A METHOD OF SHOWING RELATIVE FREQUENCY OF OCCURRENCE OF BIRDS

WITH THREE GRAPHS

By JEAN M. LINSDALE

FIELD ORNITHOLOGISTS are probably unanimous in holding the opinion that it is desirable to express the results of their studies in a more exact form than has been done, generally, in the past. However, in spite of the general agreement that the results of field investigation should be so presented as to command analysis on a basis comparable with those of some other branches of science, ornithologists have, so far, made too little progress in this direction. The reasons for this apparent neglect of an opportunity to progress in field ornithology are obvious to all persons who have even a slight experience in the field study of birds. Even if it be granted that it is at present impracticable to attempt to reduce all field observations to a mathematical basis, it seems that some phases of the field study of birds could be, and should be, made more useful by more quantitative methods. It is particularly necessary that some attention be given to developing methods whereby the relative frequencies of occurrence of bird species in a given unit of habitat may be expressed in such a way as to be intelligible and at the same time comparable with the results of similar studies in other localities.

It is the purpose of the present paper to illustrate the application of a method for expressing the relative frequency of birds, which proved to be useful in analyzing the results of certain local surveys of birds. With slight modification this procedure

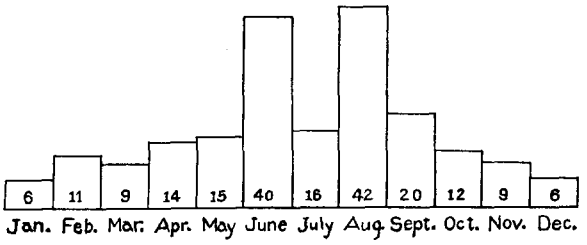

Fig. 69. CHART SHOWING DISTRIBUTION OF FIELD DAYS BY MONTHS.

might be adapted to clarify great masses of detailed information that have been gathered by many local observers. The use of the particular method described here resulted from an acquaintance with a somewhat similar method used by botanists in analyzing the frequency of occurrence of plants and which has given rise to a generalization commonly referred to as Raunkaier's law of frequence. The following quotation from Kenoyer (Ecology, VIII, 1927, p. 343) explains briefly the chief points of this law as it is applied in studies of vegetation.

"Raunkaier summarizing the conclusions obtained in eleven different pieces of work carried on in different sections of Europe by himself and others deduced what he calls the Law of Frequence. 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. On an ordinary Michigan lawn the percentage of frequence of blue grass would be 100; that of the dandelion, assuming that it is found in four out of

five sample plots, would be 80. In practically all such surveys the species of least frequence are by far the most numerous. Raunkaier points out that, as we proceed to the greater frequences, the number declines steadily, then, as the highest frequence is reached, increases slightly. In other words the curve expressing numbers of the different frequences has two peaks, a high one expressing the least frequence, and another, considerably lower, expressing the greatest frequence. If we group in five classes, which we designate as A, B, C, D, and E, the species of frequences of respectively 1-20 per cent, 21-40 per cent, 41-60 per cent, 61-80 per cent, and 81-100 per cent, then the law of distribution might be expressed $A > B > C = D < E$."

As a result of a consideration of several possible methods of presentation of the kinds of results considered here it was decided that whatever method was adopted should possess, at least, the following requirements:

1. It should involve simple calculations.
2. It should be a by-product of field work. It is in regard to this factor that, it seems to me, the present method has its chief advantage over any method which re-

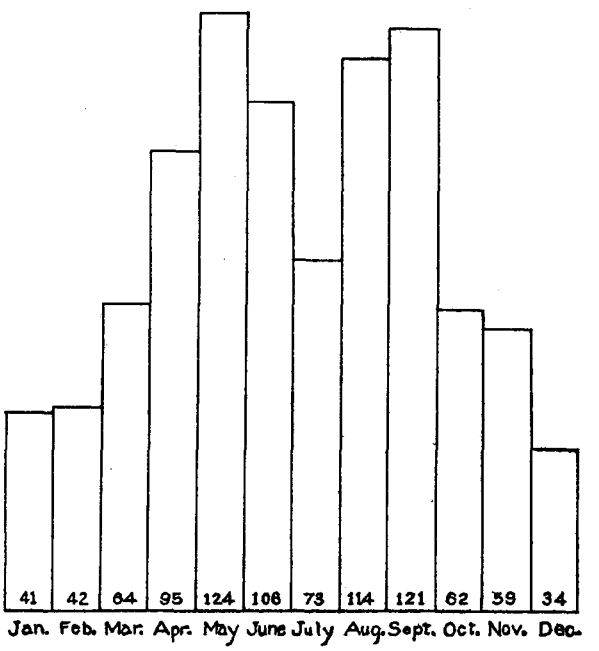

Fig. 70. CHART SHOWING NUMBER OF SPECIES PRESENT ON AREA EACH MONTH.

quires the counting of individual birds for the purpose of determining relative frequency. Usually it is desirable to spend every minute of available time in the field in making and recording life-history observations, so that it would seem to be a waste of time to give undivided attention to counting individuals of birds *if* the same result could be secured by some other method. It is unlikely that it is justifiable to devote full time in the field if the only result of such work would be the determination of the frequency of occurrence of the several species of birds.

3. Its expression should be concise and the results should be easily represented graphically so that the order of frequency of species in one locality, season or year could easily be compared with that in another locality, season or year.
4. It must give proper evaluation to the more frequent species.

As an illustration of the method herein considered in a particular problem in frequency of occurrence of birds it is desirable to enumerate the steps that were used in its application:

1. An area was chosen for study and definite boundary limits were decided upon. All the area was within one and one-half miles of the old townsite of Geary, Doniphan County, Kansas.
2. In addition to the usual field notes, records of the presence of birds were kept in a type of note book but slightly modified from that described by Chapman (Handbook of Birds of Eastern North America, 1920, p. 10).
3. Since this area included a variety of habitat, being made up of samples of nearly all the types of habitat to be encountered in the region, an effort was made to divide each day's time so that a portion could be spent in each type.
4. Two hundred full days of field work, not consecutive, but scattered over a period of nearly four years (1921-25), were occupied in making observations upon the

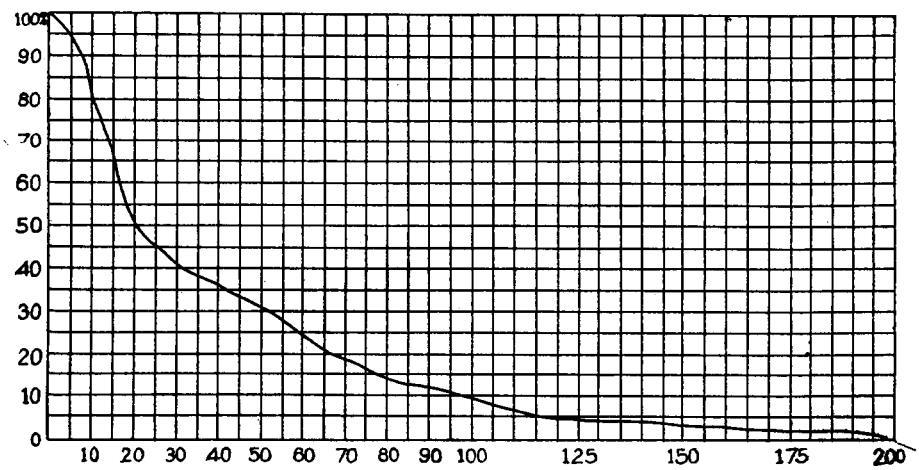

Fig. 71. GRAPH SHOWING RELATIVE FREQUENCY OF OCCURRENCE OF THE 194 SPECIES OF BIRDS THAT WERE RECORDED ON THE SURVEYED AREA.

birds of the area. The days for study were selected with a view to working more days in months when more species were present and fewer days in seasons when fewer species were to be encountered and when there was less activity. (Compare charts, figures 69 and 70.)

5. Records were kept of all species seen each day, the aim being to find all that were present each day.
6. The total number of days each species was observed in this area was divided by the total number of days (200) on which observations were made in the area. This gave a percentage of frequence for the species concerned. This figure differs from that used in botanical studies in that it is based on time units rather than on areal units (quadrats). Some such departure from the original procedure seems necessary because of the nature of the organisms involved. Birds being so highly motile, it seems more nearly representative of their frequence to use units of time rather than of space.

The 194 recorded species were arranged in a list, as here presented, with the most frequent first and the others following in order of their frequency of occurrence. Then, the percentages of frequence were plotted on a graph (fig. 71). This curve shows graphically and, I think, accurately the degrees of frequence of occurrence of the species concerned on the particular area worked and during the period of the study.

The 194 percentages of frequence are distributed in the five classes of the Raunkaier formula thus: 133,32,13,6,10 or approximately in the following percentages: 68,16,7,3,5. These results agree closely with those given by Kenoyer *(loc. cit.)* for analyses of frequency distribution in plant communities.

It seems evident that results such as those given, when accompanied by definite statements as to the area concerned and the time concerned, would form satisfactory means of comparison of the relative frequency of birds in one area with those in another or in the same area when so changed that different environmental conditions prevail. It must be kept in mind that factors such as differences in degree of development of sedentary habits in birds, disproportionate representation of types of habitat in the surveyed area, and uneven distribution of time spent in the field combine to make these results deviate from true conditions. However, these factors influence results of this nature that are derived by other methods to an even greater extent.

Funds for use in the field work upon which this paper is based were supplied by the Department of Zoology of the University of Kansas.

LIST OF SPECIES AS FOUND ON THE AREA SURVEYED IN EASTERN KANSAS, ARRANGED IN ORDER OF ABUNDANCE WITH PERCENT OF FREQUENCY FOR EACH

	Percent		Percent
1. Cardinal	100.	39. Tree Swallow	36.5
2. English Sparrow	99.5	40. Green Heron	35.5
3. Crow	98.5	41. Yellow-breasted Chat	34.
4. Chickadee	98.5	42. Field Sparrow	34.
5. Blue Jay	93.5	43. Rose-breasted Grosbeak	33.
6. Tufted Titmouse	90.	44. Red-tailed Hawk	32.
7. Carolina Wren	89.	45. Brown Thrasher	31.5
8. Downy Woodpecker	89.	46. Phoebe	31.
9. Mourning Dove	84.5	47. Orchard Oriole	30.5
10. Goldfinch	82.	48. Slate-colored Junco	30.
11. Robin	68.5	49. Purple Martin	30.
12. Red-headed Woodpecker	68.5	50. White-eyed Vireo	29.5
13. Indigo Bunting	65.5	51. Warbling Vireo	29.5
14. Red-bellied Woodpecker	65.	52. Kentucky Warbler	27.5
15. Red-winged Blackbird	63.	53. Song Sparrow	26.5
16. Yellow-billed Cuckoo	62.5	54. Belted Kingfisher	25.
17. Chimney Swift	59.	55. Mallard	23.5
18. Red-eyed Vireo	58.5	56. Screech Owl	23.
19. Baltimore Oriole	52.	57. Maryland Yellow-throat	23.
20. Western House Wren	49.5	58. Tree Sparrow	22.
21. Wood Thrush	48.	59. Towhee	21.5
22. Wood Pewee	47.5	60. Blue-winged Teal	21.5
23. Whip-poor-will	46.5	61. Least Tern	21.
24. Ruby-throated Hummingbird	45.5	62. Bronzed Grackle	19.5
25. Cowbird	45.	63. Redstart	19.
26. Bell Vireo	45.	64. Spotted Sandpiper	18.5
27. Kingbird	44.5	65. Yellow-legs	18.5
28. Bluebird	43.5	66. Yellow Warbler	18.
29. Blue-gray Gnatcatcher	40.5	67. Pectoral Sandpiper	18.
30. Hairy Woodpecker	39.5	68. Bob-white	17.5
31. Great Blue Heron	39.5	69. Bank Swallow	17.
32. Barn Swallow	38.	70. Northern Parula Warbler	17.
33. Northern Flicker	38.	71. Coot	16.5
34. Catbird	38.	72. Prothonotary Warbler	16.
35. Turkey Vulture	38.	73. Killdeer	16.
36. Crested Flycatcher	37.5	74. Cooper Hawk	15.5
37. Rough-winged Swallow	37.	75. Black Tern	15.
38. Dickcissel	36.5	76. Harris Sparrow	14.5

	Percent
77. Ruby-crowned Kinglet	13.5
78. Least Sandpiper	13.5
79. Red-shouldered Hawk	13.
80. Golden-crowned Kinglet	13.
81. Lincoln Sparrow	13.
82. Fox Sparrow	12.5
83. Cliff Swallow	12.5
84. Wood Duck	12.5
85. Black-and-white Warbler	12.
86. Marsh Hawk	12.
87. Pintail	12.
88. Wilson Warbler	11.5
89. Brown Creeper	11.
90. Shoveller	11.
91. White-breasted Nuthatch	10.
92. Purple Finch	9.5
93. Nashville Warbler	9.5
94. Summer Tanager	9.5
95. White-throated Sparrow	8.5
96. Least Flycatcher	8.5
97. Myrtle Warbler	8.5
98. Pine Siskin	8.5
99. Grinnell Water-thrush	8.5
100. Prairie Marsh Wren	8.
101. Mourning Warbler	8.
102. Herring Gull	8.
103. Solitary Sandpiper	8.
104. Swamp Sparrow	8.
105. Broad-winged Hawk	8.
106. Black-crowned Night Heron	7.5
107. Cedar Waxwing	7.
108. Nighthawk	7.
109. Semipalmated Plover	7.
110. Scarlet Tanager	6.5
111. Lesser Scaup Duck	6.5
112. Green-winged Teal	6.
113. Acadian Flycatcher	5.
114. Migrant Shrike	5.
115. White Pelican	5.
116. Pied-billed Grebe	5.
117. Wilson Snipe	5.
118. Meadowlark	4.5
119. Vesper Sparrow	4.5
120. Orange-crowned Warbler	4.5
121. Blue-headed Vireo	4.5
122. Alder Flycatcher	4.5
123. Semipalmated Sandpiper	4.
124. Sora	4.
125. Bittern	4.
126. Merganser	3.5
127. Tennessee Warbler	3.5
128. Ring-billed Gull	3.5
129. Canada Goose	3.
130. Red-breasted Nuthatch	3.
131. Ovenbird	3.
132. Black-billed Cuckoo	3.
133. White-rumped Sandpiper	3.
134. Yellow-throated Vireo	3.
135. Short-eared Owl	3.

	Percent
136. Olive-backed Thrush	2.5
137. Rusty Blackbird	2.5
138. Winter Wren	2.5
139. Black-bellied Plover	2.5
140. Franklin Gull	2.5
141. Prairie Horned Lark	2.
142. Grasshopper Sparrow	2.
143. Greater Yellow-legs	2.
144. Forster Tern	2.
145. Great Horned Owl	2.
146. Barred Owl	2.
147. Blue-winged Warbler	2.
148. Olive-sided Flycatcher	2.
149. Bald Eagle	2.
150. Canada Warbler	2.
151. Black Duck	1.5
152. Rough-legged Hawk	1.5
153. Gray-cheeked Thrush	1.5
154. Sparrow Hawk	1.5
155. Virginia Rail	1.5
156. Least Bittern	1.5
157. Leconte Sparrow	1.5
158. Wilson Phalarope	1.5
159. Baldpate	1.
160. Gadwall	1.
161. Yellow-headed Blackbird	1.
162. Little Blue Heron	1.
163. Chipping Sparrow	1.
164. Black-throated Green Warbler	1.
165. Cerulean Warbler	1.
166. Worm-eating Warbler	1.
167. Mockingbird	1.
168. Double-crested Cormorant	1.
169. Hudsonian Godwit	1.
170. Willet	1.
171. Long-billed Dowitcher	1.
172. Philadelphia Vireo	1.
173. Savannah Sparrow	1.
174. Short-billed Marsh Wren	.5
175. Swainson Hawk	.5
176. Black-poll Warbler	.5
177. Blackburnian Warbler	.5
178. Pine Warbler	.5
179. Ring-necked Duck	.5
180. Red-breasted Merganser	.5
181. Redhead	.5
182. Gambel Sparrow	.5
183. Long-eared Owl	.5
184. Clay-colored Sparrow	.5
185. Louisiana Water-thrush	.5
186. Bonaparte Gull	.5
187. Osprey	.5
188. Sharp-shinned Hawk	.5
189. Buff-breasted Sandpiper	.5
190. Long-billed Curlew	.5
191. Stilt Sandpiper	.5
192. Saw-whet Owl	.5
193. Yellow-bellied Sapsucker	.5
194. Hermit Thrush	.5

Museum of Vertebrate Zoology, Berkeley, California, January 16, 1928.