

CHEMICAL STUDIES OF WATERS OF REELFOOT LAKE¹

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INTRODUCTION

In a number of ways the chemical properties of water are important and often are of especial value when used to interpret distribution and life habits of fish and other aquatic animals. The aquatic plant life and the humus and silt accumulations in Reelfoot Lake, especially in the marsh and submerged vegetation zones, contribute to the chemical nature of the water surrounding them. A few general conclusions will be drawn from the data presented and it is hoped that the conclusions will be of service to animal and plant ecologists in the better interpretation of their studies of distribution and life habits of fish.

Bodies of water may be separated into two general classes: Those in which there is a continuous directional flow are termed rivers or streams; those in which there is little or no directional motion and in which the water movements are due largely to changes in temperature and winds are called lakes or ponds. Reelfoot Lake is of the pond type and therefore chemical studies, particularly of dissolved oxygen, are very important in determining the optimum requirements for life. Running water may obtain a plentiful supply of oxygen by its own inherent mechanical agitation, whereas the waters of lakes and ponds depend upon winds, temperature changes, currents, etc., for the distribution of oxygen through the body of the system.

In situations such as found here, where temperature, currents, and wind action are at a minimum, the submerged plants contribute most of the oxygen. Also many currents that would distribute oxygen, carbon dioxide, and other dissolved chemical compounds to help establish uniformity are hindered to no little extent by the submerged masses of aquatic vegetation and the blanketing effect of the phytoplankton (Davis, 1936).

The hard water condition of this lake, as expressed by the great amount of normal carbonate found at all stations, the strongly alkaline condition of the water with a pH average of over 7.8, and the sporadic but in many cases large amounts of carbon dioxide and bicarbonate, are all conditions that are applicable to many interpretations and correlations. The soft sand and clays of the Gulf Embayment region,

¹Contributions from the Reelfoot Lake Biological Station No. 7. The study herewith reported was made possible by a grant from the Reelfoot Lake Biological Station of the Tennessee Academy of Science, to whom the authors wish to express their appreciation.

in which Reelfoot Lake lies, rest upon a hard limestone of Paleozoic age, and thin indurated beds of calcareous character occur in the overlying rocks. These conditions probably account for the hardness of the water. In some places slight acidities, *i. e.*, pH 6.8, were noted over the marsh areas where the soil was nearly peaty. The carbon dioxide was highest in the duckweed Pleuston, and the occurrence of bicarbonates was too irregular to warrant any definite correlations.

In a pond of this type it is necessary, if there is to be an abundance of fish life, to have a plentiful supply of vegetation which can furnish oxygen. In the areas of submerged aquatics, particularly where *Ceratophyllum* was abundant, a high concentration of oxygen was found. From these preliminary data it is obvious that the vegetation plays an important role in the oxygen supply, but more extensive studies are needed to determine the inter-relationships between oxygen supply and the aquatic plant zones. There seems to be a plentiful supply of essential elements (N, K, Ca, P, etc.) for plant growth and the proper development of fish.

The data presented below is meager, but an attempt has been made to arrange it in regard to the vegetation conditions where the samples were taken. More data and future work should lead to adequate interpretations of the chemical nature of these waters in relation to the total biota of the lake, and to specific animals and plant communities.

The five tables included have been compiled from analyses² of 62 of the 102 samples taken. Some of the analyses could not be conveniently grouped under any one of the five types of stations and have been omitted. The number of the sample refers to the number given in the field notes where more detailed descriptions are recorded for future use.

The analysis of sixteen samples of water from the surface of the open stretches of Reelfoot Lake (Table 1) show the following results:

Oxygen ranges from 5.2 to 8.4 p.p.m. to show an average in sixteen samples of 7.7. Samples collected immediately after a heavy rainfall ran as high as 10.2 p.p.m. This increase in oxygen concentration at the surface is transitory, however, and is quickly equalized by diffusion into the lower levels of the pond.

The free carbon-dioxide was very low. The analyses resulted in a range of from 0 to 4 p.p.m., giving an average of 0.6 p.p.m. Since

²Procedure employed for chemical analysis: *Dissolved oxygen.* Manganous sulphate and alkaline potassium iodide were added, then concentrated sulphuric acid was added until the precipitate just dissolved. Titration was then carried out with sodium thio-sulphate solution using starch as indicator. (For methods in detail see Mason, *Examination of Water.*) Per cent of oxygen saturation cannot be reported since there is no record of barometric readings at the time the samples were collected.

Alkalinity. Reported as parts per million of carbonate and bicarbonate. The sample was titrated with 0.02 N. sulfuric acid using methyl orange as indicator, and the titration repeated using phenolphthalein as indicator.

The pH determinations were made with the LaMotte colorimetric apparatus.

eleven of the samples showed no concentration of free dissolved carbon-dioxide, this substance may be assumed to be practically nil.

The bicarbonates ranged between 0 and 30, with an average of 6 p.p.m., while the average concentration of carbonates proved to be 115 p.p.m., with the extremes marked at 160 and 82. Determinations

TABLE 1.
Open water: no aquatic vegetation

SAMPLE NUMBER	DEPTH	TEMPERATURE OF WATER	DIS-SOLVED OXYGEN	FREE CARBON DIOXIDE	BICARB-ONATES	CARBON-ATES	pH	REMARKS
Near Surface:	feet	°C.	p.p.m.	p.p.m.	p.p.m.	p.p.m.		
5	7.0	26.0	5.2	4.0	0.0	160	7.8	O†
24	2.0	25.5	5.9	0.0	10.0	116	8.0	O
39	4.0	26.0	6.6	0.0	0.0	104	8.1	O,G
40	4.0	26.0	8.2	0.0	0.0	104	8.1	O,S
49	5.0	26.5	5.4	2.0	0.0	132	7.6	O
50	11.0	24.0	5.0	2.0	0.0	132	7.6	O,G
59	3.5	23.5	7.0	0.0	10.0	102	8.0	C,G
69	4.0	24.5	7.0	0.0	30.0	82	8.5	O
73*	5.0	27.0	10.2	0.0	8.0	118	8.0	S
75*	6.0	26.0	9.8	0.0	0.0	126	8.0	O
77	7.0	26.0	5.4	2.0	0.0	140	7.9	O,S
89	4.0	27.0	9.6	0.0	14.0	92	8.2	G,M
91	4.0	27.0	8.4	0.0	2.4	110	8.0	O,G
93	3.0	28.0	8.2	0.0	14.0	100	8.2	O,G,S
95	16.0	28.0	5.2	0.0	2.0	108	8.0	X
97	25.0	28.0	7.0	0.0	6.0	110	8.0	O,G
Near bottom:								
6	7.0	26.0	4.2	4.0	0.0	156	7.7	O
11	1.0	28.0	4.0	14.0	0.0	218	7.1	O
37	4.0	24.0	5.0	0.0	8.0	122	8.0	M
38	2.0	25.0	5.0	0.0	12.0	130	8.1	C,G
48	3.0	24.0	4.4	3.0	0.0	130	7.8	O
60	3.5	24.0	5.6	0.0	1.0	100	8.1	C,G
70	4.0	24.0	3.3	4.0	0.0	106	7.4	O
74*	5.0	25.5	5.0	2.0	0.0	126	7.8	S
76	6.0	25.5	3.0	8.0	0.0	142	7.8	O
78	8.0	25.0	3.6	2.0	0.0	124	7.8	S
92	4.0	27.0	5.4	5.0	0.0	116	7.7	O,G,S
96	18.0	27.0	4.2	2.0	0.0	114	7.8	O,G
98	25.0	26.5	5.0	2.0	0.0	110	7.6	O,G

*After a heavy rain.

†Conditions of water: "O" is open water; "S" is stumps; "G" is greenish water; "M" is murky water; "X" is saw-grass area.

showed the water as being slightly alkaline, with an average pH of 8.0 and extremes of 7.6 and 8.5.

Analyses of water collected approximately five feet below the surface showed the following results: oxygen, average 4.5 p.p.m (maximum 5.4, minimum 3.0); free carbon-dioxide, average 3.4 (maximum

TABLE 2

Duckweed on surface: no submerged vegetation

SAMPLE NUMBER	DEPTH	TEMPERATURE OF WATER	DIS-SOLVED OXYGEN	FREE CARBON DIOXIDE	BICARBONATES	CARBONATES	pH	REMARKS
Near Surface:	feet	°C	p.p.m.	p.p.m.	p.p.m.	p.p.m.		
28	10.0	20.0	0.6	16.0	0.0	200	6.8	D,M†
30	9.0	19.5	0.8	16.0	0.0	204	6.8	D,M,X
42*	10.0	20.5	1.4	16.0	0.0	190	7.2	D,M
43*	10.0	20.5	2.0	16.0	0.0	184	7.2	D,M,X
72	1.0	25.0	1.6	5.0	0.0	128	7.8	D
82*	10.0	24.0	3.4	6.0	0.0	196	7.5	D,M
29	10.0	21.0	2.5	12.0	0.0	212	6.8	D,M
54	6.0	22.0	0.8	18.0	0.0	136	7.3	D

*After a heavy rain.

†Conditions of water: "D" is duckweed; "M" is murky water; "X" is saw grass nearby; "L" is numerous lilies on surface; "G" is green water; "S" is stumpy area.

14, minimum 0); bicarbonates, average 3.2 (maximum 12, minimum 0); carbonates, average 130 (maximum 218, minimum 100); pH, average 7.7 (maximum 8.1, minimum 7.1).

The table shows a very definite variation between water at the surface and water at a five-foot level. With an increase in depth there

TABLE 3

Bonnets and lilies on surface: no submerged vegetation

SAMPLE NUMBER	DEPTH	TEMPERATURE OF WATER	DIS-SOLVED OXYGEN	FREE CARBON DIOXIDE	BICARBONATES	CARBONATES	pH	REMARKS
Near Surface:	feet	°C	p.p.m.	p.p.m.	p.p.m.	p.p.m.		
15	4.0	30.0	10.2	0.0	32.0	92	8.3	L,G,M*
16	4.0	29.0	11.4	0.0	44.0	84	8.8	L,G,M
17	5.0	29.0	11.4	0.0	18.0	105	8.2	L,G,M,S
19	6.0	28.0	15.4	0.0	32.0	94	8.5	L,M,G,S
34	6.0	29.5	5.0	0.0	24.0	104	8.2	L,G
35	5.0	26.0	8.8	0.0	22.0	166	8.2	L,G
67	6.0	24.0	3.8	5.0	0.0	122	7.8	L
31	3.5	26.0	8.0	0.0	22.0	104	8.3	L
32	2.0	27.0	8.8	0.0	8.0	116	8.0	L
Near Bottom								
20	5.0	28.0	7.0	0.0	3.0	124	8.0	L,G,M,S
36	3.5	25.0	4.0	0.0	2.0	124	8.0	L,D
68	6.0	24.5	3.0	5.0	0.0	122	7.8	L

*Conditions of water: "D" is duckweed; "M" is murky water; "X" is saw grass nearby; "L" is numerous lilies on surface; "G" is green water; "S" is stumpy area.

TABLE 4
Duckweed on surface: submerged vegetation

SAMPLE NUMBER	DEPTH	TEMPERATURE OF WATER	DISSOLVED OXYGEN	FREE CARBON DIOXIDE	BICARBONATES	CARBONATES	pH	REMARKS
Near Surface:	feet	°C.	p.p.m.	p.p.m.	p.p.m.	p.p.m.		
10	2.0	26.0	1.1	10.0	0.0	216	7.2	D,P,†
12	1.5	26.0	0.0	20.0	0.0	252	7.1	D,P M
25	2.0	24.0	0.1	34.0	0.0	116	6.3	D,P
27	3.0	24.5	0.2	12.0	0.0	150	7.0	D,P

†Conditions of water. "D" is Duckweed covering; "P" is Ceratophyllum; "M" is murky.

is a decrease in free oxygen, bicarbonates, and pH. On the other hand free carbon-dioxide and carbonates are increased with an increase in depth.

With the surface of the water covered with vegetation consisting principally of duckweed (Table 2), the dissolved gases are very greatly altered. The dissolved oxygen is extremely low, averaging 1.5 p.p.m. with extremes at 0.6 and 3.4; the duckweed furnishing little or no oxygen for the waters it covers. Free carbon-dioxide averages 14 p.p.m., with a maximum in eight samples of 16 and a minimum of 5.0. Careful analysis revealed no bicarbonates in any of the samples. Carbonates ranged between 128 and 212, with an average of 181 p.p.m. The average pH was 7.2, very near the point of neutrality. The individual samples showed a variation of from 6.8 to 7.8.

With a surface vegetation consisting of lilies and bonnets (Table 3), there is again a decided shift in oxygen and carbon-dioxide concentration. The dissolved oxygen ranges between 3.8 and 15.4 p.p.m., with the nine samples having an average of 9.2. The free dissolved

TABLE 5
No surface vegetation: submerged vegetation

SAMPLE NUMBER	DEPTH	TEMPERATURE OF WATER	DISSOLVED OXYGEN	FREE CARBON DIOXIDE	BICARBONATES	CARBONATES	pH	REMARKS
Near Surface:	feet	°C.	p.p.m.	p.p.m.	p.p.m.	p.p.m.		
9	4	26.0	16.8	0.0	40.0	84	8.8	C,S†
26	5	25.5	10.4	8.0	0.0	160	7.0	C,S
44*	1	21.0	12.4	10.0	0.0	146	7.3	M,C
80*	2	24.0	10.6	0.0	10.0	114	8.2	C

*After a heavy rain.

†Condition of water. "C" is cypress trees; "S" is stumps; "M" is murky water.

carbon-dioxide is essentially zero. Bicarbonate is more nearly constant than in Tables 1 and 2, average 22.4 with extremes at 0 and 44. The carbonate is also fairly uniform, with an average of 110; a maximum of 122 and a minimum of 9.4. The pH shows the water to be definitely on the alkaline side with an average of 8.3. The extremes were set at 7.8 and 8.5.

Samples collected approximately five feet below the surface of the water showed the same variation as is indicated in Table 1. The average oxygen drops to 4.7, the bicarbonate to 1.7, and the pH to 7.9; while the carbon-dioxide increases to 1.7, and the carbonate to 123.

Table 4 presents data obtained from analyses of water which contained abundant surface duckweed and submerged *Ceratophyllum*. The oxygen concentration is very low, averaging 0.4 p.p.m., while the free dissolved carbon-dioxide is relatively high, averaging 19. No bicarbonate was found to be present, while the average concentration of carbonate in the four samples was found to be 184. The pH was practically neutral, averaging 6.9.

Analyses of water from areas having no surface vegetation but a dense growth of submerged *Ceratophyllum* (Table 5) indicate a very significant increase in dissolved oxygen; an average of 12.6 p.p.m., with individual samples ranging between 10.4 and 16.8. Free carbon-dioxide averages 4.5 p.p.m., with extremes at 0 and 10 p.p.m. This high carbon-dioxide content invariably occurs in shallow water after a heavy rain and does not represent a true *Ceratophyllum* condition. Bicarbonate concentration reflects a considerable range of concentrations from 0 to 40, with a median of 12.5 p.p.m. The carbonate is more nearly constant, showing an average of 126, and varying between 84 and 160. The water is slightly alkaline, having an average pH of 7.8 with extremes of 8.8 and 7.0.

SUMMARY

Despite the fact that very little is known regarding the oxygen requirements of various types of fishes and the chemical factors of waters that are detrimental, we believe that certain conclusions can be drawn from this study.

The data recorded from chemical analyses of waters of Reelfoot Lake indicate that certain chemical conditions are favorable for game fish while other environments are decidedly unfavorable. An abundance of oxygen is available where there is no surface duckweed. In open water with no submerged plants, in waters with an abundance of submerged *Ceratophyllum* with no floating duckweed, and in waters with dense patches of water-lilies and bonnets, the oxygen content is favorable (Wiebe, 1935). The presence of duckweed with or without submerged vegetation lowers the oxygen content of the water to a degree which is not favorable for fish life. This is due to the

blanketing action of these plants which cuts off the sunlight from the water below.

Four parts per million of oxygen is usually conceded as the standard limit for fishes, although the killing limit varies with temperature directly and an additional amount of oxygen is necessary if the carbon-dioxide increases (Krogh and Leitch, 1919; Hubbs, 1933). It has also been found that other factors may control this minimum oxygen requirement. For example, certain fish may live in one part per million of oxygen in pure water yet die in water which contains five or six parts per million accompanied by considerable organic waste. In some cases an abundance of decaying aquatic vegetation may kill fish even in four parts per million of oxygen. "It is possible, of course, to determine for fish of a given species, age, sex, and season, just how little dissolved oxygen is necessary to support life, under any given conditions." (Hubbs, 1933.) Until such experiments are conducted we may only generalize on specific requirements for fishes.

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SUMMER BIRDS OF REELFOOT LAKE¹

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The purpose of this paper is to present a list of the birds which were recorded at Reelfoot Lake during the summer of 1936. Although there are a number of papers presenting lists of the birds of this area, none of them cover this particular period. The most important and recent of these are Ganier's articles (1916, 1933) and a list by Crook (1935) which covers the late summer of 1934.

Spending June 5 to July 30 and August 10 to September 5 at the lake, the author made field trips into practically every basin and swamp in the vicinity. Numbers and habitat of each species were carefully noted. Large flocks were estimated by partial counts. The list shows a total of 116 species. All identifications were made by using 8x binoculars.

The big "Cranetown" at the north end of Big Ronaldson Slough where egrets, herons, cormorants, and water-turkeys breed (Ganier, 1933) was visited August 14 by Floyd S. Carpenter and Evelyn J. Schneider of Louisville, the author, and a guide. Usually under water, this area was dry so that the entire trip could be made on foot. No attempt was made to count the empty nests. The party remained at the colony until dusk, and there was no evidence that the herony was being used as a roosting site as reported by natives. It was learned from the guide that there had been some shooting in this vicinity. This might account for their not roosting here and might possibly result in a shift in the nesting site the following spring.

The range limits given by the Fourth Checklist of the American Ornithologists Union (1931) were used in determining subspecies. The exceptions to these names used by previous writers were incorporated.

The following is an annotated list of the summer birds of Reelfoot Lake, following the order of the 1931 Checklist of the A. O. U.

PIED-BILLED GREBE (*Podilymbus podiceps podiceps*)

This is a fairly common summer resident. Nine records were made of this little diver and they cover the entire summer. It is probable that this species is more common on the lake than the records indicate because of its ability to dive and escape through the dense surface and submerged vegetation that is so abundant in the shallow parts of the lake. On three occasions, June 27, July 4, and September 5, a

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family of these grebes was seen near the mouth of the channel that extends from the Bayou du Chien out into Upper Blue Basin. The numbers ranged from one adult and two immatures to two adults and four immatures.

DOUBLE CRESTED CORMORANT (*Phalacrocorax auritus auritus*)

The cormorant was a common resident on the lake throughout the summer. At no time was a large flock seen, although small numbers ranging up to fifty were seen almost every day. Five hundred were recorded by Crook (1934) as being seen in Grassy Bend. They like the open water. One of their most noticeable habits is to perch, sometimes with their wings outspread, on the tall cypress snags that are so characteristic of the lake.

Cormorants are of little value to the sportsman as they are unfit to eat. They are expert fishermen, being capable of diving to great depths to pursue their prey. The hazard they present to the fish supply has probably been greatly overrated because little data is available regarding their food habits. When the big cranetown was visited on August 31, the remains of forty cormorants were counted. It was learned from a native guide that certain fishermen had been shooting these cormorants and using their flesh for bait. Probably more than this number had been slaughtered.

WATER-TURKEY (*Anhinga anhinga*)

A rare summer resident during the course of study. This bird keeps to the timbered sections of the lake as already noted by C. Crook and A. F. Ganier (1932). About fifty nests in "Big Cranetown" were reported by Ganier.

WARD'S HERON (*Ardea herodias wardi*)

Although very common, they are solitary in habits, rarely more than one or two flushing from the same place. In the late part of the summer they would sometimes flock at the drying pools and basins surrounding the lake. Forty-five birds at Johnson's Basin and Otter Basin was the largest number seen in one day.

AMERICAN EGRET (*Casmerodius albus egretta*)

The egret was the commonest and most conspicuous bird on the lake. The numbers ranged from a few individuals to flocks of several hundred. Flocks as large as eight hundred were commonly seen feeding from the stumps in the open water out from the spillway at the south end of the lake. Crook made an estimate of 2,500 summering birds on the lake which the author feels is conservative. Usually preferring shallow water in which to feed, the egrets take advantage of the countless stumps and half sunken logs, using them as perches from which to spear the passing fish. Little is known of the economic significance of such action, but the reports of the fishermen that they destroy large amounts of game fish seem greatly exaggerated. In the last spring of 1935 and 1936, the writer visited the

large herony at Good Hope, Mississippi, and observed that the young egrets were fed almost entirely on crayfish which tends to corroborate the preceding statement.

LITTLE BLUE HERON (*Florida caerulea caerulea*)

A common visitor in the late summer, the little blues were rather rare in June and early July, the adults being very rare in comparison with the immatures. Although this bird fed in the stump fields along with the egrets, it was found in larger numbers in the shallow pools and basins around the lake.

EASTERN GREEN HERON (*Butorides virescens virescens*)

Called "Shikepoke" by the natives, this common little heron stays close to the shore where it is flushed from stumps hidden in the lilies or saw grass. The basins, arms, and bayous around the lake are its favorite feeding places. As many as thirty were seen during a single day. Many evenings at dusk fifteen or twenty birds in flocks of three or four were noted as they flew south over the Walnut Log Lodge, evidently going to roost.

BLACK-CROWNED NIGHT HERON (*Nycticorax nycticorax hoactli*)

A rare summer resident on the lake, twelve pairs nesting in the big herony were reported by Harry S. Vaughn (1933) and twelve nests containing eggs were found by George B. Woodring also in the big herony (1934). Several birds could usually be flushed from the trees along the edge of the Bayou du Chien, south of the biological station. On only three occasions single birds were seen flying over the open water of the lake, once at dusk and twice at sunrise. There are fourteen records for the summer with numbers ranging from one to ten.

YELLOW-CROWNED NIGHT HERON (*Nyctanassa violacea violacea*)

This is the rarest of the herons recorded on the lake. On June 7 four of these birds were seen flying south over the Bayou du Chien. Two were reported at Reelfoot Lake May 30, 1932, by Ganier.

EASTERN LEAST BITTERN (*Ixobrychus exilis exilis*)

This bird was a fairly common summer resident. On July 11, at Brewer Bar, eight adult birds and three nests were found, one nest with three young and another with four eggs. There are five records in all, three being made in Upper Blue Basin out from Walnut Log. They are very hard to find as they keep entirely to the saw grass areas.

WOOD IBIS (*Mycteria americana*)

This late summer visitor from the Gulf Coast was first seen on August 11 and became common during the last part of the month. There are ten records with numbers ranging from 1 to 250. They kept to the drying ponds and basins around the lake where they fed as scavengers on the trappd fish. Occasionally large flocks were

seen over the lake, usually circling high in the air with an alternating flapping and sailing flight.

COMMON MALLARD (*Anas platyrhynchos platyrhynchos*)

After the large flocks leave in the spring for the north, a few cripples remain. One mallard, evidently unable to fly, was seen June 7 in the opening of the long arm in Upper Blue Basin.

AMERICAN PINTAIL (*Dafila acuta tzitzihoa*)

On September 5 the writer and Mr. Carpenter of Louisville, Kentucky, found six "Sprigs" in Upper Blue Basin. These birds were evidently early arrivals and comprise the only record.

BLUE-WING TEAL (*Querquedula discors*)

A flock of 250 of these transient ducks arrived on August 30 and were seen flying over Upper Blue Basin. There are four records from August 30 to September 5 with numbers ranging from 4 to 250. The first of the ducks to return in the fall, this teal is a favorite of the huntsman, although it weighs less than half as much as the mallard.

WOOD DUCK (*Aix sponsa*)

Once considered in danger of extermination, the Wood Duck has been completely protected by law and is the only dabbling duck protected in such a manner. It is by no means a rare breeder on Reelfoot Lake which affords an ideal environment for its existence. It is called "summer" duck by the natives. Numbers ranging up to forty were present in the rice and lily fields of Upper Blue Basin during the entire study. They flushed easily and further announced their presence with shrill, plaintive call notes. Over five hundred birds were estimated to be in this area on August 30.

HOODED MERGANSER (*Lophodytes cucullatus*)

A pair of these fish ducks were seen in Upper Blue Basin on June 7. This is the only record, although it is listed as a fairly common permanent resident on the lake by Ganier (1933). Crook (1934) lists four records with numbers ranging from one to fifteen.

TURKEY VULTURE (*Cathartes aura septentrionalis*)

There are only eight records for the Turkey Vulture in the vicinity of the lake. It is more common in the hills to the east.

BLACK VULTURE (*Coragyps atratus atratus*)

More common than the preceding species in the lake area, this bird was usually seen around the ponds and basins that surround the lake, as previously noted by Crook (1934). Fourteen were recorded August 31 at the "Big Cranetown."

COOPER'S HAWK (*Accipiter cooperi*)

In the vicinity of the lake, single birds were noted on only three occasions, all after August 11.

EASTERN RED-TAILED HAWK (*Buteo borealis borealis*)

On July 30 one immature bird was seen sailing over the biological station.

FLORIDA RED-SHOULDERED HAWK (*Buteo lineatus alleni*)

This is a common summer resident. Hardly a day passed throughout the summer that the Red Shoulder's cry was not heard. It was seen on only fifteen different occasions, which is not surprising since it kept to the dense cypress woods.

BROAD-WINGED HAWK (*Buteo platypterus platypterus*)

One bird on July 28 circling over the open water of Upper Blue Basin. This comprises the only record of this hawk.

SOUTHERN BALD EAGLE (*Haliaeetus leucocephalus leucocephalus*)

Picking the tallest and strongest of the cypress snags for its perch, this king of birds was a familiar sight in Upper Blue Basin during the entire summer. There are fifteen sight records of the bird in this area. A nest near Mud Basin, two miles southwest of Walnut Log, was visited on June 15. The nest was empty, but an immature and two adult birds were seen perched in a tall cypress on the edge of the basin. On September 27 an immature bird was seen in Upper Blue Basin. August 31 two nests were visited near Big Ronaldson Slough. According to a native guide, Lem DeBerry, both nests were used their year and two birds were raised in each one. Ganier (1932) reports three or four pairs nesting on the lake.

MARSH HAWK (*Circus hudsonius*)

On August 28 one bird was seen flying over the fields at the south end of the lake and on August 31 one bird was seen over the rice fields in Upper Blue Basin. These were evidently early transients from the North.

OSPREY (*Pandion haliaetus carolinensis*)

Single birds were seen five times between June 2 and September 5. No nesting records have been established.

EASTERN SPARROW HAWK (*Falco sparverius sparverius*)

Common in the hills, this falcon was seen on the lake only twice.

EASTERN BOB-WHITE (*Colinus virginianus virginianus*)

Bob-whites were seen and heard nine times in the fields surrounding the lake and swamps.

KING RAIL (*Rallus elegans elegans*)

A fairly common summer resident, this bird keeps to the saw grass areas where it is hard to get more than a glimpse of it. It was seen five times between June 21 and August 31.

SORA RAIL (*Porzana carolina*)

Nesting farther north, the Sora Rail visits the lake only as a migrant. Two immature birds were seen on August 10 and single adult birds were seen August 11 and 12.

FLORIDA GALLINULE (*Gallinula chloropus cachinnans*)

The Florida Gallinule was heard more often than seen since it remains hidden in the vegetation. It was fairly common in Upper Blue Basin and rather abundant in a restricted area at Lake Center about two miles above Samburg. The largest number seen was fifteen, including a family of two adults and five young. There are eight sight records.

PURPLE GALLINULE (*Ionornis martinica*)

A careful study was made of the Lake Center area in search of the Purple Gallinule which had been reliably reported by natives. None were found, although one had been caught there in a turtle trap early in the spring and was mounted by Mr. Dietzel of Union City.

AMERICAN COOT (*Fulica americana americana*)

Listed as a common summer resident on Reelfoot Lake by Ganier (1933), the Coot was seen only eight times during the summer. Six were seen in the lily beds of Upper Blue Basin and seven, two adults and five immatures, were seen in Grassy Bend.

KILLDEER (*Oxyechus vociferus vociferus*)

The Killdeer kept to the fields nearby until the ponds and basins around the lake began to go dry. This formed ideal mud flats on which they fed. There are twenty records with numbers ranging up to thirty-two.

AMERICAN WOODCOCK (*Philohela minor*)

Four records from June 8 to September 3 in a very limited area indicate that the Woodcock is uncommon around the lake. Three of the records were made along the Bayou du Chien in front of the Walnut Log Lodge, the other being made in the dense woods behind the lodge.

SPOTTED SANDPIPER (*Actitis macularia*)

As previously noted by Crook (1934), the "Spotty" seemed to find plenty of food on the numerous partly submerged stumps and logs. On many occasions it was seen walking and feeding on the vegetation, mostly on duckweed, which became thick enough to support its weight when the water receded. First seen August 11, this transient later became common, eight being the most observed at one time.

EASTERN SOLITARY SANDPIPER (*Tringa solitaria solitaria*)

First recorded July 23, the Solitary became more common than the preceding species but was found only on the mud flats. On August

23 forty of these birds were found in Johnson's Basin, and as many as twenty were seen on three other occasions. There are seventeen records in all.

LESSER YELLOW-LEGS (*Totanus flavipes*)

This was a common and early arriving transient; small numbers were recorded over a long period of time. On July 21, 23, and September 5 single birds were seen flying over Upper Blue Basin. August 24 and 26 four and six birds were recorded in Brewer's Basin, and August 31 six were seen scattered along the south shore of the lake. On August 2, 1934, seventy-three individuals were observed over the lake by Crook.

PECTORAL SANDPIPER (*Pisobia melanotos*)

Although a common transient in this section, the pectoral was recorded only twice. On August 29 and 31 nine and one individuals were observed, respectively.

FORSTER'S TERN (*Sterna forsteri*)

The Forster's Tern so closely resembles the Common Tern that it is very difficult to distinguish them in the field. One of these Terns was collected on the lake by Crook (August 20, 1934). August 17, 1936, one adult and one immature, perched on one of the numerous snags, were identified by careful study and on September 2 a single bird was recorded. A careful check-up in the future might disclose that the Forster's Tern is more common in migration than formerly suspected.

COMMON TERN (*Sterna hirundo hirundo*)

It is probable that the records of these graceful terns include some Forster's along with the Common. There are seven records for these birds from August 11 to September 3, the largest flocks being seen on August 17 and numbering 25, 11, and 4 respectively. Nearly all of the records were made on the open water out from Samburg and the spillway.

LEAST TERN (*Sterna antillarum antillarum*)

First recorded on the lake on June 7, this little tern was very common throughout the summer. Flocks of about forty were usually seen on Upper Blue Basin. Nesting on the sandbars in the Mississippi River (Ganier, 1930), they find the lake an ideal feeding ground. Late in the summer, family groups appeared on the lake. The immature birds would sit on the stumps and give squealing calls, keeping their parents busy catching minnows for them.

BLACK TERN (*Chlidonias nigra surinamensis*)

The most abundant of the transient terns, the Black, was first recorded on July 25. There are seven other records with a flock of twenty being seen on September 4.

EASTERN MOURNING DOVE (*Zenaidura macroura caroliensis*)

A common summer resident, Doves were seen and heard daily about Walnut Log and the surrounding fields. The numbers ranged up to twenty.

YELLOW-BILLED CUCKOO (*Coccyzus americanus americanus*)

This bird was very common throughout the summer. Numbers of "Rain-crows" ranging up to eight were seen and heard daily around the station.

BARN OWL (*Tyto alba pratincola*)

Probably a rare permanent resident around the lake, although it is fairly common locally at Union City and vicinity. From a reliable source it was learned that at least five pairs of these owls nested there during the spring of 1936. There were only two records made near the lake, on June 18 and 23.

SOUTHERN SCREECH OWL (*Otus asio asio*)

This little owl is a fairly common summer resident, although it was heard by the writer only five times. It was often heard by Malcolm Barker, a fellow worker, who spent a great deal of time during the summer on nocturnal trips in the vicinity of the lake.

GREAT HORNED OWL (*Bubo virginianus virginianus*)

A rare permanent resident on Reelfoot Lake, this bird was heard only twice during the summer.

FLORIDA BARRED OWL (*Strix varia alleni*)

This is by far the commonest and noisiest owl at Reelfoot Lake. Its booming voice coming from the dense cypress woods was the usual program each evening. Several times as many as three or four could be heard at one time. Not always waiting for night, it sometimes sent out its call early in the evening or in the afternoon on cloudy days.

FLORIDA NIGHTHAWK (*Chordeiles minor chapmani*)

No Nighthawks were seen until the fall migration was well under way. There are three records, August 29, 30, and 31, when flocks of 22 and 32 were observed.

CHIMNEY SWIFT (*Chaetura pelagica*)

As they nested in the chimney of the Walnut Log Lodge, swifts were recorded every day. The numbers averaged twenty-five until late summer. On August 29, 149 were counted as they went down the chimney at the lodge.

RUBY-THROATED HUMMINGBIRD (*Archilochus colubris*)

The hummingbird was very common, even on the lake itself, in the open fields around the lake, and especially so in the clover fields at

the south end of the lake. The largest number seen in one day was twenty-six.

EASTERN BELTED KINGFISHER (*Megaceryle alcyon alcyon*)

The lake, the streams, and the surrounding basins were the territory of the Kingfisher. As many as seven were seen in one day.

SOUTHERN FLICKER (*Colaptes auratus auratus*)

This is probably the rarest of the woodpeckers at the lake. There are twenty records for the summer, but all were made within a limited area around Walnut Log.

SOUTHERN PILEATED WOODPECKER (*Ceophloeus pileatus pileatus*)

Seen or heard nearly every day, the Pileated Woodpecker proved to be a common resident. It is very fond of the deep cypress woods where as many as five were recorded in one day.

RED-BELLIED WOODPECKER (*Centurus carolinus*)

This is the commonest woodpecker at the lake. Numbers ranging from one to eight were recorded every day.

RED-HEADED WOODPECKER (*Melanerpes erythrocephalus*)

There are nineteen records for the summer; all from along the roads, where it was fairly common.

SOUTHERN HAIRY WOODPECKER (*Dryobates villosus auduboni*)

Twenty records scattered over the lake area comprise the summer's data on this species.

SOUTHERN DOWNY WOODPECKER (*Dryobates pubescens pubescens*)

Next to the Red-Bellied Woodpecker, the Downy was the most common. There are 45 records.

EASTERN KINGBIRD (*Tyranus tyrannus*)

Only five records of kingbirds were made before August 31, four of which were single birds. On three occasions a pair of these birds were observed mingling with the Purple Martins at Samburg. On August 31 a flock of 21, and on September 2, 15 more were recorded along the shore at Lake Center.

NORTHERN CRESTED FLYCATCHER (*Myiarchus crinitus boreus*)

The Crested Flycatcher proved to be a very common summer resident, found even in the clumps of cypress out in the lake.

ACADIAN FLYCATCHER (*Empidonax virescens*)

The Acadian Flycatcher was more common than the Crested in the lake region. It was especially so along the Bayou du Chien where it built its nest in the low overhanging branches.

EASTERN WOOD PEWEE (*Myiochanes virens*)

The Wood Pewee was an abundant summer resident, both in the cypress lowlands and in the highland mixed woods. It was the commonest of the flycatchers.

TREE SWALLOW (*Iridoprocne bicolor*)

Tree swallows first appeared on the lake on July 25 and were still present on September 5. The first group of fifteen was later followed by flocks as large as 1200.

BANK SWALLOW (*Riparia riparia riparia*)

Not recorded until August 11, the Bank Swallows soon outnumbered the preceding species. They proved to be the commonest swallows during migration.

ROUGH-WINGED SWALLOW (*Stelgidopteryx ruficollis serripennis*)

Rough-wings became abundant during migration in August and were only outnumbered by the Tree and Bank Swallows. While no suitable nesting sites were noted, even at a distance from the lake, seventeen records with numbers ranging up to 25 made during June and July indicate that this species is a fairly common summer resident in the lake area.

BARN SWALLOW (*Hirundo erythrogaster*)

On July 10 two of these graceful swallows were seen in Upper Blue Basin. They were not recorded again until August 11 when six were seen. There are ten records, the largest number being fifty seen during migration on August 13.

NORTHERN CLIFF SWALLOW (*Petrochelidon albifrons albifrons*)

Compared to the other swallows, the Cliffs were rare on the lake. First recorded August 11, they were seen on six occasions, five being the most seen at one time.

PURPLE MARTIN (*Progne subis subis*)

As recorded in the past by Ganier and Crook, these birds nested in hundreds at Samburg. The numbers of Martins increased to thousands during migration.

NORTHERN BLUE JAY (*Cyanocitta cristata cristata*)

Recorded almost every day, the Jay proved to be a common inhabitant both of the lake area and the surrounding country. Fifteen was the largest number seen at one time.

SOUTHERN CROW (*Corvus brachyrhynchos paulus*)

Common throughout the summer, hardly a trip out on the lake failed to yield some crows, as many as fifteen being seen at one time. A flock of 200 was observed on June 21.

CAROLINA CHICKADEE (*Penthestes carolinensis carolinensis*)

Common in the woods everywhere around the lake, they were especially so in the trees along the Bayou du Chien. The largest number seen in one day was 22.

TUFTED TITMOUSE (*Baeolophus bicolor*)

Although not in as large numbers as the Chickadee, the Titmouse was common, being recorded almost every day.

FLORIDA NUTHATCH (*Sitta carolinensis atkinsi*)

Nuthatches were regularly recorded from a limited area around Walnut Log; but were not numerous.

CAROLINA WREN (*Thryothorus ludovicianus ludovicianus*)

An abundant resident, this little wren was seen and heard every day.

PRAIRIE MARSH WREN (*Telmatodytes palustris dissaeptus*)

Rare at Reelfoot Lake, this bird was recorded on two occasions, August 31 and September 3. One individual was observed in the saw grass area of Upper Blue Basin and another was seen in the saw grass along the Bayou du Chien.

SHORT-BILLED MARSH WREN (*Cistothorus stellaris*)

On August 10 four birds were recorded about fifty yards from water in a weed-covered field bordering the south end of the lake.

EASTERN MOCKINGBIRD (*Mimus polyglottos polyglottos*)

Common in the hills east of the lake, the Mockingbird was seen only seven times, preferring, as usual, the vicinity of houses.

CATBIRD (*Dumetella carolinensis*)

There are only four records of the Catbird in the lake area, June 7, 8, 9, and August 18.

SOUTHERN ROBIN (*Turdus migratorius achrusterus*)

One bird, recorded August 29, was seen in the lake area. As in the case of the Catbird and Mockingbird, this bears out the observations of the previous writers.

WOOD THRUSH (*Hylocichla mustelina*)

The large areas of mixed woods around the edge of the lake and the neighboring hills proved very attractive to this species. It may be termed a common summer resident.

EASTERN BLUEBIRD (*Sialia sialis sialis*)

A family group, with the nest in a fence post near the Biological Station, accounted for all the records of this species.

BLUE-GRAY GNATCATCHER (*Polioptila caerulea caerulea*)

Being abundant summer residents in the woods along the edge of the Bayou du Chien, Gnatcatchers were recorded on fifty-five occasions.

MIGRANT SHRIKE (*Lanius ludovicianus migrans*)

Although commonly recorded along the roads surrounding the lake, the Shrike was seen only once on the lake itself.

WHITE-EYED VIREO (*Vireo griseus griseus*)

Common throughout the summer, the White-eye preferred its usual habitat of thickets.

YELLOW-THROATED VIREO (*Vireo flavifrons*)

Common, as the fifty-one records indicate, this vireo was not found in as large numbers as either the White-eye or the Red-eye.

RED-EYED VIREO (*Vireo olivaceus*)

Commonest of the vireos, the Red-eye was recorded every day in numbers ranging up to eighteen.

EASTERN WARBLING VIREO (*Vireo gilvus gilvus*)

Rare in the vicinity of the lake, this species was recorded twice. On July 29 and August 31 single birds were seen and heard in a patch of willows at Lake Center, two miles above Samburg.

BLACK AND WHITE WARBLER (*Mniotilta varia*)

Seen only four times between July 18 and September 4, this warbler must be considered rare at the lake in the summer.

PROTHONOTARY WARBLER (*Protonotaria citrea*)

Abundant, compared to the other members of its family, this brilliantly colored swamp warbler was recorded nearly every day, the numbers ranging up to thirty-six.

SWAINSON'S WARBLER (*Limnothlypis swainsoni*)

One bird, July 14, was seen and heard in the dense swamp at the upper end of Bayou du Chien. However, there are many suitable environments for this rare species. On May 2, 1936, a pair of these warblers was seen, by the writer, on the island in front of the Biological Station.

WORM-EATING WARBLER (*Helmitheros vermivorus*)

A single bird was seen on August 19 in the low bushes along the Bayou du Chien near the Biological Station.

BLUE-WINGED WARBLER (*Vermivora pinus*)

One male was seen on August 31 in the bottomlands west of the lake.

NORTHERN PARULA WARBLER (*Compsothylypis americana pusilla*)

Thirty-seven records indicate that this bird is not an uncommon summer resident. A pair nested near the Biological Station and were observed several times in the surrounding trees feeding their young which had left the nest.

EASTERN YELLOW WARBLER (*Dendroica aestiva aestiva*)

Yellow Warblers were seen on two different days in the willows bordering on the lake. A single bird was seen August 14 and another was seen August 31. On the latter date four were recorded along the Mississippi River just below Tiptonville.

MAGNOLIA WARBLER (*Dendroica magnolia*)

Five records on August 19 and a single one on September 4 comprise the data on this transient warbler.

CERULEAN WARBLER (*Dendroica cerulea*)

The status and habitat of this bird is similar to that of the Parula. There are thirty-five records, most of which were taken along the Bayou du Chien which indicates that it is a common summer resident in that area. In June and early July as many as five or six could be heard singing during the course of a day.

SYCAMORE WARBLER (*Dendroica dominica albilora*)

Widely distributed over the lake area, this species was recorded forty-nine times. It preferred the tall cypress trees and was thus heard out on the lake itself.

LOUISIANA WATER THRUSH (*Seiurus motacilla*)

This warbler was recorded twenty-eight times during the course of study, the numbers ranging from 1 to 10.

KENTUCKY WARBLER (*Oporornis formosus*)

The Kentucky Warbler was found to be a common summer resident in the dense woods. As many as fourteen were recorded in a day.

MARYLAND YELLOW-THROAT (*Geothlysis trichas trichas*)

Common throughout the summer in the saw grass areas and in fields around the lake, the Yellow-throat was recorded almost every day, with numbers ranging from 1 to 22.

YELLOW-BREASTED CHAT (*Icteria virens virens*)

There are forty-eight widely distributed Chat records for the summer, the largest number seen being twelve. The Chats were very noisy and active during the first part of the summer but by August they were quiet and hard to find. Only seven records were made during this month.

HOODED WARBLER (*Wilsonia citrina*)

Recorded thirty-six times in the dense woods, this bird proved to be a common summer resident.

WILSON'S WARBLER (*Wilsonia pusilla pusilla*)

A single bird was seen on September 3 in the woods in front of the Biological Station.

CANADA WARBLER (*Wilsonia canadensis*)

On August 19 four of these birds were seen on the island in front of the Biological Station. This is the only record of this transient species.

AMERICAN REDSTART (*Setophaga ruticilla*)

This beautiful species was very common in the dense woods during the entire summer as the forty-seven records show. The numbers ranged from 1 to 22.

SOUTHERN MEADOWLARK (*Sturnella magna argutula*)

Common in the fields a few miles east of the lake, Meadowlarks were recorded in the lake area only twice.

EASTERN RED-WING (*Agelaius phoeniceus phoeniceus*)

The Red-wings were abundant in the saw grass areas where they nested and roosted. Later in August they made daily excursions in large flocks from the lake to the neighboring cornfields. The flocks varied from fifty to several thousand. On September 3, 15,000 were estimated as they went to roost in Upper Blue Basin.

ORCHARD ORIOLE (*Icterus spurius*)

Present only from June 7 to June 26, the Orchard Oriole was a rare bird at the lake. There are nine records of one or two birds all in a very limited area near the Biological Station.

BRONZED GRACKLE (*Quiscalus quiscula aeneus*)

Abundant during the entire summer, this Grackle was only outnumbered by the Red-wings.

EASTERN COWBIRD (*Molothrus ater ater*)

Not recorded at the lake in the late summer of 1934 by Crook, Cowbirds were recorded forty times in the field between the Biological Station and Walnut Log Lodge during June and July, the numbers ranging up to twenty. Only one record was made in August. Immature Cowbirds were associated with Chipping Sparrow groups, although none were observed to be fed by them.

SUMMER TANAGER (*Piranga rubra rubra*)

Common in the wooded sections, Summer Tanagers were recorded nearly every day.

EASTERN CARDINAL (*Richmondia cardinalis cardinalis*)

Cardinals were very common in every wooded section.

INDIGO BUNTING (*Passerina cyanea*)

Abundant along the fields and thickets, Indigo Buntings were recorded nearly every day of the study, with numbers ranging from 1 to 25.

DICKCISSEL (*Spiza americana*)

Two records, July 16 and August 10, each of three birds in the fields of the south end of the lake, comprise all the data for Dickcissels.

EASTERN GOLDFINCH (*Spinus tristis tristis*)

Goldfinches were present around the lake all summer. They were first recorded on June 14. There were four records in June, nine in July, and eighteen from August 11 to September 5. Eight was the largest number seen at one time.

EASTERN CHIPPING SPARROW (*Spizella passerina passerina*)

The Chipping Sparrow was common about Walnut Log Lodge, the only place where this species was found. Four or five family groups were noted continually.

EASTERN FIELD SPARROW (*Spizella pusilla pusilla*)

The Field Sparrow was only recorded in the fields near the Biological Station and there during June and July. No more than five were recorded at any one time.

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