BREEDING BIRD POPULATIONS IN RELATION TO GRASSLAND SUCCESSION ON THE ANOKA SAND PLAIN

by

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Introduction

Biotic communities are best described by correlating the dominant animal species with the typical vegetation form (Kendeigh, 1948). Birds tend to be highly specific in regard to territory selection in preparation for the breeding season (Johnson and Odum, 1956). Because fairly adequate census methods have been worked out for bird population studies, this group offers unique possibilities when one seeks to describe a biocie. The literature reveals no intensive study of grassland communities in this respect. In contrast, the breeding bird population of many forest associes have been studied in detail.

This is a preliminary study of a grassland biocie. It was undertaken also to determine the practicality of utilizing fields at different stages of ecological succession on the Anoka Sand Plain for the study of successional and radiant energy requirements of grassland sparrows native to this region.

The project was carried out at the University of Minnesota Cedar Creek Natural History Area which is located on the Anoka Sand Plain, Anoka County, Minnesota. Information was obtained concerning the history of the grassland fields which were studied, and the dominant plant species and their relative abundance on each study area. Some information was obtained as to the variation in amount on each study tract of the measurable portion of the solar radiation.

The writer is indebted to the Committee for the Use of the Cedar Creek Natural History Area for permission to engage in this study, to Dr. Dwain Warner for suggestions concerning the problem and to Mr. Alvar Peterson for aid in locating suitable tracts for the study on the research area.

The Anoka Sand Plain

The grassland study plots were all located on the Anoka Sand Plain within the confines of the Cedar Creek Natural History Area. Following recession of the last ice sheet, the Mississippi River migrated southwest toward its old river bed, laying down a great expanse of outwash sand as it moved. The area was named the Anoka Sand Plain by Cooper (1935). In general the area is flat but there are some basins which form bogs, ponds, and lakes. The present study tracts were located on a portion of the flat upland area.

Methods

Five tracts at different stages of ecological succession were studied intensively. These ranged in size from ten to twenty-eight acres. The original plan had been to study fields which had been out of cultivation respectively for one, two, three, four, five, ten, fifteen and twenty years. The two-year and the four-year areas were dropped from the study when it became apparent on initial inspection of the fields that they did not differ significantly from some of the other fields included in the study. There were, for instance, no recognizable differences in successional advancement between the two and three-year fields or between the four and five-year fields. Rather, greater differences in development were noted within different areas of any one field than between certain fields. An eighteen-year field had to be substituted for the twenty-year tract because the latter was not available.

The five tracts studied had been out of cultivation for one, three, five, ten and eighteen years. The first of these was intermediate between bare ground and grassland, having been cultivated in corn the preceding year. Three tracts represented more ad-
vanced stages of grassland succession and the oldest one represented very early savannah development.

Each area was laid out in a grid with the markers fifty yards apart. The area was then mapped so that maps might be carried in the field. The census method employed was similar to that described by Williams (1936) and Kendeigh (1944). All data obtained through observation of birds, territorial fighting, nest building, feeding and records of singing males were recorded on the prepared maps.

The reliability of this census method is based on the thesis that most of the birds being studied maintain a type A territory as described by Nice (1941). Birds holding this type of territory are thus restricted in area during the breeding season (Johnson and Odum, 1956). There are definite limitations to counts carried out in this manner though it seems to be the most satisfactory way yet devised to study this type of territorialism. These limitations are described by Breckenridge (1950) and include the possibility of including singing non-breeding males, shifts in territories, weather conditions which influence the amount of singing and the difficulty of delimiting territories which are crowded closely together. Because of the open nature of the areas studied in this project and the sparse population of breeding birds, some of the above limitations don't apply to a grassland study as much as they do to a forest study.

Odum (1950) showed that in censusing areas ten acres or less in size, one tended to miss some of the less common species and also to get a count slightly higher than actually exists. His decision was that population figures obtained for areas ten acres or less in size should be reduced by ten per cent. This correction factor has been applied in this paper where appropriate.

Determination of territories was based on a minimum of seven early morning visits and at least one late afternoon check. These visits were made from June 15 to July 13 with most of them concentrated in the first three weeks of that period. This represented a necessarily late start but seemed to include the peak of the nesting season. At the start of the study first broods were still in the nest. This was indicative of a late spring season.

The density figures represent the actual number of occupied territories to the nearest whole number as described in the method Odum (1956) used. This means that it represents the number of pairs of birds per 100 acres assuming that each pair of birds breeds and maintains a territory. When a territory was partially outside the study area, the appropriate fraction of it which lay within the study area was included in the density figures. Species of birds which have very large territories are included as they were observed but no attempt was made to estimate the size of these territories. Birds regarded as visitors to the area are not included.

The figures in Table I for the relative abundance of flowering plants are based on the average counts along three fifty yard grid lines. A line was run from one grid marker to another six inches above the ground and all the flowering plants which touched it were counted. When a species occurred on so few transects as to average less than one, its presence is simply indicated by a “+”. These transects were run the last week in June and the first week in July. Thus this does not represent a complete botanical description of the area but only a listing of the more common plants. Botanical nomenclature is taken from Fernald (1950) and Harlow (1957).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berteroa incana</td>
<td>38</td>
</tr>
<tr>
<td>Ambrosia artemisiifolia</td>
<td>23</td>
</tr>
<tr>
<td>Convolvulus sepium</td>
<td>15</td>
</tr>
<tr>
<td>Epilobium angustifolium</td>
<td>11</td>
</tr>
<tr>
<td>Erigeron annuus</td>
<td>3</td>
</tr>
<tr>
<td>Lycnias alba</td>
<td>2</td>
</tr>
<tr>
<td>Chenopodium album</td>
<td>2</td>
</tr>
<tr>
<td>Asclepias syriaca</td>
<td>1</td>
</tr>
<tr>
<td>Lepidium sp.</td>
<td>27</td>
</tr>
<tr>
<td>Melilotus alba</td>
<td>1</td>
</tr>
<tr>
<td>Rosa sufflita</td>
<td>1</td>
</tr>
</tbody>
</table>

DECEMBER, 1961
Light energy readings were taken using a Weston photometer made available through the courtesy of Dr. Roger Bray. Initial (control) readings were made at one and a half meters above the ground with the photo cell directed upwards. A reading was then made at grass-roots level in the same manner at five successive grid markers. These figures were averaged. The light at ground level in the least densely and the most densely appearing vegetation stands was also measured. In all cases the percentage difference between the total light and that which fell on the photo cell placed on the ground was computed.

**Description of Study Areas**

**One year field.** This field, which was one of the two smallest ones studied, was bordered on one side by a savannah-type upland oak woods. It had been planted in corn the preceding year. The rows of corn were still standing and there was much bare ground between the rows. See Figure 1. Quack-grass (*Agropyron repens*) was the dominant in this field. There were, on the average, six plants per square foot between rows, but the vegetation was more dense in the rows. Hoary alyssum (*Berteroa incana*) was the most common flowering plant. The relative abundance of the flowering plants is shown in Table I. This field was fairly level though it sloped toward a lower area on the east side. Pocket gopher (*Geo mys bursarius*) holes and diggings abounded.

**Three year field.** This field was fifteen acres in size, and was bordered on the north and west by a narrow strip of successional more advanced grassland and beyond by oak upland forest. On the southwest it was bounded by oak upland forest. On the southwest it was bounded directly by a marshy area. On the east there was an old fire lane beyond which lay a field that had been out of cultivation about eight years. Both of these fields had last been planted in soy beans. The dominant here again was quackgrass. Junegrass (*Poa pratensis*) was invading the field from the east. A few low shrubby roses (*Rosa suffulta*) were present. The most common additions to the quack-grass were ragweed (*Ambrosia artemisifolia*) and peppergrass (*Lepidium sp.*). Pocket gopher diggings were very numerous. This field was highest in the center and sloped in all directions very gently.

**Five year field.** This field which was about twenty-seven acres was bounded partially on the west by more open fields beyond which lay upland forest and also by a marshy area along the southwest corner. Beyond the field to the south lay open (but more mature) field. To the southeast lay a swampy area. Along the northern portion of the east line there was more open field. A narrow fire road bounded it on the north. This field was last planted in soy beans. Quack-grass was still the dominant plant and about three times more abundant than the Junegrass. There was one large patch of hairgrass (*Agrostis scabra*). The most common flowering plant was the peppergrass. The northwest corner of the field sloped and there were small sparsely
covered hills in this area. The rest of the field was quite level. Pocket gopher diggings were present but they were much less numerous than in the younger plots. See Figure 2.

Ten year field. This field was nineteen acres in extent and had last been sown to clover. Junegrass was the dominant in this stage of succession. It formed a fairly solid sod. Quackgrass was still present, however, but was relatively sparse in distribution. Purple vetch (Vicia cracca), stiff goldenrod (Solidago rigida), evening primrose (Oenothera biennis) and daisy fleabane (Erigeron alba) were the most common flowering plants. The field was peculiarly shaped, approximating a "u". The southwest portion of the north arm of the "u" sloped to lower ground. It was completely surrounded except on the eastern portion of the north side by oak upland forest. It was being invaded along the edges by white pine (Pinus strobus), white oak (Quercus alba) and especially by sumac (Rhus glabra). Johnston and Odum (1956) pointed out that grassland surrounded by forest edges rich in birds and fruit-bearing plants is more quickly invaded by shrubs than are other grassland areas. Because of the better developed turf, very few pocket gopher holes were found. Where the forest extends between the two arms of the "u" there is a little-used summer cabin, garden and introduced plants.

Eighteen year field. The surveyed portion of this field was twenty-eight acres. The southern half had last been planted in alfalfa while the northern half had been sown in corn. Junegrass was the dominant grass. Most common among the flowering plants were daisy fleabane, rigid goldenrod and white clover (Melilotus albus). Though the field sloped rather abruptly at the east end towards a swampy area and was a bit hilly in the southeast portion, most of the field was fairly level. All around the field there was a rather narrow band of land which had been out of cultivation longer. This, in turn, was bounded by oak upland forest except as mentioned above on the east end. There was a thick sod and practically no evidence of pocket gophers except on some of the drier hills which had a less well-developed turf. At the west end of the field were some large-toothed aspen (Populus grandidentata). In addition to these young trees, there were green ash (Fraxinus pennsylvanica), northern pin oak (Quercus ellipsoidalis), willow (Salix, sp.), choke-cherry (Prunus virginiana) and some sumac. The field presents the appearance of a very early developing savannah. See Figure 3.

Results

Comparing the descriptions of the five different areas, one notes that ecological plant succession had not been
very rapid. Invasion of these areas by birds has been even slower. Only two birds were found to breed on any of the research tracts. Only one of these was a grassland sparrow, the Vesper Sparrow (Poecetes gramineus). It was the only breeding species on three of the study areas (see Table II), and it also nested on the other two tracts. It reached its highest concentration on the ten year field. Only in the eighteen year field was the Chipping Sparrow (Spizella passerina) more numerous. Not only did no other grassland sparrows nest on the areas, but no other species were seen on these areas.

Table II
Breeding Bird Population on Five Study Areas
(Pairs per Hundred Acres)

<table>
<thead>
<tr>
<th>Bird</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 3 5 10 18</td>
</tr>
<tr>
<td>Vesper Sparrow</td>
<td>yr. yr. yr. yr. yr.</td>
</tr>
<tr>
<td>(Poecetes gramineus)</td>
<td>18 18 24 27 14</td>
</tr>
<tr>
<td>Chipping Sparrow</td>
<td>00 00 00 21 24</td>
</tr>
<tr>
<td>(Spizella passerina)</td>
<td></td>
</tr>
</tbody>
</table>

The Chipping Sparrow nested on both the ten year and the eighteen year field. This bird is classified by some as an edge species, but using Odum's definition for an edge species, it does not fit that category in these circumstances. The Chipping Sparrow's invasion of the grassland occurs with the advent of shrubs and small trees.

Both of these birds are well adjusted to a grassland type vegetation. The Vesper Sparrows built their nests in hummocks of dry grass in hollows on the ground. The south side of each nest was built higher in each case providing a partial cover. This protected the incubating birds and the eggs from the direct sunlight. The males sang from stalks of vegetation or in several cases from the tops of the grid markers after they were put up. They selected these particularly in the one, three and five year fields where there weren't good natural song posts.

The Chipping Sparrows built their nests low in shrubs. The nests were placed in the fork of the branch by the main stem. The males selected song posts in nearby shrubs.

Table III shows the species which are considered to be edge species. The term edge species is used here as defined by Odum except that it is not limited to a forest-grassland edge. Included also is the marsh-grassland edge. A bird characteristic of the latter type of edge would be the Red-winged Blackbird (Agelaius phoeniceus). This species utilized the grassland adjacent to the marsh for feeding and nesting. Breeding populations of the edge species were not determined because none of them actually nested on any of the areas.

The following birds which have very large territories also used the area: Blue Jay (Cyanocitta cristata) Mourning Dove (Zenaida macroura), Red-tailed Hawk (Buteo jamaicensis) and Marsh Hawk (Circus cyaneus hudsonius). No effort was made to study the size of these territories.

Table III
Edge Species Found on the Five Study Areas

<table>
<thead>
<tr>
<th>Bird</th>
<th>1 3 5 10 18</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yr. yr. yr. yr. yr.</td>
</tr>
<tr>
<td>Baltimore Oriole</td>
<td>X</td>
</tr>
<tr>
<td>(Icterus galbula)</td>
<td></td>
</tr>
<tr>
<td>Cedar Waxwing</td>
<td>X</td>
</tr>
<tr>
<td>(Bombycilla cedrorum)</td>
<td></td>
</tr>
<tr>
<td>Song Sparrow</td>
<td>X X X X</td>
</tr>
<tr>
<td>(Melospiza melodia)</td>
<td></td>
</tr>
<tr>
<td>Eastern Kingbird</td>
<td>X</td>
</tr>
<tr>
<td>(Tyrannus tyrannus)</td>
<td></td>
</tr>
<tr>
<td>Downy Woodpecker</td>
<td>X X X</td>
</tr>
<tr>
<td>(Dendrocopos pubescens)</td>
<td>X X</td>
</tr>
<tr>
<td>Eastern Phoebe</td>
<td>X X X X</td>
</tr>
<tr>
<td>(Saxornis phoebe)</td>
<td></td>
</tr>
<tr>
<td>Warbling Vireo</td>
<td>X X</td>
</tr>
<tr>
<td>(Vireo gilvus gilvus)</td>
<td></td>
</tr>
<tr>
<td>Redwinged Blackbird</td>
<td>X X</td>
</tr>
<tr>
<td>(Agelaius phoeniceus)</td>
<td></td>
</tr>
<tr>
<td>Yellowthroat</td>
<td>X X</td>
</tr>
<tr>
<td>(Geothlypis trichas)</td>
<td></td>
</tr>
<tr>
<td>Indigo Bunting</td>
<td>X X</td>
</tr>
<tr>
<td>(Passerina cyanea)</td>
<td></td>
</tr>
<tr>
<td>Black-capped Chickadee</td>
<td>X X</td>
</tr>
<tr>
<td>(Parus atricapillus)</td>
<td></td>
</tr>
<tr>
<td>Catbird</td>
<td>X</td>
</tr>
<tr>
<td>(Dumetella carolinensis)</td>
<td></td>
</tr>
<tr>
<td>Scarlet Tanager</td>
<td>X</td>
</tr>
<tr>
<td>(Firensia olivacea)</td>
<td></td>
</tr>
</tbody>
</table>

Table IV shows the variation in available light on all five tracts. The figures are given as percents of the total light at breast height at the same time and place. Though there is a gradual decrease in the percentage of available radiation from the one year field to the eighteen year field, there was a greater variation in
available light within any one field. Actual readings in foot candles ranged between 2,000 to 11,700.

<table>
<thead>
<tr>
<th>Percentage of Solar Radiation</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 yr.</td>
<td>1</td>
</tr>
<tr>
<td>3 yr.</td>
<td>3</td>
</tr>
<tr>
<td>5 yr.</td>
<td>5</td>
</tr>
<tr>
<td>10 yr.</td>
<td>10</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>1 1/2 M above ground</td>
<td>100</td>
</tr>
<tr>
<td>At vegetation roots</td>
<td>98</td>
</tr>
<tr>
<td>36*</td>
<td>51</td>
</tr>
<tr>
<td>Barest Area</td>
<td>100</td>
</tr>
<tr>
<td>82</td>
<td>90</td>
</tr>
<tr>
<td>Densest Area</td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

* Between corn rows
** In corn rows

Light meter readings were also made at the sparrow nests which were located. With the photo cell placed within the nest, the range in readings (in foot candles) for Vesper Sparrow nests was from 2,000 to 3,000. All of these nests were constructed on the ground with the open side facing north so that the nest was protected from the sun. Readings in Chipping Sparrow nests ranged from 2,000 to 2,500 foot candles. These nests were placed low in small shrubs. One Indigo Bunting nest was found and the light intensity in it was 1,200.

**Discussion**

Comparing Odum’s description of a twenty year field with the eighteen year field studied in this paper, it seems that ecological succession progresses at a slower rate on the Anoka Sand Plain than in the region described in Georgia. One reason for this might be difference in length of growing season. Another indication of this is shown by the low breeding population of the former area as well as the lack of variety among the birds which did breed. Kendeigh (1941) studied the birds on a section of prairie near the center of the true prairie association. Parts of it had never been plowed but it had been pastured up to twelve years before the study. There were four species breeding on the study area and 104 birds per one hundred acres. Johnston and Odum (1956) reported seven species breeding on the fifteen year field and nine species breeding on the twenty year field. There were 105 pairs of nesting birds per one hundred acres on the former area and 127 pairs of breeding birds per one hundred acres on the former area and 127 pairs of breeding birds per one hundred acres on the latter area. Compared with this, only two species nested on both the fifteen year and the eighteen year tracts in Minnesota and the population density was only the equivalent of forty-eight pairs of breeding birds per hundred acres on both of these areas.

Referring to Kendeigh’s term biocies which he introduced (1948) to distinguish biotic communities, these areas would best be described as a Poecetes-Spizella Grassland Biocies. Though this term has been interpreted by some (Phillips 1959) as being indicative of the Clementsian monoclimax theory rather than the polyclimax theory of succession, it does seem to provide a unique way for describing a biotic community.

One would expect the population density to be less than in a forest habitat (Kendeigh 1958), and it is less than in the surrounding oak upland forest (Mitchell, 1960). The dry nature of these upland fields would not be conducive to heavy concentrations of birds (Johnston and Odum 1956). In a survey by Kendeigh (1948) of a poor grassland area, he reported fifty-six pairs of nesting birds per hundred acres. There were eight species included in this group. One reason for the difference in population density figures in Kendeigh’s report and in the current one may be due to the size of his study area. It comprised one hundred acres. Thus it would be probable that he would pick up some less common species. Six of the eight species were listed as one pair per hundred acres. Another reason which might be postulated for the lower population densities on areas in the current study is the ready availability of much larger grassland tracts in the surrounding countryside off the Cedar Creek Natural History Area. It might be that population pressure is not great enough to force the use of these small isolated fields. In this study, the larg-
est field available for each successional stage was chosen.

Table III shows that many of the edge species will use more than one successional stage of grassland. The first criterion for determining the edge species for a particular grassland tract is the type of edge which surrounds the field, i.e., marsh, forest, etc. Second, vegetation type appears to be more important to some birds than species composition of the type community. The Song Sparrow is found on four of the five successional areas. In contrast to this species, there were species like the Indigo Bunting and Catbird (Dumetella carolinensis) which were found utilizing only the later successional stages of grassland.

Table IV showed that while there was a gradual decrease in the average amount of available light as one advanced from one successional stage to another, there was still more variation in available light within any one field. This may help to explain how the Vesper Sparrow can nest successfully on all five areas. Light meter readings at all the Vesper Sparrow nests regardless of the tract on which they were situated ranged between 2,000 and 3,000 foot candles. Readings at Chipping Sparrow nests ranged between 2,000 and 2,500. The light intensity at the one Indigo Bunting nest was still lower. From the limited information that was gathered concerning available light in relation to selection of nest site and techniques of nest construction, it seems as if it would be profitable to continue studying the light requirements of nesting birds in an effort to determine if such a factor is important in selection of nesting sites.

References


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