

FREQUENCY OF OCCURENCE OF SUMMER BIRDS  
IN THE IMMEDIATE VICINITY OF THE  
UNIVERSITY OF MICHIGAN  
BIOLOGICAL STATION

by

Katherine A. White  
Collinsville, Illinois

A report of an original field study conducted as a  
requirement for Advanced Ornithological Studies  
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Biological Station

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## PREFACE

During the summer of 1941 I have made a study of the composition of the bird population found in the vicinity of the University of Michigan Biological Station, Cheboygan County, Michigan. The method used is based on Raunkaier's Law of Frequency, a law derived from botanical studies made in Europe. This law I have described in a previous paper (1941, pp. 6-7). Kenoyer (1927, pp. 341-349) of the Western Michigan State Teachers' College suggested that the law could be applied to various forms of animal life as well as to plants, insects, and microorganisms. Linsdale (1928, pp. 180-184) of the University of California was apparently the first person to apply the law in figuring the frequency of bird species found in a defined locality. It is his method which has been followed in this study.

Dr. Olin Sewall Pettingill has given me numerous suggestions concerning the keeping of the proper records, source material of similar studies, the arranging of a suitable time schedule, and various other problems which have arisen.

Dr. Jean M. Linsdale was kind enough to send me copies of his publications on the subject and to refer me to other similar works.

Only two previous counts of birds have been made in the vicinity of Douglas Lake: one by James Compton (1914) during the summers of 1913 and 1914; the other by Linsdale (1936) during the summer of 1924.

Another list of Douglas Lake birds was made by Wood, Smith, and Gates (1916) during the summers from 1911 to 1915, but no attempt was made to take a count.

Compton's study included the Douglas Lake region and Reece's Bog (located on Burt Lake). To indicate the frequency or the number of times each species was seen, he used the following key:

r--rare--seen one to four times  
c--common--seen five to twenty times  
a--abundant--seen more than twenty times.

He also kept a record of the number of individuals of each species seen arranging them in order of decreasing abundance. Thus the bird ranking highest in abundance is first on the list and is recorded thus: Cedar Waxwing (1). When only one individual bird was seen, it received the lowest rating of (47).

Linsdale used Raunkaier's Law of Frequency in figuring the frequency of the birds found in Northern Michigan. He based his percentages on fifty day's field work (June 9 to August 17) done while attending the University of Michigan Biological Station in the summer of 1924. He used as his unit, one day. Dice suggests the use of an hour or a half-hour as a unit. It would seem that the territory to be covered would necessarily affect the length of time used. Linsdale also made similar studies in Doniphan County, Kansas (1928), and Yosemite Valley, California (1932). Linsdale and Rodgers (1937) used the same method on the bird life of Alum Rock Park in Santa Clara County, California; and Rodgers and Sibley (1940) made a study of the University of California campus at Berkeley.

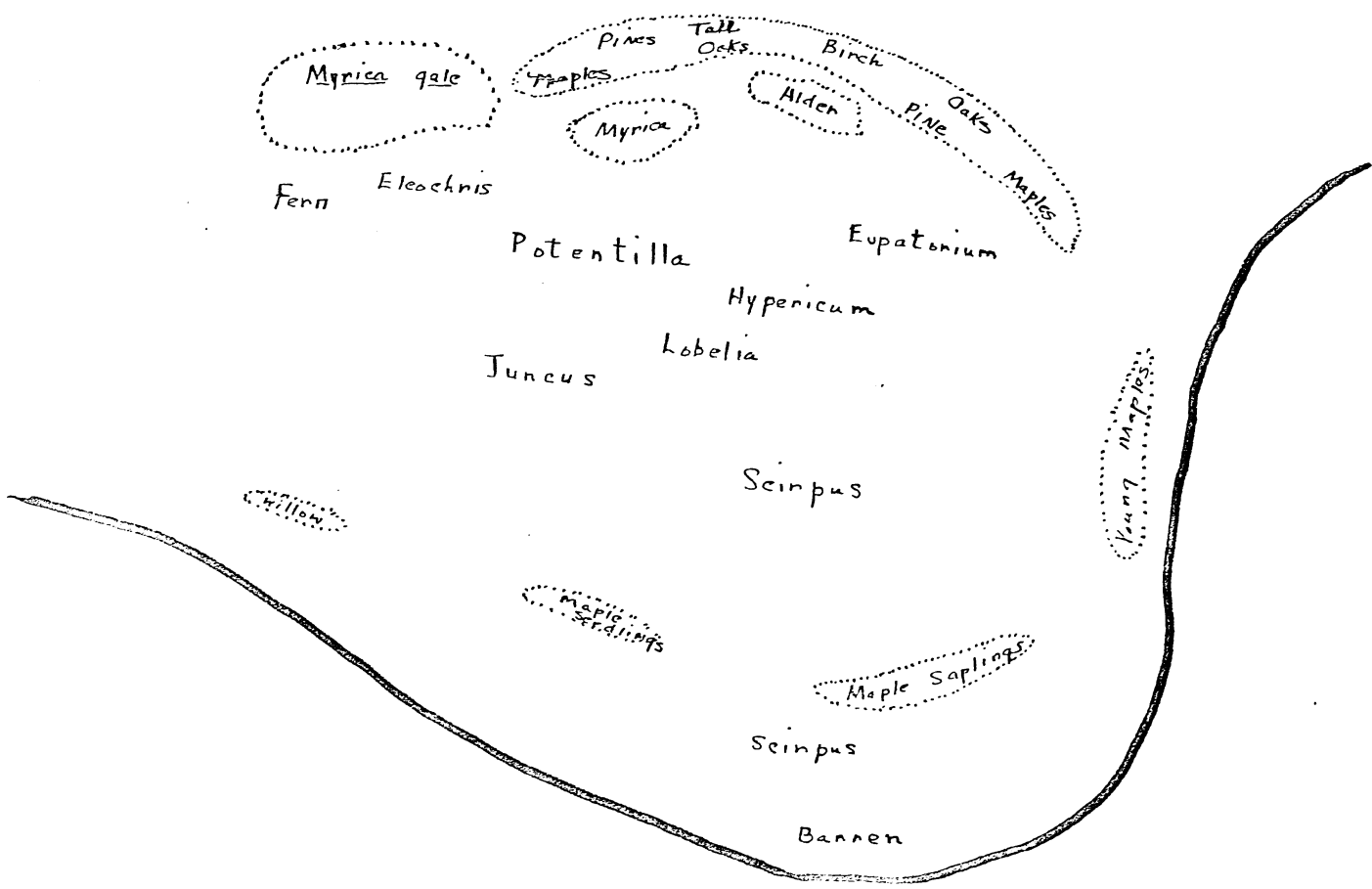
FREQUENCY OF OCCURRENCE OF SUMMER BIRDS IN THE IMMEDIATE  
VICINITY OF THE UNIVERSITY OF MICHIGAN BIOLOGICAL STATION

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

1. The Shore of the lake from the Station area to North Fishtail Bay.
2. The Woodland proceeding Northeast from the Station to North Fishtail Bay.
3. State Street, the main street of the Station which is lined on either side by student and faculty cabins.
4. The Hill immediately south of the Station.

The Shore is barren of vegetation throughout most of the territory covered until Pine Point is reached. It is however, bordered with trees, mainly white pines (Pinus strobus) intermingled with a few aspens (Populus grandidentata and P. tremuloides) and red or Norway pines (Pinus resinosa). Pine Point is covered with several species of Equisetum, Scirpus, Potentilla, Lobelia, Vaccinium, and grasses (Section 3 on map). As the name implies, the beach is bordered by a growth of magnificent tall pine trees, the white pine being more abundant than the red pine. A little farther up the beach is East Point (Section 4 on map), a point which has been formed probably within the last twenty years

thru the deposition of sand by the wind. On the beach here is a sparse growth of Scirpus bordered by a growth of maple and willow saplings and seedlings. The side of the point toward the woods is bordered by red maple (Acer rubrum), white pine, red oak (Quercus borealis), birch (Betula alba, var. papyrifera). In front of the trees are such shrubs as sweet gale (Myrica Gale), alder (Alnus incana), and Spiraea. The central section of the point, which was in recent years a beach pool, is covered with ferns (Osmunda regalis), Boneset (Eupatorium perfoliatum), Joe Pye Weed (Eupatorium purpureum), Eleocharis, Lobelia Kalmii, Potentilla anserina, Hypericum, Juncus, Scirpus validus, and grass.



The woodland area from camp to North Fishtail consists mainly of an aspen-birch association which gradually changes to an association of conifers. As one proceeds Northeastward from camp along the road to North Fishtail one passes first through a rather open growth of tall aspens (Populus grandidentata and P. tremuloides), red maple (Acer rubrum), sugar maple (Acer saccharum), red pines, and white pines surrounding the garages and sawmill. Slightly farther along the road is the Tent Colony, located between the road and the lake. The growth here is interesting as one finds tall aspens and pines on the West side of the road and a dense growth of small aspens with an occasional pine sapling on the East side of the road. The reason for this sudden difference in growth is explained by the 1923 fire which burned through from the east to the Tent Colony. Immediately past the Tent Colony is the first fire lane. The territory around the lane is a very open growth of aspens. (It was in this section that the Hermit Thrush was observed on several occasions.) Between the first and second fire lane is a thick stand of young aspens, oak, maple, beech (Fagus grandifolia), wild cherry (Prunus sp.), and white pines. Throughout all this area are such shrubs as sumac (Rhus typhina), service berry (Amelanchier canadensis), and alder. The ground is covered with bracken (Pteris aquilina) which in some places is over five feet tall, wintergreen (Gaultheria procumbens), blueberries (Vaccinium canadense, V. pennsylvanicum), and poison ivy (Rhus toxicodendron).

As one continues past the second fire lane, the growth is much the same except that the trees become larger, some of them being approximately 30 years old. This section was burned over in 1909 but not again in 1923 as the preceding area. Between the second fire lane and East Point are

two lowland thickets. The first one (Section 1 on map) contains a rather large open area thickly covered with grasses, iris, and Scirpus atrocinctus. Some golden rod (Solidago juncea), boneset (Eupatorium perfoliatum) and poison ivy is found along the road. There are several clumps of thick shrubs consisting of Labrador Tea (Ledum groenlandicum), alder, and Michigan holly (Ilex verticillata). The trees bordering this marshy spot are silver maple (Acer saccharinum) and red oak. A second marshy spot (Section 2 on map) is found a short distance up the road which contains a higher and thicker growth of the same vegetation. As one passes the first marshy spot the number of conifers begins to increase and one finds many red and white pines and white spruce (Picea canadensis). Past the second marshy spot, one passes a section of very tall aspens, birch, red maples, white pines, and some cedar. The number of conifers increases rapidly then until we have a typical Canadian zone area consisting mainly of white cedar (Thuja occidentalis) and balsam (Abies balsamea). One finds also an occasional hemlock (Tsuga canadensis), white pine, white spruce, and birch. Wild grapes (Vitis vulpina) are found among the trees and the ground cover consists largely of bracken, some wild strawberries (Fragaria) and bunchberry (Cornus canadensis).

At the end of the road and bordering North Fishtail Bay are a number of tall aspens, maple, and birch. The animals found in this area just described consist mainly of red squirrels, chipmunks, ground squirrels, deer, raccoon, skunks, rabbits, and muskrats.

The trees found around the camp and laboratories of the Station consist mainly of red oak, red maple, sugar maple, pin cherry, and birch. Numerous sumac bushes are also found around the cabins. Grasses, clover,



blueberries and bracken form the main ground cover.

The hillside immediately south of the Station is covered with a thick growth of young trees and shrubs: namely, beech, birch, red oak, moosewood (Acer pennsylvanicum), sugar maple, red maple, mountain maple (Acer spicatum), basswood (Tilia americana), arrow-wood (Viburnum acerfolium), locust (Robinia Pseudo-Acacia), and sumac. Occasional large red and white pines, hemlock and balsam are found. On top of the hill is a very open woodland consisting mainly of small aspens, maples, and birch and large red oaks and red pines. A number of jack pines (Pinus Banksiana) are also found here as well as numerous sumac bushes. The ground cover thruout this territory consists of bracken, wintergreen, bush honeysuckle (Diervilla Lonicera), wild sarsaparilla (Aralia nudicaulis), violets, and blackberries.

The whole area is typically Transition Zone with the exception of the coniferous growth at North Fishtail Bay which is decidedly an intrusion of the Canadian Zone.

Certain birds were consistently found in particular regions of the area:

I. Aquatic Association

A. Water birds--birds seen on or over the water

American and Red-breasted Mergansers  
Blue-winged Teal  
Black Ducks  
Herring and Ring-billed Gulls  
Caspian and Common Terns  
Common Loon

B. Semi-aquatic birds--birds seen in trees along water and seen catching fish

Bald Eagle  
Belted Kingfisher

C. Non-aquatic birds--birds seen feeding over water

Purple Martins  
Nighthawks  
Bank Swallows  
Rough-winged Swallows  
Barn Swallows  
Kingbirds

II. Strand Association--birds found feeding on sandy beach along lake

Spotted Sandpiper  
Least Sandpiper  
Solitary Sandpiper  
Killdeer

III. Aspen-birch-pine Association

A. Young growth.

Hermit Thrush  
Oven-birds  
Vireos  
Least Flycatchers  
Sparrows  
Cuckoos  
Pewees  
Waxwings  
Flickers  
Redstarts  
Black and White Warblers  
Chickadees  
Black-throated Green Warblers

B. Tall growth

Crested Flycatcher  
Downy and Hairy Woodpeckers  
Flickers  
Crows  
Scarlet Tanager  
Rose-breasted Grosbeak  
White-breasted Nuthatch  
Redstarts  
Black and White Warblers  
Chickadees  
Black-throated Green Warblers

IV. Marshy and shrubby area

A. Along Shore (East Point, Section 4 on map)

Song Sparrow  
Northern Yellow-throat

B. Inland (Section 1 and 2 on map)

Red-eyed Towhee  
Brown Thrasher  
Catbird  
Northern Yellow-throat

V. Cedar Association

Winter Wren  
Chickadees  
Black and White Warblers  
Scarlet Tanagers

VI. Inhabited Area

Robin  
Kingbird  
Cedar Waxwing  
Chipping Sparrow  
Goldfinch  
Purple Martin (colony)  
Bank Swallow (colony)

TIME SCHEDULE OF WALKS

As mentioned before, the region covered was divided into four different habitats and covered by four routes (see map): Route 1 the shore, Route 2 the woods from camp to North Fishtail, Route 3 State Street, and Route 4 the woods on the hill south of camp. In order to cover each of these four territories early in the morning when the birds are most active, a four day schedule of walks was arranged as follows:

#### First Day

Shore--5 to 6:30 A.M.  
Woods--6:50 to 10 A.M.  
State Street--4 to 5 P.M.  
Hill--6:45 to 8:15 P.M.

#### Second Day

State Street--5:30 to 6:30 A.M.  
Hill--7:50 to 9:30 A.M.  
Woods--2 to 4:30 P.M.  
Shore--4:50 to 6:00 P.M.

#### Third Day

Woods--5 to 8:30 A.M.  
Shore--8:30 to 10:00 A.M.  
Hill--3 to 5 P.M.  
State Street--7 to 8 P.M.

#### Fourth Day

Hill--5 to 7 A.M.  
State--8 to 9 A.M.  
Shore--2 to 3:30 P.M.  
Woods--3:50 to 6 P.M.

Chart I shows the time each walk was made on each day of the study.

The weather conditions have also been noted and recorded in Chart II. The mean temperature for the Douglas Lake region during the months of June, July, and August is 65.8; the average maximum temperature, 76.7; the average minimum, 55. The average precipitation for those months is 2.72. In 1941, the summer season was early, rapidly maturing, and dry.

The largest number of species seen in one day for the Station area was 41, recorded on July 15, a beautiful day with only a slight southerly wind. The smallest number of species, 21, was seen on the following day, July 16, when there was a very high wind. This bears out the previous statement that observations of birds are definitely affected by the weather conditions.

	Wed. 7/2	Thu. 7/5	Fri. 7/1	Sun. 7/8	Tue. 7/9	Wed. 7/9	Thu. 7/10	Fri. 7/11	Sun. 7/13	Tue. 7/16	Wed. 7/13	Thu. 7/17	Fri. 7/13	Sun. 7/20	Tue. 7/22	Wed. 7/23	Thu. 7/24	Fri. 7/25	Sun. 7/27	Tue. 7/23	Wed. 7/30	Thu. 7/31	Fri. 8/1	Sun. 8/3	Tue. 8/5	Wed. 8/5	Thu. 8/7	Fri. 8/8	Sun. 8/10	Tue. 8/13	Wed. 8/13	Thu. 8/14		
Route I 5-6:30				X				X			X				X					X				X	X			X	X		X			
Route II 6:30-10	X			X				X			X				X					X				X	X			X	X		X			
Route II 5-8:30					X				X		X			X			X				X					X				X				
Route I 8:30-10					X				X		X			X			X				X				X				X		X			
Route III 4-5 P.M.				X			X				X				X						X			X		X			X	X		X		
Route IV 6:45-8:15				X			X				X				X						X			X		X			X	X		X		
Route IV 3-5					X				X		X			X			X					X			X					X				
Route III 7-8	X				X				X		X			X			X					X			X				X		X			
Route I 2-3:30	X	X				X			X		X			X			X				X			X		X			X		X			
Route II 3:30-6		X				X			X		X			X			X				X			X		X			X		X			
Route II 2-4:30				X					X		X		X		X						X			X		X								
Route I 4:30-6				X					X		X		X		X						X			X		X								
Route III 5:30-6:30		X		X					X		X		X		X						X			X		X								
Route IV 7:30-9:30	X	X		X					X		X		X		X						X			X		X								
Route IV 5-7 A.M.						X			X		X		X		X					X			X		X			X		X				
Route III 8-9						X			X		X		X		X					X			X		X			X		X				

CHART I

CHART II

DATE	TEMPERATURE		PRECIPITATION	WIND		
	MAXIMUM	MINIMUM	24 HOUR	DIRECTION	SPEED MILES PER HOUR	
7/2/41	W	73	53		NW to N	10-12 M.P.H.
7/3	T	77	58		N	0-10
7/4	F	84	60		E	3-4
7/5	S	86	59		S	5-10
7/6	S	87	63	0.16 in.		0-5
7/7	M	65	65	0.02		0-5
7/8	T	78	55		N to NW	8-10
7/9	W	80	57	0.02	W	8-12
7/10	T	87	65		S to SW	10-15
7/11	F	66	58		N to NW	0-15
7/12	S	76	57		N to NW	10-15
7/13	S	84	60			8-10
7/14	M	85	58		SE to S	3-8
7/15	T	88	62	0.24	S to SE	5-15
7/16	W	68	60		N to NW	20-25
7/17	T	78	55	0.15	S to SW	3-10
7/18	F	68	57	0.37 cloudy	NW to N	10-15
7/19	S	62	53		SW to S	8-12
7/20	S	76	52		SW to S	8-10
7/21	M	87	65		S to SW	20-25
7/22	T	96	61		SW to S	5-15
7/23	W	93	68	clear	S to SW	10-15
7/24	T	99	68	clear	W	5-15
7/25	F	94	75	clear	W to N	5-10
7/26	S	94	59	0.11	SW to S	10-15
7/27	S	95	69	trace		
7/28	M	93	74	cloudy to clear	S to SW	10-15
7/29	T	95	73	partially cloudy		
7/30	W	97	71	0.19 cloudy-dark foggy to clear	S to SW	0-5-10
7/31	T	84	63	0.01 partially cloudy to clear	W to NW NW to W	10-5 2-10
8/1	F	85	65		N to NW	0-10
8/2	S	86	63		N	5-10

CHART II

(cont.)

DATE	TEMPERATURE		PRECIPITATION	WIND	
	MAXIMUM	MINIMUM	24 HOUR	DIRECTION	SPEED MILES PER HOUR
8/3	S	89	64	W	0-8 M.P.H.
8/4	M	83	61	N to NE	10-15
8/5	T	82	65	E to NE	2-12
8/6	W	84	60	NE to E	0-8
8/7	T	91	60	W	5-15
8/8	F	85	67		
8/9	S	83	60		
			clear-cloudy 0.14	W to NW	2-10
			clear to part cloudy	N to NW	0-15
8/10	S	84	60	NW	5-10
8/11	M	78	65	N	25-30
8/12	T	62	55	N	20-25
8/13	W	69	50	N to NW	5-15
8/14	T	78	55	S to SW	0-15
8/15	F	79	53	W to NW	0-15
8/16	S	70	57		10
8/17	S	71	53		
8/18	M	78	50		5-10

Thus the data for this analysis consist of 120 lists of species, thirty for each of four different habitats visited each day for a total of thirty days between July 2 and August 14, 1941. The birds heard, as well as those seen, were recorded in each case. The percent of frequency for each species was computed by dividing the number of days on which the species was observed by the total number of days (30). A separate list of frequencies for each of the four habitats has been made as well as a composite list for the entire Station area. The total numbers of each species has been recorded also in order to discover if the number of a species parallels the frequency of that species.

The list of frequencies for the entire area covered is compared with Compton's list of 1914. The list for the woodland area north of the Station is compared with frequencies computed from eleven days of field observation made from June 25 to August 15, 1933 by Marjery Greenberg.

In order to compare the 1941 frequencies with those of Linsdale's for 1924, the birds seen on the trips taken by the Beginning and Advanced Ornithology classes have been incorporated. This covers a period of 46 days from June 29 to August 18, 1941. Linsdale's study covered a period of 50 days from June 9 to August 17, 1924. The places visited by Linsdale were:

- |                |                              |
|----------------|------------------------------|
| * Nichol's Bog | Bryant's Bog                 |
| * Mud Lake     | * Emmet County Game Preserve |
| * Marl Bay     | (Wilderness Park)            |
| * Bessey Creek | * Burt Lake                  |
| * Black Lake   | Grapevine Point              |
| * Black River  | Cheboygan Road               |
| Frog Creek     | Smith's Bog                  |
| Big Stone Bay  | * Ingleside                  |
| * Pine Point   | * Cecil Bay                  |
| Reece's Bog    | Maple River                  |
| * Camp Davis   | Fairy Island                 |

\* also visited by bird classes



The places visited by the bird classes and not by Linsdale were:

Elliott Creek	Fontanelles Run
Indian River	Greenman's Point (Burt Lake)
French Farm Lake	Nigger Creek
Trail's End Bay	Munro Lake
Nelson Lake	Duncan Bay (Lake Huron)
Blanchard Lake	Grass Bay (Lake Huron)

Chart III shows: the entire number of species seen during the whole summer; the frequency, total numbers, and rank in number of each species seen in each of the four habitats; the same information for the entire Station area compared with Compton's results (1914); the frequencies of each species for Northern Michigan compared with Linsdale's results (Linsdale, 1936).

In order to secure the rank in number for each species, they were arranged in order of decreasing numbers. Thus the species seen in greatest numbers ranks first and the one seen in fewest numbers ranks lowest. The highest and lowest numbers and ranking for each of the areas given in the chart are as follows:

	<u>Highest number</u>	<u>Rank</u>	<u>Lowest number</u>	<u>Rank</u>
Route 1-Shore	480	1	1	37
Route 2-FishTail Woods	414	1	1	35
Route 3-State	820	1	1	18
Route 4-Hill	299	1	1	25
Entire Station Area	1271	1	1	53

Compton used the same procedure. The number for his first ranking species was 227; those species of which he saw only 1 individual, ranked 47th.

Compton (1914) ranked the various species in frequency according to the following key:

r---- rare--- seen 1-4 times  
c ---- common ---seen 5-20 times  
a ---- abundant----seen more than 20 times

I also have ranked the species seen this summer in frequency using this key:

abundant -- a -- 90-100% frequency  
common ---- c -- 65-89% frequency  
moderately common - m -- 31-64% frequency  
uncommon -- u -- 10-30% frequency  
rare -- r -- 1-9% frequency

Those on Compton's 1914 list which were not observed in 1941:

I. Abundant

Chimney Swift  
Yellow-bellied Sapsucker

II. Common

Bluebird  
Golden-crowned Kinglet  
Pine Warbler  
Cliff Swallow  
Indigo Bunting  
English Sparrow  
Red-headed Woodpecker  
Marsh Hawk  
Buffle-head

III. Rare

Olive-backed Thrush  
Blue-gray Gnatcatcher  
Mourning Warbler  
Black-throated Blue Warbler  
Black-poll Warbler  
Tennessee Warbler  
Blue-headed Vireo

III. Rare (cont.)

Yellow-throated Vireo  
Swamp Sparrow  
Lincoln Sparrow  
Savannah Sparrow  
Bronzed Grackle  
Meadowlark (Eastern)  
Bobolink  
Prairie Horned Lark  
Acadian Flycatcher  
Olive-sided Flycatcher  
Screech Owl  
Barred Owl  
Short-eared Owl  
Osprey  
Cooper's Hawk  
Broad-winged Hawk  
Sparrow Hawk  
Quail (?)  
Virginia Rail  
Wood Duck  
Bittern  
Pied-billed Grebe

Those on 1941 list which are not on Compton's:

Ring-billed Gull  
Herring Gull  
Baltimore Oriole  
Rough-winged Swallow  
Yellow-billed Cuckoo  
Black Duck  
Goshawk  
American Merganser  
Least Sandpiper  
Greater Yellowlegs  
Parula Warbler

The presence of the following birds on Compton's list (1913) and not on 1941 list is probably explained by the fact that he visited cultivated areas of farm land which is not included in the 1941 regions:

Indigo Bunting	Bobolink
Chimney Swift	Savannah Sparrow
Bluebird	Meadowlark
English Sparrow	Bronzed Grackle
Quail	Prairie Horned Lark

The fact that he did not confine himself to birds seen only on daytime walks probably explains the presence of the following birds on his list and not on the 1941 list:

Screech Owl  
 Barred Owl  
 Short-eared Owl

Species which show approximately the same frequency in 1924/and by Linsdale

1941 are:

Cedar Waxwing	Meadowlark
Kingbird	American Merganser
Robin	Red-breasted Nuthatch
Spotted Snadpiper	American Bittern
Chipping Sparrow	Veery
Song Sparrow	Myrtle Warbler
Flicker	Horned Lark
Oven-bird	Chestnut-sided Warbler
Goldfinch	Wilson's Snipe
Cowbird	White-throated Sparrow
Belted Kingfisher	Sharp-shinned Hawk
Killdeer	Field Sparrow
Ruffed Grouse	Black-throated Green Warbler
Virginia Rail	Red-shouldered Hawk
Sora Rail	Parula Warbler
Barn Swallow	Black-billed Cuckoo

Several species show only a slight increase or decrease from 1924 to 1941-- a variation probably due to the variation in places visited. Some, however, show marked changes. The following show a marked increase in frequency; i.e., the frequency in 1941 is much higher than that of 1924:

Scarlet Tanager	Black-capped Chickadee
Black Duck	Ring-billed Gull
Catbird	Black and White Warbler
Bald Eagle	American Woodcock
Redstart	Hummingbird
Purple Finch	Hairy Woodpecker
Yellow Warbler	Crested Flycatcher
Canada Warbler	Downy Woodpecker
Herring Gull	Caspian Tern
Purple Martin	Bank Swallow

The reason for the great increase in Purple Martins and Bank Swallows is the presence of a colony of each in the camp area. Two Martin houses were erected in 1934. One was occupied that summer and both were occupied the following summer. Gravel was removed from the hill in back of camp during the winter of 1940-41, leaving at the top of the bank a suitable place for Bank Swallows. Hence Bank Swallows nested in camp during the summer of 1941.

The cause of the increase in the other species I am unable to explain except by the fact that I covered the same territory for 30 days, while Linsdale visited each place only one or a few times.

Species showing a marked decrease in frequency are:

Hermit Thrush  
Golden-crowned Kinglet  
Chimney Swift  
English Sparrow  
Slate-colored Junco

In the past the Hermit Thrush and the Junco have both nested in the vicinity of the Biological Station, the Hermit Thrush quite abundantly. Both have decreased until this year there were apparently only two pair of Hermit Thrush nesting in the vicinity of the Station and no Juncos. The Junco, of course, is a Canadian Zone bird and hence nests largely to the north of the Station. The decrease in the frequency of the Hermit Thrush may possibly be explained by the fact that the vegetation has grown up considerably in recent years and crowded the Hermit Thrush out of his preferred habitat of recently burned-over or cut-over forests.

A number of species were observed in 1941 that were not recorded in 1914 or 1923:

Baltimore Oriole  
American Merganser  
Yellow-billed Cuckoo  
Goshawk  
Pileated Woodpecker

The American Merganser and the Pileated Woodpecker were seen only rarely in 1941 hence it is probably coincidental that they were not recorded in 1913 or 1923. The Goshawk was found nesting near North Fishtail Bay in 1940 and 41. The appearance of the Baltimore Oriole in rather large abundance is perhaps due to the presence of higher trees. Compton made his study shortly after the 1909 fire, while Linsdale's was immediately after the 1923 fire. Since that time there have been no fires, so the trees have had opportunity to grow unhindered.

Chart IV shows the number of days each species was seen in the entire Station area. They are ranked according to the percent of frequency, 100% being at the top and 3.3% at the bottom.

Chart V shows the distribution of species according to Raunkaier's Law of Frequency.

The distribution of species do not agree with the distribution stated in Raunkaier's Law of Frequency

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

except in the case of the entire camp area where  $A > B > C < D < E$ . The distributions all show, however that the species of lowest frequency are the most numerous.

CHART V

Showing the Distribution of Species Among the Five Classes of Frequences

Number of Species in Each Class						
Classes of Frequences	Route I Shore	Route II Woods	Route III State	Route IV Hill	Entire Station Area	Northern Michigan
Class A Frequence, 1-20%	42	27	19	27	34	80
Class B Frequence, 21-40%	6	11	6	8	11	14
Class C Frequence, 41-60%	7	8	0	3	10	14
Class D Frequence 61-80%	7	7	4	3	12	14
Class E Frequence 81-100%	3	4	4	3	13	11
Summary of Distribution of Species according to Raunkaier's Law	A>B<C=D>E	A>B>C>D>E	A>B>C<D=E	A>B>C=D=E	A>B>C<D<E	A>B=C=D>E

At the end of the paper are included copies of the actual records kept day by day during the study. These charts are:

Chart VI -- Shore  
Chart VII -- North Fishtail  
Chart VIII -- State  
Chart IX -- Hill  
Chart X -- Camp area  
Chart XI -- Northern Michigan

I believe the use of Raunkaier's Law of Frequency the most accurate method for determining the frequency of birds in a region similar to that surrounding the Biological Station.

The fact that the frequencies agree rather closely with the total numbers of individuals seen <sup>(see Chart XII)</sup> bears out Linsdale's statement that the numbers of individual birds of one species seen over a period of time will parallel the frequency of occurrence of that species. The chief exceptions in my study to this statement were the Purple Martin and the Herring Gull. The exceptionable high number of Martins seen was due, as previously stated, to the presence at the Station of two Martin houses. The number of Herring Gulls seen was much less than the number of Ring-billed Gulls seen although the frequencies were almost the same. Flocks of gulls were seen feeding on the lake each day, the flocks being composed largely of Ring-billed Gulls. However, on nearly all occasions there was one or two Herring Gulls among the group.

The chief source of inaccuracy of this method to my mind is the slighting of the nocturnal birds. By recording only the birds seen and heard on the walks taken at specified times of the day, only one nocturnal bird was recorded at all-- the Whippoorwill. Owls were known to be in the region as they had been heard on numerous occasions during the early part of the summer.



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CHART XII

Showing the Relation Between the Total Numbers of  
Birds Seen and the Percent of Frequency

Birds Seen on State  
Street

<u>Species</u>	<u>% of Frequency</u>	<u>Species</u>	<u>Total No. Seen</u>
1. Robin	96.7%	1. Purple Martin	820
2. Cedar Waxwing	93.3	2. Cedar Waxwing	222
3. Kingbird	93.3	3. Robin	123
4. Purple Martin	86.7	4. Kingbird	115
5. Red-eyed Vireo	70	5. Bank Swallow	80
6. Goldfinch	66.7	6. Chipping Sparrow	60
7. Chipping Sparrow	66.7	7. Red-eyed Vireo	38
8. Least Flycatcher	63.3	8. Goldfinch	38
9. Purple Finch	36.7	9. Least Flycatcher	36
10. Ring-billed Gull	26.7	10. Purple Finch	36
11. Bank Swallow	26.7	11. Baltimore Oriole	21
12. Baltimore Oriole	26.7	12. Ring-billed Gull	16
13. Nighthawk	23.3	13. Common Tern	12
14. Grosbeak	23.3	14. Nighthawk	12
15. Common Tern	20	15. Cowbird	9
16. Phoebe	20	16. Rose-breasted Grosbeak	9
17. Cowbird	16.7	17. Phoebe	9
18. Herring gull	13.3	18. Chickadee	7
19. Pewee	13.3	19. Herring Gull	5
20. Black-capped Chickadee	13.3	20. Wood Pewee	4
21. Black-billed Cuckoo	10	21. Black-billed Cuckoo	3
22. Flicker	6.7	22. Flicker	3
23. Loon	3.3	23. Downy Woodpecker	2
24. Bald Eagle	3.3	24. Loon	1
25. Caspian Tern	3.3	25. Bald Eagle	1
26. Mourning Dove	3.3	26. Caspian Tern	1
27. Downy Woodpecker	3.3	27. Mourning Dove	1
28. Tree Swallow	3.3	28. Tree Swallow	1
29. Rough-winged Swallow	3.3	29. Rough-winged Swallow	1
30. White-breasted Nuthatch	3.3	30. White-breasted Nuthatch	1
31. Vesper Sparrow	3.3	31. Vesper Sparrow	1
32. Nashville Warbler	3.3	32. Nashville Warbler	1
33. Scarlet Tanager	3.3	33. Scarlet Tanager	1









July

SUMMER BIRDS IN THE REGION OF DOUGLAS LAKE

August

Chart XI  
Route I - Shore

No. Times Seen Total No.

Table with columns for days of the week (S, M, Tu, W, Th, F, S, S, M, Tu, W, Th, F, S) from July to August, and rows for various bird species including Canada warbler, American redstart, English sparrow, Chipping sparrow, Eastern meadowlark, Eastern red-wing, Baltimore oriole, Bronzed grackle, Eastern cowbird, Blue jay, Rose-breasted grosbeak, Indigo bunting, Eastern evening grosbeak, Eastern purple finch, Northern pine siskin, Eastern goldfinch, White-winged crossbill, Red-eyed towhee, Eastern savannah sparrow, Eastern henslow's sparrow, Eastern vesper sparrow, Blue-colored junco, Eastern chipping sparrow, Blue-colored sparrow, Eastern field sparrow, White-crowned sparrow, White-throated sparrow, Swamp sparrow, and Eastern song sparrow. Each cell contains a count of birds observed on that date.





July

SUMMER BIRDS IN THE REGION OF DOUGLAS LAKE

August

Route II - Woods

No. Times Seen Total Nos.

Table with columns for bird species and months (July and August). Rows include species like Ruby-throated hummingbird, Eastern bluebird, and many warblers. Includes handwritten counts and a circled '10' in the Dickcissel row.

July

SUMMER BIRDS IN THE REGION OF DOUGLAS LAKE

August

Route II - Woods

No. Times Seen Total No.

Species	July							August							No. Times Seen		Total No.				
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Canada warbler																					
American redstart																					
English sparrow																					
Bobolink																					
Eastern meadowlark																					
Eastern red-wing																					
Baltimore oriole																					
Bronzed grackle																					
Eastern cowbird																					
Scarlet tanager																					
Rose-breasted grosbeak																					
Indigo bunting																					
Eastern evening grosbeak																					
Eastern purple finch																					
Northern pine siskin																					
Eastern goldfinch																					
White-winged crossbill																					
Red-eyed towhee																					
Eastern savannah sparrow																					
Eastern henslow's sparrow																					
Eastern vesper sparrow																					
Blue-colored junco																					
Eastern chipping sparrow																					
Gray-colored sparrow																					
Eastern field sparrow																					
White-crowned sparrow																					
White-throated sparrow																					
Swamp sparrow																					
Northern song sparrow																					



























FREQUENCY OF OCCURRENCE OF SUMMER BIRDS AT  
THE UNIVERSITY OF MICHIGAN BIOLOGICAL  
STATION

BY KATHERINE A. WHITE

Reprinted from THE WILSON BULLETIN, vol. 54, No. 3, Sept., 1942, pp. 204-210

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FREQUENCY OF OCCURRENCE OF SUMMER BIRDS AT  
THE UNIVERSITY OF MICHIGAN BIOLOGICAL  
STATION<sup>1</sup>

BY KATHERINE A. WHITE<sup>2</sup>

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 Frequency. 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 frequency 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 frequency 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 frequency is 25 divided by 25, or 100 per cent; if it is found on 5 plots, the frequency 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 frequency than of higher frequencies. As one proceeds to the greater frequencies, the number declines steadily until the highest (or next highest) frequency is reached, at which point it increases slightly. To express this in a formula, Raunkaier let A, B, C, D, and E represent frequencies 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 frequencies could then be expressed:

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

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:

<sup>1</sup> Contribution from the University of Michigan Biological Station.

<sup>2</sup> I wish to express my appreciation to Dr. Olin Sewall Pettingill, Jr. of Carleton College, Northfield, Minnesota, for numerous suggestions concerning the keeping of proper records, source material of similar studies, and especially for the reading and constructive criticism of the manuscript for publication. I am also grateful to Dr. Jean M. Linsdale of the Museum of Vertebrate Zoology, Berkeley, California, for several helpful suggestions and his explanation of a similar bird frequency study made in northern Michigan.



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 reliability 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	36	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 Towhees	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	74	22	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 frequency 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 frequencies 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 frequencies 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 frequency-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 frequencies 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 frequency; it shows the number of days on which the species was seen, the per cent of frequency, 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 frequency rating according to the following scale:

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

The fact that the frequencies 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 frequency 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 frequency of 100 per cent. The number of Herring Gulls recorded was much less than the number of Ring-billed Gulls although the frequencies 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 Frequency is a highly accurate method for determining the frequency 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.

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