# FREQUENCY OF OCCURRENCE OF SUMMER BIRDS AT THE UNIVERSITY OF MICHIGAN BIOLOGICAL STATION [1]

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THE need of an accurate and uniform method of expressing the results of bird population studies has long been recognized. Quantities of data already available are of little value because of the inexactness and variation of method used by field investigators.

In making a study of the bird population in the vicinity of the University of Michigan Biological Station during the summer of 1941, I applied Raunkaier's Law of Frequence. This method of study is an adaptation of a system used by botanists in analyzing populations of plants.

Raunkaier, a Danish botanist, based his law on eleven different botanical investigations carried on by himself and others in Europe. Kenoyer (1927) states the law as follows: The percentage of frequence of a given species is the percentage ratio which the plots on which the species occurs bears to the whole number of plots taken. Kenoyer also explains its application as follows: using at least 25 plots, the number of species on each plot is counted. Then to determine frequence of the species on 25 plots, the number of plots on which any one species is found is divided by 25. If a species is found on each plot, the frequence is 25 divided by 25, or 100 per cent; if it is found on 5 plots, the frequence is 5 divided by 25, or 20 per cent. In making a number of such surveys, it was usually found that there were larger numbers of species of low frequence than of higher frequences. As one proceeds to the greater frequences, the number declines steadily until the highest (or next highest) frequence is reached, at which point it increases slightly. To express this in a formula, Raunkaier let A, B, C, D, and E represent frequences from 1–20 per cent, 21–40 per cent, 41–60 per cent, 61–80 per cent, and 81–100 per cent respectively. The distribution of the frequences could then be expressed:

$$A > B > C \gtrless D < E$$

Kenoyer was the first to suggest the use of Raunkaier's Law in making animal population studies, while Linsdale (1928, 1932, 1936; Linsdale and Rodgers, 1937) was the first to apply the law to bird life.

Linsdale (1932) points out several advantages in the use of Raunkaier's Law in studying bird populations:

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[1] Contribution from the University of Michigan Biological Station.

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1. It gives a more nearly correct impression of the relative abundance of birds than any other method.
2. It makes it possible to analyze the composition of the bird population.
3. It makes it possible to compare the population of one locality with that of other localities and regions.
4. Over a period of time birds are likely to be observed on a certain area on the number of occasions which parallels their abundance.

Linsdale (1932) also points out several factors which decrease the reliableness of this method:

1. Nocturnal birds will be slighted, as will be small birds of retiring habits.
2. The numbers of birds observed will be affected by weather conditions.
3. Daily variations in the route and distribution of attention of the observer will also affect the birds recorded.

## The 1941 Study at Douglas Lake

The University of Michigan Biological Station is located on South Fishtail Bay at the south end of Douglas Lake in Cheboygan County, Michigan. Douglas Lake lies about midway between Lake Michigan and Lake Huron and about thirty miles below the northern end of the Lower Peninsula. The territory covered by this study included four routes:

Route 1. The shore of the lake from the Station area to North Fishtail Bay (2½ miles).
Route 2. The woodland lying northeast from the Station to North Fishtail Bay (2 miles).
Route 3. State Street, the main street of the Station which is lined on either side by student and faculty cabins (½ mile).
Route 4. The hill immediately south of the Station (1½ miles).

The shore is barren of vegetation throughout most of the territory covered. It is bordered with white pines (*Pinus Strobus*) intermingled with a few aspens (*Populus grandidentata* and *P. tremuloides*) and red pines (*Pinus resinosa*). The woodland consists mainly of an aspen-birch association which gradually changes to an association of conifers as one progresses northward from the Station. The trees found there are aspens, red maple (*Acer rubrum*), white birch (*Betula alba* var. *papyrifera*). beech (*Fagus grandifolia*), white and red pine, red oak (*Quercus borealis*), and wild cherry (*Prunus* sp.). Also present are such shrubs as sumac (*Rhus typhina*), service berry (*Amelanchier canadensis*), and alder (*Alnus incana*). The conifer area consists mainly of white cedar (*Thuja occidentalis*), and balsam (*Abies balsamea*). The trees found around the camp and laboratories of the Station consist mainly of red

TABLE 1

FREQUENCY OF SPECIES OCCURRENCE AND NUMBERS OF INDIVIDUALS OBSERVED

| The 80 species recorded | Number of days seen | Per cent of frequency | Total individuals | Rank in numbers | Rank in frequency |
|---|---|---|---|---|---|
| Black-capped Chickadee | 30 | 100 | 666 | 2 | A |
| Cedar Waxwing | 30 | 100 | 567 | 3 | A |
| Robin | 30 | 100 | 512 | 4 | A |
| Kingbird | 30 | 100 | 399 | 7 | A |
| Red-eyed Vireo | 30 | 100 | 282 | 8 | A |
| Spotted Sandpiper | 30 | 100 | 264 | 10 | A |
| Wood Pewee | 29 | 96.7 | 124 | 12 | A |
| Purple Martin | 28 | 93.3 | 1271 | 1 | A |
| Ring-billed Gull | 27 | 90 | 477 | 5 | A |
| Chipping Sparrow | 27 | 90 | 212 | 11 | A |
| Least Flycatcher | 25 | 83.3 | 117 | 14 | C |
| Black and White Warbler | 25 | 83.3 | 87 | 18 | C |
| Herring Gull | 25 | 83.3 | 74 | 21 | C |
| Blue Jay | 24 | 80 | 276 | 9 | C |
| Flicker | 24 | 80 | 124 | 12 | C |
| Oven-bird | 24 | 80 | 109 | 15 | C |
| Song Sparrow | 23 | 76.7 | 77 | 19 | C |
| Purple Finch | 23 | 76.7 | 71 | 23 | C |
| Caspian Tern | 23 | 76.7 | 66 | 25 | C |
| Baltimore Oriole | 22 | 73.3 | 121 | 13 | C |
| Nighthawk | 22 | 73.3 | 103 | 16 | C |
| Rose-breasted Grosbeak | 21 | 70 | 75 | 20 | C |
| Redstart | 21 | 70 | 46 | 28 | C |
| Goldfinch | 20 | 66.7 | 70 | 24 | C |
| Cowbird | 20 | 66.7 | 53 | 26 | C |
| Hairy Woodpecker | 17 | 56.7 | 39 | 30 | M |
| Mourning Dove | 17 | 56.7 | 36 | 32 | M |
| Bank Swallow | 16 | 53.3 | 433 | 6 | M |
| Downy Woodpecker | 16 | 53.3 | 37 | 31 | M |
| Common Tern | 15 | 50 | 71 | 23 | M |
| Brown Thrasher | 15 | 50 | 49 | 27 | M |
| Red-eyed Towhee | 15 | 50 | 44 | 29 | M |
| Crested Flycatcher | 15 | 50 | 39 | 30 | M |
| Black-billed Cuckoo | 15 | 50 | 24 | 35 | M |
| White-breasted Nuthatch | 15 | 50 | 21 | 37 | M |
| Ruffed Grouse | 11 | 36.7 | 73 | 22 | M |
| Crow | 11 | 36.7 | 24 | 35 | M |

| | | | | | |
|---|---|---|---|---|---|
| Scarlet Tanager | 11 | 36.7 | 20 | 38 | M |
| Black-throated Green Warbler | 11 | 36.7 | 19 | 39 | M |
| Kingfisher | 11 | 36.7 | 15 | 42 | M |
| Killdeer | 10 | 33.3 | 92 | 17 | M |
| Rough-winged Swallow | 9 | 30 | 27 | 34 | U |
| Hermit Thrush | 9 | 30 | 15 | 42 | U |
| Vesper Sparrow | 8 | 26.7 | 16 | 41 | U |
| Yellow-billed Cuckoo | 7 | 23.3 | 13 | 44 | U |
| Phoebe | 7 | 23.3 | 8 | 47 | U |
| Northern Yellow-throat | 6 | 20 | 9 | 46 | U |
| Canada Warbler | 6 | 20 | 9 | 46 | U |
| Great Blue Heron | 5 | 16.7 | 10 | 45 | U |
| Catbird | 5 | 16.7 | 5 | 49 | U |
| American Merganser | 4 | 13.3 | 34 | 33 | U |
| Barn Swallow | 4 | 13.3 | 23 | 36 | U |
| Black Duck | 4 | 13.3 | 14 | 43 | U |
| Wood Thrush | 4 | 13.3 | 8 | 47 | U |
| Goshawk | 4 | 13.3 | 6 | 48 | U |
| Bald Eagle | 4 | 13.3 | 4 | 50 | U |
| Red-wing | 3 | 10 | 18 | 40 | U |
| Common Loon | 3 | 10 | 4 | 50 | U |
| Chestnut-sided Warbler | 3 | 10 | 4 | 50 | U |
| Least Sandpiper | 3 | 10 | 3 | 51 | U |
| Nashville Warbler | 3 | 10 | 3 | 51 | U |
| Blackburnian Warbler | 3 | 10 | 3 | 51 | U |
| Blue-winged Teal | 2 | 6.7 | 13 | 44 | R |
| Red-breasted Nuthatch | 2 | 6.7 | 3 | 51 | R |
| Sharp-shinned Hawk | 2 | 6.7 | 2 | 52 | R |
| Tree Swallow | 2 | 6.7 | 2 | 52 | R |
| Winter Wren | 2 | 6.7 | 2 | 52 | R |
| Solitary Sandpiper | 1 | 3.3 | 2 | 52 | R |
| Whip-poor-will | 1 | 3.3 | 2 | 52 | R |
| Slate-colored Junco | 1 | 3.3 | 2 | 52 | R |
| Red-breasted Merganser | 1 | 3.3 | 1 | 53 | R |
| Greater Yellow-legs | 1 | 3.3 | 1 | 53 | R |
| Ruby-throated Hummingbird | 1 | 3.3 | 1 | 53 | R |
| House Wren | 1 | 3.3 | 1 | 53 | R |
| Veery | 1 | 3.3 | 1 | 53 | R |
| Parula Warbler | 1 | 3.3 | 1 | 53 | R |
| Yellow Warbler | 1 | 3.3 | 1 | 53 | R |
| Myrtle Warbler | 1 | 3.3 | 1 | 53 | R |
| Field Sparrow | 1 | 3.3 | 1 | 53 | R |
| White-throated Sparrow | 1 | 3.3 | 1 | 53 | R |

The bird names used in this table are taken from the A.O.U. Check-list of 1931.

oak, red maple, pin cherry (*Prunus pennsylvanica*), and birch; numerous sumac bushes are also found around the cabins. Grasses, clover, blueberries, and bracken (*Pteris aquilina*) form the main ground cover.

In order to divide the early mornings among the four routes I arranged a four-day schedule of walks. Four walks were made each day beginning on the following hours: 5:00 A.M.; 7:30 A.M.; 2:00 P.M.; 4:30 P.M. The routes covered were rotated each day so that in a period of four days, each route was traversed at a different time of day.* The weather conditions each day were noted and recorded.

Thus the material serving as a basis for this analysis consists of 120 lists of species; 30 lists for each of four different habitats visited each day for a total of 30 days between July 2 and August 14, 1941. The birds heard as well as those seen were recorded in each case. The per cent of frequence for each species was derived by dividing the number of days on which the species was observed by the total number of days, namely, 30. A separate list of frequences for each of the four habitats was made in addition to a composite list for the entire area. The total numbers of each species were recorded and it was found that the species seen in largest numbers were generally those seen most frequently.

One study of bird frequences was made in the vicinity of the Biological Station by Linsdale (1936) during the summer of 1924. Linsdale based his percentages on 50 days' field work. His study area was much larger and less compact than mine. He included, for example, several trips to points on both Lake Huron and Lake Michigan. The results of our two studies cannot, therefore, be satisfactorily compared.

Table 2 shows the number of species found in each frequence-class and the ratio between the number of species in each class and the total of species both for the present study and for Linsdale's studies.

TABLE 2

| | Present study | | Linsdale's studies | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Michigan | | Kansas | | California | |
| | No. of species | Ratio | No. of species | Ratio | No. of Species | Ratio | No. of Species | Ratio |
| Class A | 34 | .43 | 62 | .59 | 133 | .68 | 111 | .73 |
| Class B | 11 | .14 | 16 | .15 | 32 | .16 | 20 | .13 |
| Class C | 10 | .12 | 11 | .10 | 13 | .07 | 7 | .05 |
| Class D | 12 | .15 | 10 | .09 | 6 | .03 | 5 | .03 |
| Class E | 13 | .16 | 5 | .05 | 10 | .05 | 8 | .05 |

It will be noted that there are more species of high frequences in the present study than in the previous studies by Linsdale. This is due

* The trip to North Fishtail Bay and back (Routes 1 and 2) covered a period of approximately five hours; the route along State Street (Route 3), forty-five minutes; and the hill (Route 4), one and one half hours.

to two factors: (1) Exactly the same territory was covered each day. This was not the case in the earlier studies. (2) The bird population was more stable and homogeneous due to the fact that the study extended only through the breeding season and few non-breeding birds were included.

Table 1 shows the species seen during the period of observation, listed in order of decreasing frequence; it shows the number of days on which the species was seen, the per cent of frequence, the total number of individuals of each species recorded, the rank in number (the species observed in greatest abundance ranks first and the one seen in least abundance ranks fifty-third), and gives a frequence rating according to the following scale:

| | | | | | |
|---|---|---|---|---|---|
| A (abundant) | 90 | to | 100 | per cent | frequence |
| C (common) | 65 | to | 89 | per cent | frequence |
| M (moderately common) | 31 | to | 64 | per cent | frequence |
| U (uncommon) | 10 | to | 30 | per cent | frequence |
| R (rare) | 1 | to | 9 | per cent | frequence |

The fact that the frequences agree very closely with the total numbers of individuals seen bears out Linsdale's statement (1932:225) that the numbers of individual birds of one species seen over a period of time will parallel the frequence of occurrence of that species. The chief exceptions in my study to this statement were the Purple Martin, the Bank Swallow, and the Herring Gull. The exceptionally high number of Martins and Bank Swallows was due to the presence at the Station of colonies of each. Both groups migrated before the end of the period of observation, thus preventing them from showing a frequence of 100 per cent. The number of Herring Gulls recorded was much less than the number of Ring-billed Gulls although the frequences are almost the same. The flocks of gulls that fed on the lake were made up largely of Ring-billed Gulls, but a few Herring Gulls were always present.

The use of Raunkaier's Law of Frequence is a highly accurate method for determining the frequence of birds in a region of the type surrounding the Biological Station. It involves simple calculations and is easily represented graphically. At the same time, it gives a precise picture of the bird life of a habitat which can readily be compared with that of another habitat (when another habitat is studied in the same way) or with the bird life of the same habitat studied in the same way at a different time.

## Literature Cited

Kenoyer, Leslie A.
1927 A study of Raunkaier's Law of Frequence. *Ecology*, 8, No. 3: 341–349.

LINSDALE, JEAN M.
1928 A method of showing relative frequency of occurrence of birds. *Condor,* 30: 180–184.
1932 Frequency of occurrence of birds in Yosemite Valley, California, based on records by Mr. and Mrs. Charles W. Michael. *Condor,* 34: 221–226.
1936 Frequency of occurrence of summer birds in northern Michigan. *Wilson Bulletin,* 48: 158–163.
LINSDALE, JEAN M. and THOMAS L. RODGERS
1937 Frequency of occurrence of birds in Alum Rock Park, Santa Clara County, California. *Condor,* 39: 108–11.

COLLINSVILLE, ILLINOIS

ORNITHOLOGISTS OF THE UNITED STATES ARMY MEDICAL CORPS. By Edgar Erskine Hume, Johns Hopkins Press, Baltimore, 1940: 7 x 10 in., xxv + 583 pp., frontisp. and 109 figs. $5.00.

The publication of a volume of biographies of ornithologists is a notable event, especially when the author has done a scholarly job and the publishers a fine piece of book making.

We are all familiar with the British army officers' great tradition of natural history investigation in the remote parts of the earth but few Americans have realized the important part that has been played by United States Army officers, particularly those of the Medical Corps. Col. Hume, formerly Librarian of the U.S. Army Medical Library, is well qualified to be the biographer of the Army Medical Corps ornithologists and obviously he has worked long and faithfully. He started to write a brief paper but it soon grew into a series of articles, the first of which was actually published in the *Bulletin of the History of Medicine* in 1940. Fortunately the Johns Hopkins Press then decided to publish the manuscript in this handsome and much more convenient book form.

The thirty-six biographies are arranged in alphabetical order and contain a vast amount of new information as well as much that was never before thus correlated. At the close of each chapter is a list of the principal sources. Included in most of the biographies are excerpts of the subject's published and unpublished writings. Certain of the quotations strongly confirm this reviewer's old suspicion that ornithologists are commonly very bad poets.

There is an interesting foreword by Alexander Wetmore who properly calls attention to the important part that Baird had in promoting and encouraging the work of many of these pioneer ornithologists.

Col. Hume modestly disclaims any knowledge of ornithology but his book contains much evidence to the contrary. Our confidence in the reliability of the book is partly the result of our almost complete failure to detect typographical slips or errors of any kind. The usefulness of the book is enhanced by an excellent index.—J. Van Tyne.