduous or coniferous forests
D. Second Growth	
Icteria virens virens (Linnaues)	thickets and thorns, streamside tangles
Thryothorus ludovicianus (Linnaeus)	thickets
Coccyzus americanus americanus (Linnaeus)	moist thickets
Zenaidura macroura carolinensis (Linnaeus)	coniferous margins
Dendroica pensylvanica (Linnaeus)	young second growth woodland
E. Old Field	
Charidrius vociferous vociferous (Linnaeus)	plowed fields, short grassland
Colinus virginianus virginianus (Linnaeus)	roadsides
Passerina cyanea (Linnaeus)	
Sturnella magna magna (Linnaeus)	

F. Generalists

Species	Affinities
Bubo virginianus virginianus (Gemlin)	ubiquitous
Colaptes auratus auratus (Linnaeus)	open country with trees
Corvus brachyrhynchos paulus (Howell)	woodland, farmland, suburban
Cyanocitta cristata cristata (Linnaeus)	open country with trees, oaks
Hylocichla guttata faxoni (Bangs-Benard)	coniferous, deciduous, thickets
Mimus polyglottos polyglottos (Linnaeus)	open country
Quescalas quiscula stonei (Linnaeus)	open woods, fields, lawns
Sayornis phoebe (Latham)	bridges near lakes, streams or clifts
Turdus migratorius achasterus (Batchelder)	open woods, farmland, suburban areas

G. Lakes, Ponds, Rivers

Ardea herodias herodias (Linnaeus)

Butorides virescens virescens (Linnaeus)

Anas platyrhynchos platyrhynchos (Linnaeus)

Aythya valisineria (Wilson)

Aix sponosa
(Linnaeus)

Pandion haliaetus
carolinensis (Gemlin)

Actitis macularia
(Linnaeus)

Megaceryle alcyon
alcyon (Linnaeus)

H. Freshwater Marshes

Agelius phoeniceus
phoeniceus (Linnaeus)

Florida caerulea
caerulea (Linnaeus)

Casmerodius albus
egretta (Gemlin)

Botaurus lentiginosus
(Rackett)

Wilsonia citrina
(Boddaert)

Iridoprocne bicolor
(Vieillot)

I. Salt Water Marsh

Anas rubripes
(Brewster)

(Habitat preference after Ball and Farrand, 1977; Bird List after American Ornithologists' Union, 1957)

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