THE ECOLOGICAL SUCCESSION OF WINTER BIRDS AT RALEIGH, NORTH CAROLINA

by
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A thesis submitted to the Faculty of the State College of Agriculture and Engineering of the University of North Carolina in partial fulfillment of the requirements for the degree of Master of Science in the Department of Zoology and Entomology.

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Approved by.

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LIST OP ABBREVIATIONS

Birds

S.-s. Hawk	Sharp-shinned Hawk
M. Dove	Mourning Dove
R.-b. Woodpecker	Red-bellied Woodpecker
H. Woodpecker	Hairy Woodpecker
D. Woodpecker	Downy Woodpecker
W.-b. Nuthatch	White-breasted Nuthatch
B-h. Nuthatch	Brown-headed Nuthatch
G.-c. Kinglet	Golden-crowned Kinglet
R.-c, Kinglet	Ruby-crowned Kinglet
B.-h. Vireo	Blue-headed Vireo
White-th. Sparrow	White-throated Sparrow
Sp.	Sparrow

Plant Stages

BF	Bare Field
CG	Crab Grass
CG-TW	Crab Grass-Tall Weeds
Past.	Pasture
TW-B	Tall Weeds-Broomsedge
B-P	Broomsedge-Pine
P	Pine
Dec, W	Deciduous Woods

1. The purpose of the work was to determine which birds occurred in winter on the different stages of the plant succession on upland areas in the vicinity of Raleigh, North Carolina.

2. Forty-eight plots were used, as follows: bare fields, 14; crab grass, 7; crab grass-tall weeds, 2; pasture, 7; tall weeds-broomsedge, 5; broomsedge-pine, 6; pine, 5; deciduous woods, 2. The total acreage was 930.4.

3. Ninety censuses were taken, between November 1, 1939, and February 29, 1940.

4. The birds included in the study are listed with their scientific names and their residence status at Raleigh,

5. Each census is reported in full, and the results tabulated. The results are discussed, and the birds of each stage listed according to abundance and frequency of occurrence.

6. Forty-three species of birds were recorded. Ten species occurred in but one stage, seventeen in two stages, six in three, six in four, one in five, two in six, one in seven, and none in all eight stages.

7. Fifteen species of birds occurred on the bare fields. The Meadowlark was the most abundant. The Mourning Dove was somewhat less abundant. The Killdeer occurred as often as the Dove, but in lower numbers.

8, Twelve species occurred In crab grass. The Savannah Sparrow was the most abundant species. The Meadowlark was

Second.

9. Seven species occurred in the crab grass-tall weeds plots, nine in the tall weeds-broomsedge plots, and eight in the broomsedge-pine plots. In all three stages the Field Sparrow and the Junco respectively were the most abundant birds. The Song Sparrow and the Savannah Sparrow were common in these stages,

10. Twelve species occurred on the pastures. Of these the Meadow lark was the commonest and most widespread bird. The Starling was second. At least one Sparrow Hawk was present on or over each group of pastures and each group of bare fields.

11. Twenty-five species were recorded in the pine plots. Of these, sixteen appeared in no previous stage. Five appeared in no other stage. Four species were abundant and of high frequence. These were; Golden-crowned Kinglet (most abundant), Ruby-crowned Kinglet, Pine Warbler, and Carolina Chickadee. Several species were common and of more or less regular occurrence.

12. In the deciduous woods, twenty-two species were – recorded. Eighteen of these also occurred in the pine plots. The Golden-crowned Kinglet was the commonest species. Individuals were fewer than in the pine woods.

ABSTRACT

THOMAS LAVELLE QUAY. The Ecological Succession of Winter Birds at Raleigh, North Carolina. (Under the direction of Dr. Z. P. METCALF).

Ninety censuses were taken between November 1, 1939, and February 29, 1940), on forty-eight plots divided among eight stages of the plant succession on upland areas.

Forty-three species of birds were recorded. Ten species occurred in but one stage, seventeen in two stages, six in three, six in four, one in five, two in six, one in seven, and none in all eight stages.

The commonest birds of each stage were as follows: bare field--Meadowlark, Mourning Dove, and Killdeer crab grass--Savannah Sparrow, and Meadowlark; crab grass--tall weeds, tall weeds--broomsedge, and broomsedge-pine--Field Sparrow, and Junco; pasture--Meadowlark; pine--Golden-crowned Kinglet, Ruby-crowned Kinglet, Pine Warbler, and Carolina Chickadee; deciduous woods--Golden-crowned Kinglet.

I. INTRODUCTION

Problem

The present study is an attempt to determine the ecological succession of winter birds at Raleigh, North Carolina, in relation to the plant succession on upland areas. To this end, it was necessary to obtain accurate records of the relative abundance of all species of birds to be found in each stage of the sere. Much of the work has been concerned with finding a method of censuring bird populations which would give the desired information. There was no intention of determining total densities, birds per unit area, nor of treating the data statistically.

The only purpose has been that of determining which birds occur on the various stages of the succession. No investigation has been made of the factors influencing and governing bird abundance and distribution.

Review of Literature on Census Methods

Several writers have discussed the relative merits of various types of bird censuses (Dice, 1930; Lack, 1935, 1937; Nicholson, 1931; Wight. 1938). One classification of censusing methods might be as follows;

Designed to give absolute abundance

Complete individual census

Song census

Nest Census

Count of individuals

Sampling, by quadrat or transect

Designed to give relative abundance

Random sampling

Time unit

Area unit

Frequency of occurrence

Time unit

Area unit

All methods may be applied equally well to the censusing of either one species or groups of species. Ordinarily, the single-species census is conducted over a more extensive area than is the group census. A census of Hooks in England covered sixty-five and a half square miles (Yapp, 1934). Many specialized techniques have been developed for the censusing of particular game birds (Errington and Hamerstrom, 1936; Leopold, 1933; Wight, 1938). These concern single-species censuses and will not be discussed.

Censuses designed to give absolute abundance, birds per acre, are usually made on plots not exceeding one hundred and fifty acres, even when done by more than one person (Anon, 1937; Nicholson, 1931). The complete individual census is conducted on an area which is well-defined within itself and the results hold only for the plot examined. The sampling census is made on one or more, usually more, quadrats or transects which are typical parts of a larger area, the results being used to figure the total population of the whole area.

The outstanding example of the song census is that made by the United States Department of Agriculture during the years 1941-1920, on farmlands (Cooke, 1915, 1916, 1923a). The method

consisted of counting the singing males, during the breeding season, at daylight. "At this time every male bird is usually in full song near the nest site; and, after migration is over, each one may safely be considered to represent a breeding pair" (Gooke, 1923b). The results showed that there was a population of about one pair of birds per acre on farmlands of northeastern United States in summer. It has since been learned that the unmated males in summer may represent from forty to sixty per cent of the total male population (Anon., 1937; Lack, 1937).

The nest census is now recognized as being the only accurate method of determining the complete population of birds during the breeding season. Bird-Lore magazine, in its breeding-bird censuses, requires that the nest or definite evidence of nesting be found before recording a breeding pair (Anon., 1937). A survey of woodlands in England and Wales was made by the nest method (Elton, 1935). Hicks (1935) used it in his ten-year study of an eighty-acre plot in Ohio. Burns (1901) used this method in making what seems to be recognized as the first large-scale bird census {Lack, 1937; Cooke, 1915),

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The song and the nest methods are adapted for summer censuses. The individual count method, which consists in counting only the individuals seen *or* heard, may be used in both summer and winter. Abel (1920) used it in censusing the bird population of a square mile of Iowa prairie. Shaver (1933) and Van Deventer (1936, 1939) used it in year-round studies.

Breckenridge (1935) used four sample strips to secure the total population of one square mile of uniform territory.

Schiermann (Nicholson, 1931) used sixteen plots of two hundred and fifty square meters each to obtain the population of a forest area of ten and eight-tenths square miles.

Forbes and Gross (1925a, b, c) used a combination of methods in censusing the birds of Illinois farm land in all seasons, during the years 1906-1909. Two men, walking in parallel lines one hundred and fifty feet apart in fields, and sixty to ninety feet apart in orchards and open woods, counted all birds flushed by them or crossing their track. The distance covered was 2825 miles, and no transect was censused twice. The results were given in birds per square mile of each kind of crop.

Censuses designed to give the relative abundance of birds may be based on a unit of time instead of a unit of area. The first censuses of this type apparently were made by Grinnell and Storer (1924), studying the birds of Yosemite National Park. Birds were listed per hour of observation on random samples of the plant communities of the different life zones. The annual Bird-Lore Christmas census (Anon., 1938; Brooks, 1940) is a random sampling census based on both area and time. Bach census lists all the individuals recorded in one day's observation within an area fifteen miles in diameter.

Linsdale (1928, 1956) has made censuses the results of which he expressed in terms of frequency of occurrence. In

this method only the species were recorded. The unit of observation was one day and the number of days on which each species was recorded was expressed as a percentage of the number of days on which observations were made. This method was adapted from one developed for the study of plants (Kenoyer, 1927). Dice (1930) has suggested that this method be used in particular plant communities with half-hour time units.

Review of Literature on Bird Succession

Adams (1908) was one of the first to speak of bird succession. He says; "Bird succession means a change from the dominance of certain species or associations to that of others.....This process of change, as a rule, is not limited to a single species, but usually involves several or all the members of the association." The bird succession on Isle Royale (Lake Superior) in relation to the plant succession, as worked out by the writer, is given.

Brock (1914), in a discussion of bird distribution, says, "The strength of the connection between the vegetation and the dependent avifauna is otherwise made clear in the close correlation between plant succession and bird succession."

Elton (1927, p. 25), discussing ecological succession, says, "Another method of determining the course of animal succession is to work from a knowledge of the succession relations of the plant communities...."

Bird (1930) lists the principal birds of each of the

successional and climax plant communities of the aspen parkland of Central Manitoba.

Bird-Lore's breeding-bird censuses (Anon., 1937), begun in 1937, are designed to study the "bird succession accompanying the plant succession". The rules and regulations concerning these censuses are the most rigid and exacting of all ever attempted.

Wight (1938, p. 23) states that the random sampling method of determining the relative abundance of birds is "suitable for determining the bird succession in its relation to plant succession".

Lack (1937) in a review of the literature on bird population problems, states, "As yet bird census work has contributed relatively little to the study of animal population problems." And; "The study of bird ecology must be regarded as in its infancy".

Plant Succession

The climax vegetation of the eastern United States is deciduous forest (Weaver and Clements, 1938, P. 508).

The plant succession in the vicinity of Raleigh, North Carolina, on upland areas has been worked out (Orafton and Wells, 1934, p. 245).

> There are three definite stages in the revegetation of abandoned fields in the vicinity of Raleigh, Hotrth Carolina. While there are a few variations In the species[1] representation throughout the state, the general trend is the same. The pioneer stage may involve several species. On the thin soil, poverty grass, ragweed, and button weed become the dominants. The more fertile soils become vegetated commonly with crab grass. Bermuda grass is less common.

The intermediate stage is always represented by the tall weeds. The several species occupy most any soil habitat. It seems that dog fennel is most particular and favors the sandy soils. Broom-sedge becomes established following the ecesis of weeds. Usually the pines follow this grass.

List of the Dominant Plants of the Stages in the Succession

(Adapted from Grafton and Wells, 1934)

1. Pioneer consocies

Crab Grass	Syntheriema sanguinale
Bermuda Grass	Cynodon Dectylon
Ragweed	Ambrosia artemisiifolia
Poverty Grass	Aristida sp.

2. Tall weeds consocies

Aster	Aster ericoides
Aster	Aster tradescanti
Golden Rod	Solidago rugosa
Golden Rod	Solidago odora
Dog Fennel	Eupatorium capillifolium

3. Broomsedge consocies

Broomsedge	Andropovon Elliotti
Broomsedge	Andropogon virginicus

4. Pine consocies

Short-leaf Pine	Pinus echinata
Loblolly Pine	pinus taeda
Virginia Scrub Pine	Pinus virginiana

5. Deciduous forest association

Oaks	Quercus spp.

Hickories	Hicoria spp.
Maples	Acer spp.
Beech	Fagus grandifolia

Pastures do not constitute a state in the direct succession from bare fields. But abandoned pastures do go into either the tall weed or the broomsedge stage, from which point the succession goes on as usual. Because of this, the pastures are included in the investigation.

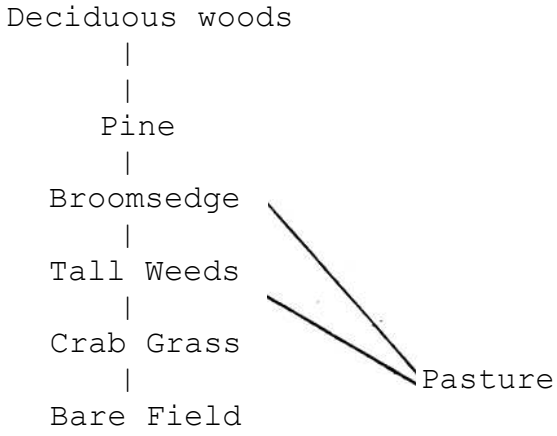

Diagram showing Relation of Abandoned Pasture to the Succession

Classification Used

The classification used is that authorized in the American Ornithologists' Union's "Check-list of North American Birds", fourth edition, 1931.

All identifications were made at sight, by the writer, in the field. No specimens were collected. No attempt was made at subspecific identification. In the list of the birds studied subspecific names are given where, for geographical reasons, or because of the known occurrence of only one form, there is no

doubt about the subspecific identification. Where doubt exists, because of the possible presence of two (or more) subspecies, as with the Horned Larks and the Robins, subspecific names are left off.

Materials

Only a limited amount of equipment was used. All bird censuses were made with the aid of a pair of eight-power Hensoldt binoculars. The photographs were made with a Leica camera, equipped with the thirty-five millimeter lens. Contact prints of the three aerial photographs encompassing the region surveyed were used throughout in various ways. There were two sets of these, one being nine inches square, the other twenty-three inches square. Both sets were purchased through the Raleigh office of the Agricultural Adjustment Administration. Each of the forty-eight plots censused was measured from the twenty-three inch prints with a rotometer.

Area Studied

All plots used in this study lie in a rectangular area bordering Raleigh on the west. The region is coextensive with that included in the Agricultural Adjustment Administration's aerial photographs B O P 14 52, B 0 P 14 54 and BOP 14 56. The area can be delimited by an imaginary line drawn from the point where the Highland Ridge Road joins the Durham Highway (U. S. 15-A), southward through State College to a point just south of Lake Raleigh, thence westward to Lake Johnson, northward

through the State Pair Grounds to the State Prison farm, and back to the starting point.

Method

The method consisted of repeated censuses on selected plots of known acreage and vegetational constitution. Forty-eight plots were set up, as follows: bare field, l4; crab grass, 7; crab grass-tall weeds, 2; pasture, 7; tall weeds-broomsedge, 5; broomsedge-pine, 6; pine, 5; deciduous woods, 2. The vegetation of each plot was analyzed according to a method which will be explained later. All but two census trips were made in the morning between sunup and noon.

At first, trips were made only on clear days when the wind was not blowing herd. However, it was discovered that this procedure would not provide for sufficient censuses, and some trips had to be taken on cloudy days and on days when snow was on the ground. No definite schedule was followed. As many censuses were made as were possible in the time available,

Every census was made in the same way. The plot was systematically examined by walking back and forth until completely covered. The purpose was to find and identify every bird present. Only birds definitely in the plot were recorded. Birds flying over but not alighting were not counted with two exceptions: Marsh Hawks flying within three feet of the ground,

and Sparrow Hawks hovering in the air over one spot. Identifications were made by sight, song, or note.

The time spent censusing the different plots varied according to the ease or difficulty of seeing the birds. Bare fields were covered quickly. Crab grass fields had to be examined literally foot by foot, because of the Savannah Sparrow's habit of running through the grass like a mouse and not flushing readily, and because these sparrows occur singly. The crab grass-tall weeds, tall weeds-broomsedge, and broomsedge-pine areas presented much the same condition, though most of the birds in these plots occurred in flocks. The pine and the deciduous woods plots were covered even more slowly, because of the limited visibility therein. In these last two plots particularly a special effort had to be made to see certain birds, as the Brown Creeper on the bark, and the Winter Wren around brush piles. Thus there was no time limit placed on any census.

Review of Methods Tried

When the study was begun in the winter of 1938-39, the writer tried to set up plots of from fifty to a hundred acres, each one with its vegetation uniform throughout. The plan was to census just the middle of the plot, leaving a hundred-foot margin all the way around. Lay (1938) found that the effect of clearings extended at least a hundred feet into the bordering woods.

When the area to be studied was surveyed, it was found that no such plots existed. Blocks of vegetation that could be considered as successional or climax stages were mostly small, from two to twenty acres usually, and of irregular shape. This caused the writer to believe that the particular problem in mind could not be investigated in the vicinity of Raleigh on the basis of acreage units.

The remainder of the winter was spent considering other possible methods of approach. The observation-unit method of Van Deventer (1926) was tried. This consisted in walking at random through the fields and woods and recording the habitat in which each bird was seen. Each such observation was called a unit of observation. When all observations ©f each bird were added together, it could be seen which habitat was preferred. This method was abandoned because it was felt that it was not only difficult of exposition but also inexact; that it was best adapted to studying all birds on one black of a square mile or so.

A time-unit method was tried during the summer. Beginning June 1, 1939, half-hour walks were made in the various stages. All trips were taken between sunup and 8:00 a. m. Walking slowly, all species and individuals identified within thirty minutes were recorded. This method had several unforeseen difficulties which rendered the summer's work valueless. Plots were scattered and not enough trips could be taken to allow the results to be treated statistically, since each of the eight

stages required separate consideration. Throughout June, the song and the call notes were relied on greatly for locating and counting the birds. By July, many birds were either singing less or not at all. Thus, a half-hour in July yielded fewer birds than in June. Virtually no birds were singing in August. In some stages birds were more-easily observed than in others. This rendered the results incomparable. All of the species in even small plots of ten acres often were not recorded in the time allowed. Many times, several species were identified after the thirty minutes were over.

Acknowledgments

To everyone who has in any way been of assistance, the writer expresses his grateful appreciation. Special thanks are extended to Dr. Z. P. Metcalf, who suggested the problem and directed the work; to Dr. T. B. Mitchell for aid with the photography; to Dr. B. W. Wells for information about plant succession; and to Mr. H. E. Kichline for permission to copy data from the U. S. Weather Bureau records for Raleigh

II. BIRDS STUDIED List of the Birds Studied

Accipiter velox (Wilson). Sharp-shinned Hawk

Circus hudsonius (Linnaeus). Marsh Hawk

Falco sparverius sparverius Linnaeus. Eastern Sparrow Hawk

Golinus virginianus virginianus (Linnaeus). Eastern Bob-white

Oxyechus vociferus vociferus (Linnaeus). Killdeer

Zenaldura macroura carolinensis (Linnaeus). Eastern Mourning Dove

Strix varia Barton. Barred Owl

Colaptes auratus (Linnaeus). Flicker

Centurus carolinas (Linnaeus). Red-bellied Woodpecker

Sphyrapicus varius varius (Linnaeus). Yellow-bellied Sapsucker

Dryobates villosus (Linnaeus). Hairy Woodpecker

Dryobates pubescens (Linnaeus), Downy Woodpecker

Sayornis phoebe (Latham). Eastern Phoebe

Otocoris alpestris (Linnaeus). Horned Lark

Corvus brachyrhynchos brachyrhynchos Brehm. Eastern Crow

Penthestes carolinensis carolinensis (Audubon). Carolina Chickadee

Baeolophus bicolor (Linnaeus). Tufted Titmouse

Sitta carolinensis carolinensis Latham, White-breasted Nuthatch

Sitta pusilla pusilla Latham. Brown-headed Nuthatch

Certhia familiaris americana Bonaparte. Brown Creeper

Nannus hiemalis hiemalis (Vieillot). Eastern Winter Wren

Thryothorus ludovicianus ludovicianus Latham. Carolina Wren

Turdus midgratorius Linnaeus. Robin

Hylocichla guttata faxoni Bangs and Penard. Eastern Hermit Thrush

Sialia sialis sialis (Linnaeus). Eastern Bluebird

Regulus satrapa Lichtenstein. Golden-crowned Kinglet

Corthylio calendula (Linnaeus). Ruby-crowned Kinglet

Anthus spinoletta rubescens (Tunstall). American Pipit

Sturnus vulgaris vulgaris Linnaeus. Starling

Vireo solitarius solitarius (Wilson). Blue-headed Vireo

Dendroica coronata (Linnaeus). Myrtle Warbler

Dendroica pinus pinus (Wilson). Pine Warbler

Sturnella magna (Linnaeus). Meadowlark

Molothrus ater ater (Boddaert). Eastern Cowbird

Richmondena cardinalis cardinalis (Linnaeus). Eastern Cardinal

Spinus tristis tristis (Linnaeus). Eastern Goldfinch

Passerculus sandwichensis (Gmelin). Savannah Sparrow

Pooecetes gramineus gramineus (Gmelin). Eastern Vesper Sparrow

Junco hyemalis hyemalis (Linnaeus). Slate-colored Junco

Spizella passerina passerina (Bechstein). Eastern Chipping Sparrow

Spizella pusilla pusilla (Wilson). Eastern Field Sparrow

Zonotrichia albicollis (Gmelin). White-throated Sparrow

Nelospiza melodia melodia (Wilson). Eastern Song Sparrow

Table I. residence Status of Birds Studied

(Adapted from Brimley {1917, 1930)

Permanent Residents	Winter Residents	Average Arrival	Average Departure
S.-s, Hawk	Marsh Hawk	9/12	4/15
Sparrow Hawk			
Bob-white	Sapsucker	10/10	4/14
Killdeer			
M. Dove	Horned Lark	12/7	2/20
Barred Owl			
Flicker	Brown Creeper	10/10	4/10
R.-b. Woodpecker			
Hairy Woodpecker	Winter Wren	10/11	4/14
Downy Woodpecker			
Phoebe	Hermit Thrush	10/21	4/18
Crow			
Chickadee	G.-c. Kinglet	10/15	4/5
Titmouse			
W.-b. Nuthatch	R.-c. Kinglet	10/16	4/20
B.-h. Buthatch			
Carolina Wren	Pipit	10/24	3/22
Robin			
Bluebird	Myrtle Warbler	10/17	5/4
Starling			
Blue-headed Vireo	Cowbird	10/17	4/3
Pine Warbler			
Meadowlark	Savannah Sparrow	10/11	5/6
Cardinal			
Goldfinch	Vesper Sparrow	10/20	4/12
Field Sparrow			
	Junco	10/31	4/12
Summer Resident	White-th. Sp.	10/16	5/12
Chipping Sparrow	Song Sparrow	10/13	4/4

Total:

Permanent--26

Winter-----16

Summer----- 1

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Period of Study

The period of study extended from November 1, 1939, through February 29, 1940. This is the longest possible period which is relatively uninfluenced by late fall and early spring migratory movements. The preceding table shows that one of the sixteen winter residents arrives in September, and fourteen during October. The Horned Lark appears rarely and irregularly, during December, January, and February. All but the Horned Lark are still present in undiminished numbers on March 1, but the summer visitors and the transients begin appearing after that date.

The records during this winter of study show that a better period might be from November 15 to February 15. The only Chipping Sparrow record was of one bird on November 2. Vesper Sparrows were not seen after November 9. Cowbirds were present in large flocks during the first half of November, in smaller numbers until November 26, and thereafter were recorded but once (Jan. 4). After February 15, Robins appeared in flocks numbering up to two hundred or more, and spread all over the open fields and through the woods. Myrtle Warblers likewise appeared in larger numbers after February 15, and spread to the pastures.

Lynds Jones (1902), studying at Oberlin, Ohio, considered the winter period to include only December, January, and February.

Relation of Species Studied to Species Present in Area

The forty-three species of birds appearing in this study represent but a little more than half of the total number to be found in the vicinity of Raleigh in winter. The reason for the difference is obvious. Many of the better-known bird habitats were not investigated, such as open water, marshy swamp, hedgerow, thicket, barnyard, and garden. Bird-Lore's annual Christmas Census was taken at Raleigh on. December 21, 1939, over the same area covered in the present study. Coming in the middle of the winter, it gives a good picture of the total bird population.

The census is printed below, just as it appeared in Bird-Lore (1940). The total number of species is seventy-three.

Raleigh, N. C. (Triangular area: 5-mile base east and west, 3 miles north, including City limits, Boneyard Lake, Lake Raleigh, Lake Johnson, LeadMines). December 21; 7:30 a.m. to 5:00 p.m. Clear; 10-1.4 m.p.h. west wind; temp. 33 to 54. Four parties in morning on foot, two parties in afternoon on foot and in car: 27 hours, 14 miles on foot; 46 miles by car. Common Loon, 1; Pied-billed Grebe, 6; Great Blue Heron, 3; Mallard, 10; Black Duck, 8; Green-winged Teal, 7; Ring-necked Duck, 16l; Canvas-back, 1; Lesser Scaup, 7; Golden-eye, 1; Old-squaw, 1; Hooded Merganser, 13; Turkey Vulture, 26; Black Vulture, 11; Sharp-shinned Hawk, 1; Cooper's Hawk, 3; Red-tailed Hawk, 4; Rod-shouldered Hawk, 2; Marsh Hawk, 1; Sparrow Hawk, 10; Bob-white, 32 (3 coveys);

Killdeer, 32; Woodcock, 1; Wilson's Snipe, 7; Ring-billed Gull, 2; Mourning Dove, 249; Barred Owl, 2; Kingfisher, 4; Flicker, 18; Red-bellied Woodpecker, 3; Red-headed Woodpecker, 2; Yellow-bellied Sapsucker, 4; Hairy Woodpecker, 2; Downy Woodpecker, 12; Phoebe, 5; Blue Jay, 48; Crow, 75; Carolina Chickadee, 29; Titmouse, 26; White-breasted Nuthatch, 3; Brown-headed Nuthatch, 9; Brown Creeper, 4; Winter Wren, 15; Carolina Wren, 19; Mockingbird, l4; Brown Thrasher, 1; Robin, 12; Hermit Thrush, 3; Bluebird, 155; Golden-crowned Kinglet, 58; Ruby-crowned Kinglet, 28; Pipit, 36; Cedar Waxwing, 7; Migrant Shrike, 1; Starling, 390; Myrtle Warbler, 34; Pine Warbler, 34; English Sparrow, 158; Meadow lark, 177; Red-wing, 280; Cowbird, 10; Cardinal, 46; Purple Finch, 17; Goldfinch, 43; Red-eyed Towhee, 12; Savannah Sparrow, 10; Vesper Sparrow, 3; Slate-colored Junco, 494; Field Sparrow, 173; White-throated Sparrow, l44; Fox Sparrow, 9; Swamp Sparrow, 5; Song Sparrow, 138. Total: 73 species; 3371 individuals, The Loon and Green-winged Teal have not been recorded before on any census from the central part of the State. Ring-billed Gulls observed by the Quays at Lake Raleigh, noting greenish-yellow legs, under tips of wings black as above, and size, both birds adults. Dr. and Mrs. R. W. Green, Mr. and Mrs. T.L. Quay, Mrs. Roxie Simpson, D.L. Wray, C. H. Bostian, and John Grey; members Raleigh Bird Club.

III. PLOTS Numbers

The forty-eight plots used in this study are numbered and apportioned as follows:

1.1—1.14	Bare Field stage
2.1—2.7	Crab grass stage
3.1—3.2	Crab grass-tall weeds stage
4.1—4.7	Pasture .
5.1—5.5	Tall weeds-broomsedge stage
6.1-6.6	Broomsedge-pine stage
7.1—7.5	Pine stage
8.1—8.2	Deciduous woods

Discussion

All the plots in any one stage are not absolutely similar. They vary in the composition of the vegetation, topography, size, shape, and surroundings. These differences, while significant, are not sufficient to warrant eliminating certain plots or setting up new stages. Some of the variations from plot to plot will be discussed.

BARE FIELD. None of the fields was completely bare. The first eight plots were the barest. These had been thoroughly plowed in the fall and sown to grain. Throughout the period of study the grain stood about two inches high in rows six inches apart. The green blades of grass provided no cover, and probably no food, for any birds. This kind of field has been called a "winter grain” field. One field was

bare but for the scattered remains of lespedeza plants. The remaining fields were bare except for scattered tufts of crab grass. All the fields had been plowed in the fall.

CRAB GRASS. Four of the crab grass plots were corn fields. With one exception only, the corn stubble remained during the winter. Two of the plots had as much lespedeza as crab grass. Only one plot was pure crab grass.

GRAB GRASS-TALL WEEDS. The conditions in the two plots were similar. More acreage was desired but could not be found.

No pure tall weeds plots were located.

PASTURE. No attempt was made to identify the grasses making up the pasture vegetation. All pastures used were grazed throughout the summer and to some extent during the winter.

TALL WEEDS-BROOMSEDGE. No separation into species was made in this stage. In some cases only one species of tall weed was represented. In other cases, several species were present. The growth varied from three to eight feet in height, the average being about four feet. The plots showed a graded series from those in which the tall weeds were dominant and the broomsedge subdominant, to those in which the broomsedge was dominant and the tall weeds were subdominant.

No plots of pure broomsedge were located.

BROOMSEDGE-PINE. The pines in this stage were young, from three to twenty feet high, and scattered. In the first two plots the broomsedge was dominant, and pine was common, but not subdominant or codominant. In the remaining plots

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pines were codominant. In all plots tall weeds were common to uncommon, but not rare.

PINES. Pine plots varied considerably. The first plot had a dense stand of thin pines, and no other vegetation. The second plot had nearly mature trees but was open enough to allow some broomsedge. The remaining plots were of mature pine with undergrowth of deciduous trees. That all the plots belonged to the pine stage was supported by the similarity of the bird life throughout.

DECIDUOUS WOODS. No attempt was made at close analysis of the relative abundance of the various deciduous trees present. Deciduous trees were dominant. Pines were always common, though neither codominant nor subdominant. No pure deciduous forest was to be found. At the Lead Mines, areas of an acre or two were in pure beech, or oak-hickory. Narrow extensions of deciduous tree growth reached along the streams and low places, with pines closely paralleling along the upper slopes and hill tops. No separation into oak-hickory and beech-maple was possible. The boundaries of the Lake Raleigh plot were clear. At the Lead Mines, observations were made within a vague line beyond which pine became more than common.

In describing the condition of the vegetation on and surrounding the various plots certain general, terms such as, “open”, “sparse”, “dense”, and “pure” are used. These are used in their ordinary senses.

IV. CENSUS REPORTS

Explanation of Manner of Reporting

The ninety censuses taken are listed plot by plot, and stage by stage. The form followed in each plot is the same throughout. First, there is a description of the plot under four headings - size, location, vegetation, and surroundings. Next come the censuses in chronological order. Each new date indicates a separate census.

In the majority of cases, each plot is located in one of five regions:

The State Hospital region includes all plots (4) on the property of the State Hospital at Dix Hill, and are found on Plate 1.

The Central Farm region includes all plots (16) located in the immediate vicinity of the North Carolina Central Agricultural Experiment Station Pane, the State College Poultry Plant, and the State College Campus. Central Farm, north refers to the part north of Western Boulevard. Central Farm, south refers to the part south of Western Boulevard (Plate 1, upper right).

The Dixie Trail region includes all plots (13) touching upon, or located between, Dixie Trail and the Highland Ridge road (Plate 2, center).

The Meredith College region includes all plots (8) west and northwest of Meredith College (Plate 2, middle left).

On Plates 1, 2, and 3 each plot is outlined and numbered in red ink.

The vegetation is analyzed by the use of the numbers one, two, three, four, and five (Wells, 1937). These denote the five categories into which all the plants are placed. Thus:

1——dominant, or codominant

2------subdominant

3------common, or frequent, but neither dominant, nor subdominant

4------uncommon, but not rare

5------rare

Notes on topography are included under the heading of vegetation.

Under surroundings, points of the compass are abbreviated with small letters, as follows:

n.	north
n.e.	northeast
e.	east
s.e.	southeast
s.	south
s.w.	southwest
w.	west
n.w.	northwest

Notes on the weather follow the date and time of each census. Included are statements of nebulosity, wind direction and velocity, and temperature. Thus, Clear; wind west, 10; 35° F. means that the sky was clear of clouds, the wind was blowing from the west, velocity ten miles an hour, and the temperature was thirty-five degrees Fahrenheit.

All numbers from one to ten, and uneven numbers up to one hundred, represent actual counts. Even numbers above ten, in most cases, represent estimates based on counting.

Censuses

Plot 1.1 j Bare Field

Size: 25.3 acres. Location: State Hospital (plate 1). Vegetation: Winter grain; terraced; surface smooth. Surroundings: n., bare field; e., divided from bare fields by a ditch bank of willow trees; s. and s.w., pine woods; w., dirt road.

Dec. 21; five minutes, at 8:00 a.m. Clear; wind west, 10; 35°F. Pipit, 25. Not a complete census.

Dec, 29; five minutes, at 10:50 a.m. Cloudy; wind north, 9; 36° F. Dove, 80. These birds were seen from the bordering dirt road. They flew east to the adjoining bare field.

Jan, 21; 9:40 to 10:15 a.m. Clear; wind west, 13; 28° F. No birds.

Jan. 28; 9:00 to 9:10 a.m. Clear; wind west, 10; 15° F. Meadowlark, 9. Snow on ground.

Plot 1.2, Bare Field

Size: 45.3 acres. Location: State Hospital (Plate 1)» Vegetation: Winter grain. Surroundings: n., woody hedgerow; e., weedy hedgerow and orchard; s., separated from bare field by shrubby gulley; w., separated from bare field by ditch bank of willow trees.

Dec, 29. Dove, 80, See Dec, 29 census on plot 1.1, Above.

Feb, 22; 8:45 to 9:30 a.m. Clear; wind northeast, 9; 34° F. No birds.

Plot 1.3, Bare Field

Size: 15.3 acres. Location: Borders on the north of the Avent Ferry Road; due north of west end of Lake Raleigh; (Plate 1) terraced, sloping steeply westward; surface smooth. Vegetation: Winter grain. Surroundings: n., cut-over and grazed pine-oak woods; e., broomsedge; s., dirt road; w., wooded ditch bank.

Nov. 26; 12:15 to 12:40 p.m. Clear; wind north, 12; 44° F. Killdeer, 40; Pipit, 125; Starling, 5; Cowbird, 16. Ground very wet.

Dec. 15; 9:30 to 10:00 a.m. Clear; wind north, 10; 36° F. Killdeer, 1.

Dec. 21; ten minutes, at 11:00 a.m. Clear; wind west, 9; 45° F. Killdeer, 2; Bluebird,- 30; Goldfinch, 5; Junco, 100. Juncos within seventy-five feet of west woods, and flew to it; Bluebirds and Goldfinches perched on isolated corn stubs.

Dec. 29; 9.30 to 10100 a.m. Cloudy; wind north, 9; 34° F. No birds. Ground on upper terraces frozen, on lower terraces soft and muddy.

Jan. 23. Ground covered with snow. No birds.

Plot l.4, Bare Field

Size: 7.4 acres. Location. Central Farm, south; (Plate l) flat; surface smooth. Vegetation: Winter grain. Surroundings: e., grassy pasture; s., crab grass and lespedeza, and

poultry plant buildings; w., separated from open fields by dirt road.

Dec, 26; 3:15 to 3:45 p.m. Cloudy, threatening rain; wind south, 5; 45° F. Horned Lark, 12; Starling, 20; Meadow-lark, 45. Horned Larks the first recorded this winter for Raleigh, recent drops in temperature apparently bringing them down from farther north.

Dec. 28; 10:15 to 10:40 a.m. Cloudy, threatening rain; wind northeast, 7; 35°F. Horned Lark, 2; Meadowlark, 86. As usual, the Meadowlarks drifted in from the bare field 1.11 to the west and, when flushed, flew to the crab grass and lespedeza field 2.7. .

Feb. 21; 9:45 to 9.55 a.m. Cloudy; wind northeast, 7; 40° F. Flicker, 1; Starling, 3; Meadowlark, 23.

Plot 1.5, Bare Field

Size: 16.5 acres. Location: Central Farm, north (Plate 1). Vegetation: Winter grain; ground flat and smooth. Surroundings: n.e., grassy pasture; n.w., crab grass; s., paved highway. .

Nov. 2; 9:40 to 10:00 a.m. Clear; wind north, 11; 52° F. No birds.

Dec. 18; 8:50 to 9.10 a.m. Clear; wind north, 8; 54° F. Meadowlark, 4.

Feb. 21; 9:25 to 9:40 a.m. Cloudy; wind northeast, 7; 40° F. Crow, 7.

Plot 1.6, Bare Field

Size: 2,2 acres. Location: Meredith College (Plate 2).

Vegetation: Winter grain; ground flat and smooth. Surroundings: n., clump of oaks; e., bare field; s., paved highway; w., bare field.

Jan, 4; 8:05 to 8:15 a.m. Cloudy; wind north, 2; 26° F. Killdeer, 5.

Plot 1.7, Bare Field

Size: 19 acres. Location: Meredith College (Plate 2). Vegetation: Winter grain; terraced, sloping toward center ditch from both east and west; surface smooth. Surroundings: n., cut-over pine-oak-hickory woods; e., dense young pines; s., dirt road; w., pasture.

Jan. 4; 8:35 to 9:15 a.m. Cloudy; wind southwest, 4; 30° F. Killdeer, 8. Ground surface dry and hard.

Plot 1.8, Bare Field

Size: 4.7 acres. Location: Central Farm, north (Plate 1). Vegetation: Winter grain; ground flat and smooth; low and wet. Surroundings: n., wooded ditch bank; e., grove of deciduous trees; s. and w., pasture.

This area was censused two times, but no birds were found on it.

Plot 1.9, Bare Field

Size: 52.2 acres. Location: State Hospital (Plate 1). Vegetation: Scattered tufts of crab grass and an occasional corn stub. The summer crop was corn. A thick growth of crab grass appeared by fall. The whole was roughly plowed, the distance from the bottoms of the furrows to the tops of the clods varying from six to twelve inches. Terraced; sloping

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steeply south and west. Part of a terrace in northeast corner left unplowed. Surroundings: n., bare field; e., orchard and bare field; s., Lake Raleigh; w., separated from bare field by ditch grown up to willow trees,

Jan. 24; 10:45 to 11:15 a.m. Clear; wind northwest, 18; 35° F. Four Inches of snow fell on Jan. 23. At the time of the present census bare spots varying from two to ten inches in diameter were scattered irregularly over the field. It was estimated that one-tenth of the ground was bare. Sparrow Hawk, 2, on ground and flying over; Horned Lark, 400, in two different flocks; Savannah Sparrow, 13, each bird separate. The Horned Larks came across the field from the bare fields farther east and moved around in this field, feeding, until flushed. They flew west, over the pine woods. One Sparrow Hawk flew through one flock, scattering the birds, but not taking any. The birds fed continuously, on the bare spots.

Feb. 22; 9:45 to 10:45 a.m. Clear; wind northeast, 9; 37° F. Sparrow Hawk, 2, one of them on the ground; Savannah Sparrow, 4, each one occurring along a terrace top by some crab grass.

Plot 1.10, Bare Field

Size: 21.3 acres. Location: Central Farm, south (Plate l). Vegetation: Scattered tufts of crab grass and corn stubble. The summer crop of crab grass and corn was plowed under in early December. Terraced; surface rough. Surroundings: n., garden; e., clump of tall pines; s., separated from weedy field by wooded ditch bank; w., woods of pines and deciduous trees.

Dec, 29; 8:30 to 9:00 a.m. Cloudy; wind north, 9; 34° F. Mourning Dove, 16; Flicker, 2; Meadowlark, 26. These birds did not leave the field when flushed.

Jan. 24; 9:00 a.m. Clear; wind northwest, 15; 30° F. Snow on ground, no bare spots. No birds.

Jan. 26; 9:00 a.m. Clear, wind west, 10; 16° F. Meadowlark, 18. Snow on ground.

Feb. 21; 10:35 to 11:00 a.m. Clear; wind north, 6; 42° F. Mourning Dove, 11. Ground recently replowed and made somewhat smooth. .

Feb. 22; 8:20 to 8:35 a.m. Clear; wind north, 7; 31° F. Bobwhite, 6, flushed from center of field and flew south one hundred and fifty-eight paces to the wooded ditch bank; Mourning Dove, 18; Meadowlark, 62.

Plot 1.11, Bare Field

Size: 22 acres. Location: Central Farm, south (Plate l). Vegetation: The terrace tops are plowed bare. The between-tops are partly plowed, leaving a partial covering of crab grass; also scattered patches of prostrate green vetch. Terraced. Surroundings: n., cotton patch; e., mowed lespedeza hay field and dirt road; w., dirt road.

Dec. 28; 11:00 to 11:45 a.m. Cloudy; wind northeast, 5; 36° F. Sparrow Hawk, l, on overhead wire; Killdeer, 3; Mourning Dove, 1; Savannah Sparrow, 6. Field wet and muddy; Savannah Sparrows all close to east lespedeza field.

Plot 1.12, Bare Field

Size: 29.5 acres. Location: Meredith College (Plate 2). Vegetation: Scattered remains of withered lespedeza plants

and a few sprigs of crab grass; ground flat and smooth. Surroundings: n., bare field; e., Meredith College campus; s.e., marshy field; w., dirt road.

Jan. 15; 9:00 to 9:10 a.m. Clear; wind west, 12; 36° F. Killdeer, 3; Horned Lark, 9; Meadowlark, 20. Census incomplete; taken from dirt road.

Feb. 29; 8:20 to 8.55 a.m. Cloudy; wind northeast, 12; 40° F. Sparrow Hawk, 1; Killdeer, 3; Mourning Dove, 27; Meadow lark, 47.

Plot 1.13, Bare Field

Size: 12.8 acres. Location; Meredith College (Plate 2). Vegetation: Scattered tufts of crab grass; fall growth of crab grass had been plowed into regular furrows six inches across and five inches deep; ground flat. Surroundings: n., hayfield; e., crab grass; s., paved highway; w., pasture.

Jan. 3; 10:20 to 10:40 a.m. Clear; wind northwest, 10; 22° F. Meadowlark, 40, came in from west pasture; Savannah Sparrow, 40, came into this plot when flushed from east crab grass.

Plot 1.14, Bare Field

Size: 7.7 acres. Location: Meredith College (Plate 2). Vegetation: Ground furrowed as in plot 1.13; furrow tops with a good growth of crab grass; least bare of all fields placed in “bare field" category. Surroundings: n., hayfield; e., dirt road; s., paved highway; w., crab grass.

Jan. 3; 9:40 to 10:20 a.m. Clear; wind northwest, 10; 22° F. Meadowlark, 20; Savannah Sparrow, 12. Ihe Sparrows remained within the plot; the Meadowlarks flew away.

2 Plot 2^1, Crab Grass

Size: 1.7 acres. Location: State Hospital (Plate 1). Vegetation: Crab grass; some corn stubble; flat, consisting of one terrace. Surroundings: Enclosed by bare field 1.9.

Feb 22; 9:30 to 9.45 a.m. Clear; wind northeast, 9; 37° F. Savannah Sparrow, 16. A census during the following hour in the fifty-two acre bare field surrounding this plot disclosed four Savannah Sparrows.

Plot 2.2, Crab Grass

Size: 14.5 acres. Location: Meredith College (Plate 2). Vegetation: Crab Grass; ground flat and smooth. No sign of the summer crop of tomatoes present. Surroundings: n.e., mowed lespedeza hay field; e. and s.e., bare field 1.14; s., paved highway; w. and n.w., bare field 1.13.

Jan. 3; 8:40 to 9:40 a.m. Clear; wind northwest, 10; 22° F. Harsh Hawk, 1, flying low *over* field (two feet above ground); Crow, 7; Meadowlark, 24; Savannah Sparrow, 150.

Jan. 15 9:00 to 9:20 a.m. Clear; wind west, 12; 36^0 F. Savannah Sparrow, 30. An incomplete count; ground very wet.

Feb. 29; 9:00 to 9:25 a.m. Cloudy; wind northeast, 12; 40^0 F. Meadowlark, 14; Savannah Sparrow, 42.

Plot 2.3, Crab Grass

Size: 9.5 acres. Location: Bordering on north of Avent Ferry Road, end due north of easternmost extension of Lake Johnson (Plate 1). Vegetation: Crab grass, 1; tall weeds (cockleburr), 4; corn stubble. Surroundings: n.e., grassy pasture; s.e., s., and w., standing corn and crab grass.

Jan. 11; 12:00 noon to 12:30 p.m. Cloudy; wind east, 7; 36° F. Savannah.Sparrow, 70.

Plot 2.4, Crab Grass

Size: 8.5 acres. Location: Central Farm, north (Plate 1). Vegetation: Crab grass, 1; tall weeds, 4; corn stubble. Irregular in shape; flat; southern part sparsely vegetated. Surroundings: n., fields of mixed grasses, tall weeds, and broomsedge; e., pasture; s., bare field; w., cotton patch.

Nov. 2; 8:30 to 9:10 a.m. Clear; wind north, 10; 48° F. Savannah Sparrow,,200, many of these birds undoubtedly in migration; Field Sparrow, 6.

Nov. 7; 7:15 to 8:15 a.m. Cloudy; wind west, 4; 39° F. Savannah Sparrow, 40; Vesper.Sparrow,.12; Junco, 12; Field Sparrow, 5; Song Sparrow, 20.

Jan, 8; 2:00 to 3:30 p.m. Cloudy; wind west, 5; 31° F. Mourning Dove, 74; Flicker, 1; Meadowlark, 45; Savannah Sparrow, 16; Field Sparrow, 2; Song Sparrow, 6. This plot was sprinkled with manure early in December. This altered the conditions considerably, both more individuals and more species being present since that time.

Plot 2.5, Crab Grass

Size: 21.3 acres. Location: Central Farm, south (Plate l). Vegetation: Crab grass, l; tall weeds, 4; corn (being harvested at the time of the census), 1. Surroundings: Same as for plot 1.10. . .

Nov. 2; 10:00 to 11:00 a.m. Clear; wind north, 11; 56^0 F. Mourning Dove, 40; Flicker, 1, Starling, 140; Meadowlark, 35; Vesper Sparrow, 5; Junco, 7; Chipping Sparrow, 1;

Field Sparrow, 24; Song Sparrow, 20. All the Sparrows except the Vespers were within fifty feet of the southern edge and flew there when flushed.

Plot 2.6, Crab Grass

Size: 1.9 acres. Location: Central Farm, south (Plate 1). Vegetation: Lespedeza, 1; crab grass, 2; open enough for birds to walk through; ground flat and smooth. Surroundings: n., bare field (winter grain); e., pasture; s., isolated trees, and poultry plant buildings; w., chicken houses and a grassy patch.

Feb. 21; 9:55 to 10:00 a.m. Cloudy; wind northeast, 7; 40° F. Meadowlark, 37; Savannah Sparrow, 17.

Plot 2.7, Crab Grass

Size: 9.2 acres. Location: Central Farm, south (Plate l). Vegetation: Lespedeza, 1; crab grass, 2; open enough for birds to walk through; ground flat and smooth. Surroundings: n., paved highway; e. and s.e., a grove of oaks, and a garden; s., s.w., and w., pasture; w., mowed hayfields.

Feb. 21; 10:20 to 10:35 a.m. Cloudy; wind northeast, 7; 40° F. Savannah Sparrow, 44. Whenever Meadowlarks were flushed from bare field 1.4 they flew to this plot.

Plot 3.1, Crab Grass-Tall Weeds

Size: 5.5 acres. Location: Central Farm, south; the westernmost field of this group (Plate l). Vegetation. Crab grass, 1; tall weeds, 1; plant growth open, giving the birds access to the ground; ground flat and smooth. Surroundings: n., pine woods; e., farm buildings and garden; s., pine-oak woods; w., dirt road, and a grove of tall oaks.

Jan. 11; 12:30 to 1:00 p.m. Cloudy; wind southeast, 8; 37° F. Bluebird, 8; Goldfinch, 20; Savannah Sparrow, 50; Junco, 75; Field Sparrow, 100; Song Sparrow, 20.

Plot 3«2# Crab Grass-Tall Weeds

Size: 1.6 acres. Location: Dixie Trail (Plate 2). Vegetation: Crab grass, l; tall weeds, 1; growth dense; ground flat and smooth. Surroundings: n., pine-oak woods, open and of medium height, dry; e., tall weeds and broomsedge; s.e., orchard grown up to broomsedge and blackberries; s.w., crab grass, lying flat on ground; w., dirt road and bare field.

Dec. 26; 10:20 to 10:40 a.m. Cloudy; wind southeast, 6; 38° F. Carolina Chickadee, 2; Savannah Sparrow, l4; Junco,35; Field Sparrow, 55; Song Sparrow, 20. The Juncos and Field Sparrows flew to the pine-oak woods' edge and worked eastward; the Savannahs and Song Sparrows stayed within the plot.

Plot 4.1, pasture

Size: 24.5 acres. Location: Central Farm, north (Plate 1). Vegetation: Grass from one to ten inches high and so dense that no ground visible, difficult for small birds to walk through; terraced, sloping northward. Surroundings: n.e., ditch, with dense growth of willow, cane, and honeysuckle; n.w., bare field (winter grain), and a small grove of catalpa trees; e., grove of tall oaks and hickories; s., bare field; w., crab grass plot 2.4, and field of mixed grasses, tall weeds, and broomsedge.

Nov, 2; 7:50 to 8:30 a.m. Clear; wind northwest, 12; 45° F. Sparrow Hawk, 1, on wire over field; Meadowlark, 2.

Dec. 26; 3:00 to 3:15 p.m. Cloudy, threatening rain; wind south, 5; 45° F. Sparrow Hawk, 1, on wire over field; Meadowlark, 11.

Feb. 21; 9:10 to 9:25 a.m. Cloudy; wind northeast, 8; 38° F. No birds.

Plot 4.2, Pasture

Size: 27 acres. Location: Central Farm, north (Plate l). Vegetation: Pasture grass, 1, from one to six inches high, dense; tall weeds, 4; broomsedge, 5; terraced, sloping southward. Surroundings: n., railroad; e. and s., ditches, with dense growths of willow, cane, and honeysuckle; w., weedy pasture; a cotton patch and orchard jut into the northeast corner.

Nov. 9; 8:15 to 8.50 a.m. Clear; wind north, 9; 40° F. Savannah Sparrow, 5.

Feb. 21; 8:4o to 9:10 a.m. Cloudy; wind northeast, 8; 38° F. Flicker, 2; Robin, 70; Starling, 6; Myrtle Warbler, 6; Meadowlark, 30. The Robins and the Myrtle Warblers are indicative of the beginning of the spring migration. At the time of the present census the pasture was green with new spring growth.

Plot 4.3, Pasture

Size: l6.5 acres. Location: Central Farm, north (Plate l). Vegetation: Grass one to two inches high; sod removed from half of the field during the winter. Surroundings: n., railroad; e., college dormitories and a cow lot; s., pasture; w., ditch, with dense growth of willow, cane, and honeysuckle.

Nov. 1; 8:30 to 9:15 a.m. Clear; wind west, 6; 45° F. Starling, 55; Meadowlark, 12; Cowbird, 50; Goldfinch, 4; Savannah Sparrow, l4. The Starlings and the Cowbirds were in one flock together, following the twelve cows present. The presence of Cowbirds indicated that the fall migration was not yet complete.

Plot 4.4, Pasture

Size: 6.7 acres. Location: Central Farm, south (Plate l). Vegetation: Grass dense; ground flat and smooth. Surroundings: n., pasture; e., isolated deciduous trees, and dirt road; s. and w., ditch, with dense growth of willow, cane, and honeysuckle.

Nov. 1; 7:45 to 8:10 a.m. Clear; wind west, 9; 42° F. Starling, 30; Myrtle Warbler, 6; Meadowlark, 12; Cowbird, 10. Four bulls present.

Feb. 21; 8:30 to 8:4o a.m. Cloudy; wind northeast, 8; 38° F, Sparrow Hawk, 1, on wire over field; Meadow lark, 1. Ground soaked; field green with new spring growth.

Plot 4.5, Pasture

Size: 31 acres. Location: Meredith College (Plate 2). Vegetation: 1 Pasture grass; some lespedeza. Surroundings: n., separated from similar fields by a narrow ditch grown up to tall weeds, cane, and shrubs; a similar ditch runs through the middle of the field; e., bare field; s., paved highway; w., similar pastures.

Jan. 3; 10:40 to 11:30 a.m. Clear; wind northwest, 12; 30° F, Marsh Hawk, 1, on ground; Meadowlark, 40.

Plot 4.6, Pasture

Size: 97 acres. Location: Meredith College (Plate 2). Vegetation: Pasture grass, 1; lespedeza, 1; broomsedge, 3, commonest on slopes; tall weeds, 4; isolated oaks, 4. This field is cut both east-west and north-south by ditches with steep banks. At the confluence of the streams there is a marshy area of about five acres. Surroundings: n.w., field of soy beans; n., cut-over pine-oak woods; n.e., abandoned pasture grown up to broomsedge, blackberries, and bushes; e., bare fields; s., separated by dirt road from open, grazed pine-oak woods; w., pasture.

Jan. 4; 9:20 to 11:45 a.m. Cloudy; wind south, 4-6; 30 to 39° F. Sparrow Hawk, 1, in tree; Killdeer, 6; Crow, 13; Starling, 300, in western part near buildings and cattle; Meadowlark, 180; Cowbird, 10; Savannah Sparrow, 16.

Plot 4.7, Pasture

Size: 26.8 acres. Location: Central Farm, south (Plate l). Vegetation: Pasture grass, 1; mowed broomsedge, 3; divided north to south by a narrow ditch; western part has a clump of pines and oaks along, a short ditch. Surroundings: n., mowed lespedesa-crab grass fields; e., isolated oaks separating it from a garden and bare field 1.10; s., small pine woods; w., bare field.

Feb. 21; 10:00 to 10:20 a.m. Cloudy; wind northeast, 7; 40° F. Cattle present. Flicker, l; Robin, 40; Starling, 25; Meadowlark, 70. None of these birds left the field when flushed.

Plot 5.1, Tall Weeds-Broomsedge

Size: 6 acres. Location: Central Farm, south (Plate 1).

Vegetation: Tall weeds, 1; broomsedge, 2; lespedeza, 3; growth dense. A narrow ditch runs north-south through eastern part, entering the creek which forms the eastern boundary. Surroundings: n., bare field; e. and s.e., separated from weedy field by creek; s., creek, and dirt road; w., pine woods.

Nov. 9; 10:00 to 10:30 a.m. Clear; wind north, 9; 52° F. Meadowlark, 4; Vesper Sparrow, 2; Field Sparrow, 20; Song Sparrow, 70. The Song Sparrows were along the narrow ditch which runs through the plot.

Jan. 24; 9:00 to 9:15 a.m. Clear; wind northwest, 15; 30° F.; four inches of snow on ground, no snow adhering to vegetation. Savannah Sparrow, 3; Junco, 12; Field Sparrow, 12; Song Sparrow, 22.

Plot 5.2, Tall Weeds-Broomsedge

Size: 6 acres. Location: Dixie Trail (plate 2). Vegetation: Broomsedge, 1; tall weeds, 1; pines, one to two feet high, and principally at west end where brooms edge commoner than tall weeds, 3; low weeds and grasses, 4; growth dense. Surroundings: n., pine woods; e., pine-oak woods; s., open woods of mediumly high pines and oaks (cleaned up for real estate development); w., separated from grazed pine lot by dirt road.

Dec. 14; 10:00 to 10:35 a.m. Clear; wind northwest, 10; 40° F. Junco, 30; Field Sparrow, 50; Song Sparrow, 2.

Plot 5.3, Tall Weeds-Broomsedge

Size: 14 acres. Location; Dixie Trail, at northern extremity

(Plate 2). Vegetation: Broomsedge, 1; tall weeds, 2; blackberries, 3; grass and low weeds, 3; pines, one to two feet high, 4; tall weeds dominant on terrace tops; broomsedge dominant between terrace tops; field has a banded appearance; blackberries in isolated patches; some scattered bare spots. Surroundings: n., broomsedge-pine field; e., separated from broomsedge-pine field by dirt road; s., separated from tall weed-broomsedge field by dirt road; w., buildings, and a weed patch.

Dec. 26; 8:30 to 9:50 a.m. Cloudy; wind southeast, 7; 38° F. Marsh Hawk, 1; Sparrow Hawk, 1; Savannah Sparrow, 9.

Plot 5.4, Tall Weeds-Broomsedge

Size: 12 acres. Location: Dixie Trail (Plate 2). Vegetation: Broomsedge, 1 (locally pure, or nearly so); tall weeds, 2 (locally codominant with broomsedge); blackberries, 3; pines, one foot high, 4; apple trees, 4; hickory, 5; scattered bare spots of irregular shape, varying from two to twenty inches in diameter; ground flat and smooth; vegetation mediumly dense. Surroundings: n.w., abandoned orchard grown up to broomsedge and blackberries, and broomsedge-pine plot 6.2; n., burned broomsedge and pine field; e., tall pine-low oak woods; s., pine woods; w., grove of oaks, and farm buildings.

Dec. 31; 9:50 to 11:00 a.m. Cloudy; wind west, 11; 36^0 F. Chickadee, 4, from south pine woods; Savannah Sparrow, 2; Junco, 42; Field Sparrow, 24; Song Sparrow, 2.

Jan. 17; 8:15 to 8:45 a.m. Partly cloudy; wind southwest, 6; 38° F. Savannah Sparrow, 3; Junco, 30; Field Sparrow, 30; Song Sparrow, 2.

Jan. 25; 9:45 to 10:45 a.m. Cloudy; wind northwest, 16; 23° F.; snow on ground, no snow adhering to vegetation. Three separate flocks. First flock, south central part of field, near pine woods: Savannah Sparrow, 3; Junco, 4; Field Sparrow, 12; Song Sparrow, 1. Second flock, southwestern part of field: Savannah Sparrow, 3; Junco, 20; Field Sparrow, 60; moved into edge of south pine woods. Third flock, in northwest part of field: Junco, 15; Field Sparrow, 90; moved into adjoining broomsedge-pine plot. Total: Savannah Sparrow, 6; Junco, 39; Field Sparrow, 162; Song Sparrow, 1. All birds fed continuously, while either on the snow or perched on the broomsedge or tall weed plants.

Plot 5.5, Tall Weeds-Broomsedge

Size: 12.5 acres. Location: Dixie Trail (Plate 2). Vegetation: Broomsedge, 1; tall weeds, 3; blackberries, 4; pines, one to two feet high, 5; scattered small bare spots; ground flat and smooth. Field horse-shoe shaped, extending around a set of farm buildings on three sides; tall weeds up to subdominant and codominant positions on inner edges. Surroundings: n., broomsedge-pine plot; e., isolated oaks, and tall pine-low oak woods; s., low, cut-over pine-deciduous tree woods; w., dirt road; n.w., field of sparse tall weed-broomsedge growth, partly burned.

Dec. 8; 9:00 to 9:30 a.m. Clear; wind north, 11; 50° F. No birds. This census did not include the inner edges where the tall weeds are subdominant.

Feb. 16; 8:45 to 9:30 a.m. Clear; wind, northeast, 6; 34^0 F. Three different flocks. First flock: Savannah

Sparrow, 7; Field Sparrow, 40; Second flock: Field Sparrow, 30. Third flock: Savannah Sparrow, 6; Field Sparrow, 50. Total: Savannah Sparrow, 13; Field Sparrow, 120. None of these birds left the field when flushed.

Plot 6.1, Broomsedge-Pine

Size: 13.2 acres. Location: Bordering House Creek on the north, between the Lead Mines and the State Prison Farm (Plate 2). Vegetation: Broomsedge, 1; pines, four to eight feet high, 3; tall weeds, 4; blackberry, 4; sapling sweet gum trees, 5; scattered small bare spots; terraced. Surrounding: n. and e., streams four to six feet wide, with twenty to thirty feet wide growths of dense deciduous trees and bushes; s., narrow ditch with a growth of bushes separating it from a corn stubble field; w., winter grain field.

Jan. 17; 5:00 to 9:50 a.m. Partly cloudy; wind south-west, 6; 38° F. Savannah Sparrow, 6; each one flushed separately from one of the small bare spots.

Plot 6.2, Broomsedge-Pine

Size: 24.4 acres. Location: Immediately north of previous plot. Vegetation: Broomsedge, 1; pines, three to fifteen feet high, 3; low weeds and lespedeza, 3; tall weeds, 4; blackberry, 5; deciduous trees(china berry, sweet gum, apple), 5; scattered bare spots; terraced. Surroundings: n., pine woods; e., separated from grazed oak-hickory woods by narrow creek; s., the north border of the previous plot.

Jan. 17; 11:15 a.m. to 12:10 p.m. Clear; wind west, 9; 50° F. Bluebird, 2; perched in china berry tree; Savannah Sparrow, 8, flushed separately, from bare spots.

Plot 6.3, Broomsedge-Pine

Size: 5.6 acres. Location: Dixie Trail (Plate 2). Vegetation: Broomsedge, 1; pines, six to ten feet high, 1; tall weeds, 3; blackberry, 3; grass and low weeds, 3; terraced. Surroundings: n. and e., low pine-oak woods, dry; s. and w., broomsedge and tall weeds.

Dec. 26; 9:50 to 10:15 a.m. Cloudy; wind southeast, 6; 38° F. Savannah Sparrow, 3; Junco, 20; Field Sparrow, 40; Song Sparrow, 2.

Plot 6.4, Broomsedge-Pine

Size: 4.4 acres. Location: Dixie Trail (Plate 2). Vegetation: Broomsedge, l; pines, up to three feet on upper terrace bordering road, up to ten and twelve feet on lower three terraces, 1; tall weeds, 4 to 5; vegetation on upper terrace sparse, leaving some bare ground. Surroundings; n., open, low pine-oak woods; e., broomsedge-tall weeds; s., broomsedge-tall weeds plot and a clump of oaks; w., dirt road.

Dec. 26; 11:15 to 11:30 a.m. Cloudy; wind southeast, 6; 38° F. Junco, 10; Field Sparrow, 40; Song Sparrow, 4.

Dec, 31; 11:00 to 11:50 a.m. Cloudy; wind west, 11; 40° F. Savannah Sparrow, 4; Junco, 20; Field Sparrow, 40; Song Sparrow, 4.

Jan, 25; 10:45 to 11:20 a.m. Cloudy; wind northwest, 16; 24° F. Savannah Sparrow, 8; Junco, 30; Field Sparrow, 150; Song Sparrow, 4. Snow on ground, none adhering to vegetation. Part of the birds came from the adjoining plot 5.4. The birds fed continuously, standing on the snow or

perching half-way up the broomsedge and tall weed plants, not coming to the tops of the plants as on less windy days.

Plot 6.5, Broomsedge-Pine

Size: 8 acres. Location: Dixie Trail (Plate 2). Vegetation: Broomsedge, 1; pines, eight to twenty feet high, 1; tall weeds, 3; blackberry, 3. Surroundings; n., ditch, with growth of deciduous trees and bushes; e., tall pine-low oak woods; s., broomsedge-tall weeds; w., dense low pines.

Dec. 8; 9:45 to 10:35 a.m. Clear; wind northwest, 13; 52° F. Bobwhite, 18; Goldfinch, 2; Junco, 18; Field.-Sparrow, 24; White-throated Sparrow, 3; Song Sparrow, 5; the last two species within twenty feet of ditch.

Feb. 16; 9:30 to 10:00 a.m. Clear; wind northeast, 6; 37° F. Field Sparrow, 35.

Plot 6.6, Broomsedge-Pine, Burned

Size: 4.5 acres. Location: Dixie Trail (Plate 2). Vegetation: Formerly like plot 6.5. All vegetation burned off; pines burned but standing; ground bare. Surroundings: n., narrow ditch, with deciduous trees and shrubs; e., tall pine-low oak woods; s., broomsedge-tall weeds; w., sparse tall weeds-broomsedge.

Dec. 31; 12:15 to 12:25 p.m. Clear; wind west, 10; 42° F. Junco, 20; Field Sparrow, 70; feeding on ground; when flushed flew to ditch.

Plot 7.1, Pine

Size: 15.5 acres. Location: Dixie Trail (plate 2). Vegetation: Dense, slim young pines, twenty to twenty-five feet high; no broomsedge or other herbaceous vegetation

present; old terraces plainly evident. Surroundings: n., ravine, with a ditch, grown up to tall oaks and tulip trees; e., bare field; w., tall pine-low cak woods.

Dec. 12; 10:10 to 11:10 a.m. Clear; wind northeast, 7; 39 to 42° F. Barred Owl, 1; Carolina Chickadee, 15; Tufted Titmouse, 27; G,-c. Kinglet, 42; R.-c. Kinglet, 21; Blue-headed Vireo, 1; Pine Warbler, 8.

Feb. 25; 10:45 to 11:30 a.m. Cloudy; wind northwest, 9; 48° F. Downy Woodpecker, 3; Carolina Chickadee, 5; Tufted Titmouse, 3; Brown Creeper, 2; G.-c. Kinglet, 24; R.-c. Kinglet, 7; Myrtle Warbler, 3; Pine Warbler, 3; all birds in one flock.

See also census of Feb. 25 in plot 7.5. .

Plot 7.2, Pine

Size: 25 acres. Location: Dixie Trail (Plate 2). Vegetation: Pines, twenty-five to forty feet high, up to-ten inches in diameter; mediumly dense; broomsedge, 3; blackberry, 3; tall weeds, 4; old terraces evident. The pines in this plot are older and taller than those in the previous plot, but are not dense enough to eliminate the tall weeds and broomsedge. Surroundings: n., broomsedge-tall weed plot 5.4; e., tall pine-low oak woods; s., ditch, with growth of deciduous trees, shrubs, and cane; s.w., marshy area with grove of tall oaks; n.w., grazed pine lot.

Jan. 7; 10:00 to 11:00 a.m. Cloudy; wind east, 8; 27° F. Carolina Chickadee, 4; Hermit Thrush, 4; G.-c. Kinglet, 26; R.-c. Kinglet, 10; Pine Warbler, 12; Myrtle Warbler, 10;

Junco, 30 (crossed the eastern end of the plot from north to south).

Feb. 16; 10:15 to 11:45 a.m. Clear; wind northeast, 6; 37 to 45° F. Downy Woodpecker, 3; Carolina Chickadee, 15; Brown-headed Nuthatch, 5; Brown Creeper, 11; G.-c. Kinglet, 44; R.-c, Kinglet, 15; Myrtle Warbler, 4; Pine Warbler, 11; Cardinal, 1; all birds in one flock.

Plot 7.3, Pines

Size: 16.4 acres. Location: Borders Lake Raleigh on the south (Plate 1). Vegetation: tall pines, 1; young deciduous growth, mostly sweet gum, up to five feet high, 3; tall deciduous trees (oak, hickory, and dogwood) 4 to 5; old terraces evident; ground slopes toward lake; vegetation quite open. Surroundings: n., Lake Raleigh; e. and s., cultivated fields, bare in winter; w., pine-oak-hickory woods 8.1.

Nov. 16; 8:40 to 10:10 a.m. Partly cloudy to clear; wind 8; temp. 52 to 60° F. Mourning Dove, 45, sitting in the tops of the pines at the southeastern edge next to the open fields; Flicker, 2; Yellow-bellied Sapsucker, 1; Carolina Chickadee, 8; Brown-headed Nuthatch, 4; Carolina Wren, 3; Robin, 2; G.-c. Kinglet, 18; R.-c. Kinglet, 3; Myrtle Warbler, 5; Pine Warbler, 3; Junco, 1; all birds, except doves, in one loose flock; doves in a separate flock.

Feb. 26; 8:30 to 9:45 a.m. Clear; wind north, 10; 28° F. In one large flock: Brown-headed Nuthatch, 2; Brown Creeper, 10; G.-c. Kinglet, 60; R.-c. Kinglet, 50; Myrtle Warbler, 35; Pine Warbler, 30; Not in a flock: Crow, 6; Carolina Wren, 4;

Winter Wren, 1. Census incomplete, about one-fourth of the plot not examined.

Plot 7.4, Pines

Size: 11 acres. Location: Dixie Trail (Plate 2). Vegetation: Tall pines, 1; deciduous tree saplings, up to six feet; 3 to 4; old terraces evident. Surroundings: n., ditch, with tall deciduous trees; s., sapling stand of deciduous trees, six to seven feet tall; w., broomsedge and broomsedge-pine plots.

Dec. 10; 10:00 to 11:00 a.m. Partly cloudy; wind southwest, 7 to 9; 49 to 54°F. In one flock: Downy Woodpecker, 1; Carolina Chickadee, 14; Tufted Titmouse, 3; Brown Creeper, 12; G.-c. Kinglet, 30; R.-c. Kinglet, 2; Pine Warbler, 5; Goldfinch, 5; Not in a flock: Barred Owl, 1; Hairy Woodpecker, 1; Hermit Thrush, 1.

Plot 7.5, Pine

Size: 25.5 acres. Location: Dixie Trail (Plata 2). Vegetation: Tall pines, 1; deciduous tree saplings, up to six feet, 3; tall oaks, 5; ground flat and smooth. Surroundings: n. and e., dense young pines; s., ditch, with growth of deciduous trees and shrubs; w., separated by dirt road from a similar area opened up for real estate development.

Dec. 12; 8:30 to 10:00 a.m. Clear; wind northeast, 8; 35° F. Two separate flocks; one in southwestern edge, the other in northeastern edge. Not associated with a flock: Crow, 4; Hermit Thrush, 5.

Bird	First Flock	Second Flock	Total
Hairy Woodpecker	--	1	1
Downy Woodpecker	--	2	2
Carolina Chickadee	16	25	41
Tufted Titmouse	10	20	30
White-breasted Nuthatch	1	--	1
Brown Creeper	3	16	19
Golden-crowned Kinglet	18	60	78
Ruby-crowned Kinglet	6	25	31
Blue-headed Vireo	--	1	1
Myrtle Warbler	--	1	1
Pine Warbler	14	25	39
Goldfinch	5	--	5

Jan. 7; 9:00 to 9:50 a.m. Cloudy; wind east, 9; 27° F. One flock: Sharp-shinned Hawk, 1; Downy Woodpecker, 1; Carolina Chickadee, 34; Tufted Titmouse, l6; White-breasted Nuthatch, 3. Brown Creeper, 9; G.-c. Kinglet, 54; R,-c. Kinglet, 24; Pine Warbler, 5; Myrtle Warbler, 2; Goldfinch, 8. Not associated with a flock: Carolina Wren, 3; Hermit Thrush, 1; Junco, l4; south edge.

Feb. 25; 9:55 to 10:25 a.m. Cloudy; wind northwest, 9; 47° F. One flock, along the border line between this plot and the adjoining dense young pines, the birds extending about thirty feet into each plot; no separation possible: Carolina Chickadee, 9; Tufted Titmouse, 5; Brown-headed Nuthatch, 2; Brown Creeper, 3; G.-c. Kinglet, 45; R.-c. Kinglet, 20; Myrtle Warbler, 1; Pine Warbler, 10. Not in a flock: Sharp-shinned Hawk, 1; Crow, 2.

Plot 8.1, Deciduous Woods

Size: 87 acres. Location: Borders the southern and western edges of Lake Raleigh (Plate 1). Vegetation: Deciduous trees (oaks, hickory, beech, maple, and dogwood), 1; pines, 3. The whole area slopes toward the lake and is cut by several narrow (three feet wide) streams, along which there is some cane. Surroundings: n., creek, with deciduous trees; n.e., marsh; e., Lake Raleigh; s., cut-over oak-hickory-pine; s.w. cut-over deciduous tree-pine woods; n.w., open field with tree stumps.

Nov. 26; 9:45 a.m. to 12:00 noon. Clear; wind north, 12:35 to 44° F. Flicker, 1; Red-bellied Woodpecker, 2; Sapsucker, 1; Hairy Woodpecker, 2; Downy Woodpecker, 2; Phoebe, 1; Carolina Chickadee, 2; Tufted Titmouse, 5; White-breasted Nuthatch, 2; Brown Creeper, 2; Winter Wren, 8; Carolina Wren, 7; Hermit Thrush, 1; G.-c. Kinglet, 15; R.-c. Kinglet, 1; Cardinal 2; Junco, 4; White-throated Sparrow, 12.

Dec. 21; 8:30 to 10:30 a.m. Clear; wind west, 9; 40 to 45° F. Sapsucker, 1; Carolina Chickadee, 5; Tufted Titmouse, 3; Brown Creeper, 1; Winter Wren, 12; Carolina Wren, 4; G.-c. Kinglet, 12; R.-c. Kinglet, 6.

Jan. 28; 9:30 to 11:30 a.m. Clear, wind west, 10; 16 to 23° F. Sapsucker, 2; Hairy Woodpecker, 1; Downy Woodpecker, 1; Brown Creeper, 1; Winter Wren, 2; Carolina Wren, 9; G.-c. Kinglet, 6; Myrtle Warbler, 10; Pine Warbler, 4; Cardinal, 5; Goldfinch, 2; Junco, 1; White-throated Sparrow, 4.

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Plot 8.2, Deciduous Woods

Size: about 55 acres. Location: Lead Mines (Plate 3). Vegetation: Deciduous trees (Oaks, hickory, beech, maple), 1; Pines, 3 to 4. The whole area slopes northward and westward; two narrow streams cutting through it empty into House Creek, which forms the western boundary. The sides of the ravines through which the streams run are in beeches and maples, the hill tops are in the oaks, hickories, and pines. Surroundings: n., e., and s., woods of pines and deciduous trees in more or less equal numbers; cut-over, almost no large trees; w., House Creek.

Dec. 17; 8:45 to 10:15 a.m. Partly cloudy; wind south-west, 9; 43 to 53° F. Phoebe, 1; Carolina Chickadee, 2; Winter Wren, 1.

Feb. 15; 9:00 to 11:15 a.m. Clear; wind northwest, 18; 33 to 39° *$.* Hairy Woodpecker. 1; Downy Woodpecker, *3}* Carolina Chickadee, 20; Tufted Titmouse, 12; White-breasted Nuthatch, 2; Brown Creeper, 12; Carolina Wren, 1; Robin, 60; Bluebird, 9; G.-c. Kinglet, 70; R.-c. Kinglet, 1; Myrtle Warbler, 1; Pine Warbler, *3.*

Tables of Censuses

The following tables summarize the essential information about each census on each plot, and give the total plots, acreage, censuses, time spent censusing, and species for each of the eight stages considered.

Table II. Bare Field Stage

Plot	Size, in Acres	Census Dates	Time, in Minutes	Species	Individuals
1.1	25.3	12/21 12/29 1/21 1/28	5 5 35 10	1 1 0 1	25 80 0 9
1.2	45.3	12/29 2/22	5 45	1 0	80 0
1.3	15.3	11/26 12/15 12/21 12/29 1/23	25 30 10 30 5	4 1 4 0 0	186 1 137 0 0
1.4	7.4	12/26 12/28 2/21	30 25 10	3 2 3	77 88 27
1.5	16.5	11/2 12/18 2/21	20 20 15	0 1 1	0 4 7
1.6	2.2	1/4	10	1	5
1.7	19.0	1/4	40	1	8
1.8	4.7	11/1 1/24	10 10	0 0	0 0
1.9	52.2	1/24 2/22	30 60	3 2	415 6
1.10	21.3	12/29 1/24 1/28 2/21 2/22	30 5 10 25 15	3 0 1 1 3	44 0 18 11 86
1.11	22.0	12/28	45	4	11
1.12	29.5	1/15 2/29	10 35	3 4	32 78
1.13	12.8	1/3	20	2	80
1.14	7.7	1/3	40	2	32
14	281.2	33	720 (12 hours)	15	

Table III. crab Grass Stage

Plot	Size, in Acres	Census Dates	Time, in Minutes	Species	Individuals
2.1	3.7	2/22	15	1	16
2.2	14.5	1/3	60	4	182
		1/15	20	1	30
		2/29	25	2	56
2.3	9.5	1/11	30	1	70
2.4	8.5	11/2	40	2	206
		11/7	60	5	89
		1/8	90	6	144
2.5	21.3	11/2	60	9	273
2.6	1.9	2/21	5	2	54
2.7	9.2	2/21	15	1	44
7	68.6	11	420 (7 hrs.)	12	

Table IV. Crab Grass-Tall Weeds Stage

Plot	Size, in Acres	Census Date	Time, in Minutes	Species	Individuals
3.1	5.5	1/11	30	6	273
3.2	1.6	2/26	20	5	126
2	7.1	2	50	7	

Table V. Pasture Stage

Plot	Size,in Acres	Census Dates	Time, in Minutes	Species	Individuals
4.1	24.5	11/2 12/26 2/21	40 15 15	2 2 0	3 12 0
4.2	27.0	11/9 2/21	35 30	1 5	5 114
4.3	16.5	11/1	45	5	135
4.4	6.7	1/1 2/21	25 10	4 2	58 2
4.5	31.0	1/3	50	2	41
4.6	97.0	1/4	145	7	526
4.7	26.8	2/21	20	4	136
7	229.5	11	430 (7h.,10m.)	12	

Table VI, Tall Weeds-Broomsedge Stage

Plot	Size,in Acres	Census Dates	Time, in Minutes	Species	Individuals
5.1	6.0	11/9 1/24	30 15	4 4	96 49
5.2	6.0	12/14	35	3	82
5.3	14.0	12/26	80	3	11
5.4	12.0	12/31 1/17 1/25	70 30 60	5 4 4	74 65 208
5.5	12.5	12/8 2/16	30 45	0 2	0 133
5	50.0	9	395 (6h.,35m.)	9	

Table VII. Broomsedge-Pine

Plot	Size, in Acres	Census Dates	Time, in Minutes	Species	Individuals
6.1	13.2	1/17	50	1	6
6.2	24.4	1/17	55	2	10
6.3	5.6	1/26	25	4	65
6.4	4.4	12/26 12/31 1/25	15 50 35	3 4 4	54 68 192
6.5	8.0	12/8 2/16	50 30	6 1	70 35
6.6	4.5	12/31	10	2	90
6	60.1	9	320	8	

Table VIII. Pine

Plot	Size, in Acres	Census Dates	Time, in Minutes	Species	Individuals
7.1	15.5	12/12 2/25	60 65	7 8	115 50
7.2	23.0	1/7 2/16	60 90	7 9	96 109
7.3	16.4	11/16 2/26	90 75	12 9	95 198
7.4	11.0	12/10	60	11	75
7.5	25.5	12/12 1/7 2/25	90 50 30	14 14 10	258 175 97
5	91.4	10	670 (11h.,10m.)	25	

Table IX. Deciduous Woods

Plot	Size, in Acres	Census Dates	Time, in Minutes	Species	Individuals
8.1	87.0	11/26 12/21 1/20	135 120 120	17 8 13	69 44 48
8.2	55.0	12/17 2/15	90 135	3 13	4 195
2	142.0	5	600 (10 hrs.)	22	

Table X. Summary of Censuses by Stages

Stage	Plots	Size	Censuses	Hours	Min.	Species
BF	14	281.2	33	12	--	15
CG	7	68.6	11	7	--	12
CG-TW	2	7.1	2	--	50	7
Past.	7	229.5	11	7	10	12
TW-B	5	50.5	9	6	35	9
B-Pine	6	60.1	9	5	20	8
Pine	5	91.4	10	11	10	25
Dec.W	2	142.0	5	10	--	22
8	48	930.4	90	60	5	43

V. RESULTS Explanation of Tables

In the following tables the birds are listed according to their frequency and abundance. The frequency is a measure of the number of times the species occurred in the stage. It is obtained by dividing the number of censuses taken into one hundred, and multiplying by the number of censuses on which the species was recorded. Thus, in the bare field stage, thirty-three censuses were taken. The factor is three (actually 3.03, but the fraction is too small to be of importance). The Meadow lark was recorded on twelve different censuses. Its frequency then is thirty-six.

Abundance is in part a subjective value. The numbers one, two, three, four, and five are used in much the same way as in the vegetation analysis. However, since this work is of the most preliminary nature, it is not desired to use such ecological terms as "dominant", "subdominant", "influent", and "subinfluent". Number 1 denotes the commonest, most abundant, and widespread bird. Number 2 denotes a bird which is abundant but not the most abundant. Number 3 denotes commonness. Number 4 denotes uncommonness. Number 5 denotes a bird which is rare (accidental in the plot, or extremely low in numbers).

Abundance evaluation was not based on frequency alone. The number of individuals per census was equally important. In the pine woods, the G.-c. Kinglet occurred in flocks of from twenty-four to seventy-eight individuals; the Downy

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Woodpecker occurred in ones, twos, and threes. Another consideration was that of duration of occurrence; that is, whether the bird was present throughout the study period, as the Meadow lark, or present for only a part of the period, as the Horned Lark and the Vesper Sparrow. Still another factor involved the consideration of whether the bird was definitely in the plot, or merely a straggler from a neighboring plot. The White-throated Sparrow that appeared in one of the broomsedge-pine plots came into the plot just a few feet from a bordering thicket of deciduous trees.

The birds are listed in order of their frequency, since these figures are more difficult to keep in mind than are the abundance values. The correlation between abundance and frequency is not perfect, but nearly so. It is made principally in order to check the two values against each other. Where two or more birds of the same frequency occur, the sequence is that of the A. O. U. Check-list, 1931.

An asterisk (*) means that the bird so marked occurred in the one stage only.

The figures under "Numbers Per Census" were taken from the censuses in the order in which they are there reported.

Frequency and Abundance Tables

Table XI. Birds of the Bare Field Stage

Abundance	Frequency	Bird	Numbers Per Census	
1	36	Meadowlark	9-45-86-23-4-26-18-62-20-47-40-20	
3	24	Killdeer	40-1-2-5-8-3-3-3	
2	21	M. Dove	80-80-16-11-18-1-27	
4	15	Savannah Sp.	13-4-6-40-12	
4	12	Sparrow Hawk	2-2-1-1	
4	12	* Horned Lark	12-2-400-9	
4	9	Starling	5-20-3	
5	6	Flicker	1-2	
4	6	*Pipit	25-125	
5	3	Bob-white	6	
4	3	Crow	7	
5	3	Bluebird	30	
5	3	Cowbird	16	Species—-15
5	3	Goldfinch	5	Censuses—33
5	3	Junco	100	F. factor— 3

Table XII. Birds of the Crab Grass Stage

Abundance	Frequency	Bird	Numbers Per Census	
1	91	Savannah Sp.	16-150-30-42-70-200-40-16-17-44	
2	45	Meadowlark	24-14-45-35-37	
4	36	Field Sp.	6-5-2-24	
4	27	Song Sp.	20-6-20	
4	18	M. Dove	74-40	
5	18	Flicker	l-l	
5	18	Vesper Sp.	12-5	
5	18	Junco	12-7	
5	9	Marsh Hawk	1	
4	9	Crow	7	Species--12
5	9	Starling	l40	Censuses—11
5	9	*Chipping Sp.	1	F. factor—9

Table XIII. Birds of the Crab Grass-Tall Weeds Stage

Abundance	Frequency	Bird	Numbers	Per Census
1		Field Sp.	100-55	
2		Junco	75-35	
3		Savannah Sp.	50-14	
3		Song Sp.	20-20	
5		Goldfinch	20	-
5		Bluebird	8	Species—-7
5		Chickadee	2	Censuses—2

Table XIV, Birds of the Pastures

Abundance	Frequency	Bird	Numbers Per Census
1	81	Meadow lark	2-11-30-12-12-1-40-180-70
2	45	Starling	6-55-30-300-25
4	36	Sparrow Hawk	1-1-1-1
4	27	Cowbird	50-10-10
4	27	Savannah Sp.	5-14-16
4	18	Flicker	2-1
4	18	Robin	7O-40
5	18	Myrtle Warbler	6-6
5	9	Marsh Hawk	l
5	9	Killdeer	6
4	9	Crow	15
5	9	Goldfinch	4

Species--- 2
Censuses--11
F. factor--9

Table XV. Birds of the Tall Weeds-Broomsedge Stage

Abundance	Frequency	Bird	Numbers Per Census	
1	77	Field Sp.	20-12-50-24-30-162-120	
3	66	Savannah Sp.	3-9-2-3-6-13	
3	66	Song Sp.	70-22-2-2-2-1	
2	55	Junco	12-30-42-30-39	
5	11	Marsh Hawk	1	
5	11	Sparrow Hawk	1	
5	11	Chickadee	4	Species---9
5	11	Meadowlark	4	Censuses--9
5	11	Vesper Sp.	2	F. factor—11

Table XVI. Birds of the Broomsedge-Pine Stage

Abundance	Frequency	Bird	Numbers Per Census	
1	77	Field Sp.	40-40-40-150-24-35-70	
2	66	Junco	20-10-20-30-18-20	
3	55	Savannah Sp.	6-8-3-4-8	
3	55	Song Sp.	2-4-4-4-5	
5	11	Bob-white	18	
5	11	Bluebird	2	Species-- 8
5	11	Goldfinch	2	Censuses— 9
5	11	White-th. Sp.	3	F.factor—11

Table XVII. Birds of the Fine Stage

Abundance	Frequency	Bird	Numbers Per Census
1	100	G.-c. Kinglet	42-24-26-44-18-60-30-78-54-45
2	100	R.-c. Kinglet	21-7-10-15-3-50-2-31-24-20
2	100	Pine Warbler	8-3-12-11-3-30-5-39-5-10
2	90	Chickadee	15-5-4-15-8-14-41-34-9
3	80	Myrtle Warbler	3-10-4-5-35-1-2-1
3	70	Brown Creeper	2-11-10-12-19-9-3
3	60	Titmouse	27-3-3-30-16-5
3	50	D. Woodpecker	3-3-1-2-1
3	40	*B.-h. Nuthatch	5-4-2-2
3	40	*Hermit Thrush	4-1-5-1
4	30	Crow	6-4-2
4	30	Carolina Wren	3-4-3
4	30	Goldfinch	5-5-8
4	30	Junco	30-1-14
4	20	*S.-s. Hawk	1-1
4	20	*Barred Owl	l-l
4	20	H. Woodpecker	1-1
4	20	W.-b. Nuthatch	1-3
5	20	*B.-h. Vireo	l-l
5	10	M. Dove	45
5	10	Flicker	2
5	10	Sapsucker	1
5	10	Winter Wren	1
5	10	Robin	2
5	10	Cardinal	1

Species——25

Censuses——10

F. factor—10

Table XVIII. Birds of the Deciduous Woods

Abundance	Frequency	Birds	Numbers Per Census	
3	80	Chickadee	2-5-2-20	
3	80	Brown Creeper	2-1-1-12	
3	80	Winter Wren	8-12-2-1	
3	80	Carolina Wren	7-4-9-1	
2	80	G.-c. Kinglet	15-12-6-70	
4	60	Sapsucker	1-1-2	
4	60	H. Woodpecker	2-1-1	
4	60	D« Woodpecker	2-1-3	
4	60	Titmouse	5-3-12	
4	60	R«-e. Kinglet	1-6-1	
5	40	♦Phoebe	1-1	
4	40	W.-b. Nuthatch	2-2	
4	40	Myrtle Warbler	10-1	
4	40	Pine Warbler	4-3	
4	40	Cardinal	2-5	
5	40	Junco	4-1	
4	40	SThite-th, Sp#	12-4	
5	20	Flicker	1	
5	20	»R,-b. Woodpecker	2	
5	20	Robin	60	Species---22
5	20	Bluebird	9	Censuses—- 5
5	20	Goldfinch	2	F. factor—20

Discussion

BARE FIELD. The smaller plots, which were surrounded by pastures and other stages, had the most species and individuals. The larger plots, those at the State Hospital, were barren of birds most of the time.

The Meadowlark appeared in good-sized flocks on all types of bare fields. The Killdeer appeared in small numbers in all types of fields. The Mourning Dove occurred in only five of the fourteen plots. It was apparently found more in fields where soy beans, corn, and other grain foods were available. All three birds so far mentioned were wide-ranging, and usually flew to other fields when disturbed. The Savannah Sparrow's presence was conditioned apparently by the existence of some plant cover, such as crab grass or lespedeza. It did not occur on any of the winter grain fields. One or two Sparrow Hawks were always found around each group of fields. Power lines across fields were favorite perches. Where no such perches existed, the hawks perched on any slight hump on the ground. Horned Larks were present only between December 26 and January 24, when the temperature was unusually low and there was considerable snow and ice. The Pipit was last seen on December 21. The Starling occurred on plots that were close to farm buildings.

Only three species of birds - Meadowlark. Mourning Dove, and Killdeer – can be considered as regular and abundant inhabitants of the bare fields.

CRAB GRASS. The census of November 2, in plot 2.5, gave the only Chipping Sparrow of the winter. It was a late migrant. Mo other Chipping Sparrows were recorded by anyone at Raleigh during the winter. This census was probably a little early. It was the only one on which no Savannah Sparrow was seen.

The census of January 8, in plot 2.4, was taken after manure had been placed on the ground.

If both censuses mentioned were eliminated, the following birds would not appear on the list: Mourning Dove, Flicker, Starling, and Chipping Sparrow. The Savannah Sparrow would then have a frequency of one hundred.

The Savannah Sparrow never left the particular plot when flushed. Other birds usually did. No definite figure can be set, but this Sparrow in crab grass plots probably had a higher density than any other bird in any stage.

CRAB GRASS-TALL WEEDS. Both the number of censuses and the acreage were probably not large enough to give an accurate picture of the birds inhabiting this stage. However, the results seemed to agree very well with those obtained for the crab grass and the tall weeds-broomsedge stages. The frequency of occurrence was not included in the table because of the low number of censuses.

PASTURE. It is to be kept in mind that the pasture is not a stage in the sere from bare fields. Abandoned pastures go into tall weeds or broomsedge, and the succession then goes on as usual.

The birds of the pastures were quite similar to those of the bare fields. The Meadow lark was by far the most abundant bird of both stages. The Starling moved up to number two position. Each group of pastures had one or more Sparrow Hawks. The Killdeer was less common than in bare fields.

The Starling and the Cowbird appeared only when cows were present.

TALL WEEDS-BROOMSEDGE, and BROOMSEDGE-PIKE. The birds of the tall weeds-broomsedge and the broomsedge-pine stages can be considered together. In both, the Field Sparrow was number one, the Junco number two, and the Savannah and the Song Sparrows number three. Exactly the same condition occurred in the crab grass-tall weeds stage. The Song and the Savannah Sparrows were of about the same frequency as the Field Sparrow and the Junco, but occurred in much smaller numbers. The Song Sparrow occurred in large numbers in plot 5.1, which was dominantly tall weeds and cut by a narrow ditch. It was noticed throughout that the Song Sparrow preferred moist places. Along the marshy edges of Lake Raleigh, Song Sparrows were as common as Swamp Sparrows. Field Sparrows and Juncos usually occurred in flocks, in the ratio of about two to one, respectively.

The number of species in the three stages were seven, nine, and eight, respectively. All but the four species discussed were in the number five position.

Since all the plots of each stage are considered together, some of the finer differences can be discerned only by referring to the separate census as. Plots 6.1 and

6.2 were almost pure broomsedge; the amount of tall weeds and pine was low. In these plots nothing but a few Savannah Sparrows (and two bluebirds, in a tree) were recorded. In the field, it was noticed that no birds occurred in pure broomsedge, except Savannah Sparrows when there were some bare spots. The occurrence of the other Sparrows seemed to be regulated by the presence of tall weeds mixed evenly through the broomsedge. Scattered young pines up to fifteen and twenty feet had no noticeable influence on the bird life.

PINE, and DECIDUOUS WOODS. Most of the species in pine woods occurred in loosely knit flocks. This stage had the largest number of species. The deciduous woods had but three less (22), but was much less rich in individuals. Most of the birds in the pine stage stayed either on the bark or among the needles. There were almost no differences from plot to plot. The list of birds is too long to discuss each one individually. The table shows a perfect correlation between abundance and frequency.

Only a few species are abundant or of high frequence. Most of them are of medium to low frequence and uncommon to rare. The same condition is found in all stages. Linsdale (1928, 1936) found this to be true in his studies on frequency of occurrence.

In the deciduous woods, no bird was abundant enough to be placed in the number one position. There was one number two.

The pine and the deciduous woods were quite similar in

their species make-up. Two species occurred in the deciduous that were not recorded in any other stage. Five species were found only in the pine woods. Of the twenty remaining species in each stage, eighteen were the same.

CONCLUSIONS

The preliminary nature of this investigation does not allow many conclusions. Judging on the basis of the results obtained, there appears to be a distinct succession of bird species through the stages of the plant succession. Also, it appears that the birds found in each stage form a more or less graded series from those which are abundant to those which are rare. However, until such factors as size and shape of the plots, density and composition of the vegetation, available food and cover, surroundings, weather, and probably many other factors, have been properly evaluated, it can not be known to what extent the results herein obtained are valid.

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