

MOVEMENTS OF FISHES INTO LAKE PANASOFFKEE AS RELATED TO PHYSICAL AND CHEMICAL CHANGES IN THE CONNECTING WITHLACOOCHEE RIVER IN CENTRAL FLORIDA

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DESCRIPTION OF WATERS

Lake Panasoffkee has been described (Moody, 1954) as a spring-fed lake about seven miles long by a mile wide whose overflow is received by Withlacoochee River through connecting Outlet River. The watershed of Panasoffkee is in the region of the Ocala Uplift (Cooke, 1945), but is derived from above the underlying Ocala limestone of Eocene age. The Withlacoochee River is a narrow sluggish stream well over a hundred miles in length which rises in Polk County (Cooke, 1939) and receives drainage principally from surface water run-off in the large flat grassy and cypress area in Hernando, Citrus and Sumter Counties immediately north of its source. It follows a north-north-westerly course past Lake Tsala Apopka, with which it is connected in several places, widens at Dunnellon where its waters are impounded by a power dam to form the Backwaters, and empties into the Gulf at Yankeetown. The Outlet River is a stream about three miles in length flowing slowly from the central part of the West shore of Lake Panasoffkee into the Withlacoochee approximately midway of its length. The waters of Outlet River are normally composed entirely of lake water and are light colored, in contrast to the darker tea color of the waters of the River which receives it.

At rare periods, however, because of greater rainfalls over the river's watershed than over the lake, water from the river enters the Outlet, where it backs up at the mouth of the lake until it has sufficient volume to empty into Lake Panasoffkee. The writer knows of only two such periods, and is acquainted with no one who remembers others (the latter is perhaps a commentary on the extreme recency of the lake's development: twenty years ago it was almost inaccessible by land, and there were only two inhabited spots on its shores). The first period of the reversal of the Outlet's flow occurred in September, 1950, as a result of a hurricane which brought sixteen inches of rain at Inverness (Table II, from Supplement 1955), after a period of extreme low water (Table I).

INITIAL FISH ACTIVITIES AND WATER FLUCTUATIONS

Reports on observations of the appearance of large schools of fishes in Outlet River over a period of years were so widespread that it was difficult not to lend them a certain credence; hence when on July 30, 1955 large numbers of shellcracker and bluegill were reported moving in schools from the Outlet into the Lake, a study was instituted. In the evening of August 7, 1955, hundreds of bass of all sizes were seen swimming in the Outlet towards Lake Panasoffkee. The following morning several dead individuals were seen floating in Outlet River with no external cause of death evident. Bass were, also, seen in schools that day, August 8; and the following morning, August 9, more dead individuals of varying sizes were observed. Correlated with this phenomenon, the Withlacoochee River had begun a rapid rise (Table I), because of increased rainfall in its watershed (Table II, from Supplement 1955).

A search of fisheries records for Panasoffkee in 1954 (Unpublished data) disclosed that a similar phenomenon occurred on August 12, 1954, when large numbers of shellcracker, bluegill, and bass were seen in the Outlet, and their appearance marked the beginning of a period of excellent fishing success. Excellent fishing ensued in Outlet River and in Lake Panasoffkee, also, following the appearance of the fish on August 7, 1955; many of them were darker in color than those ordinarily taken in Lake Panasoffkee and Outlet River. Fishes taken in the Withlacoochee River are almost invariably of that same dark coloration.

CHEMICAL AND PHYSICAL METHODS

Air and water temperatures at the surface were taken at selected stations in the Lake, River, and Outlet. Hydrogen ion concentration was determined colorimetrically, and dissolved oxygen and acidity in terms of carbon dioxide in parts per million, following a procedure outlined by Welsh (1948), were also defined. During the last two days of the study an analysis of alkalinities as milligrams per liter of calcium carbonate was made using the Welsh (Op Cit.) method.

WITHLACOOCHEE RIVER

It was found that as the level of the Withlacoochee rose pH values of its waters dropped, acidities in terms of carbon dioxide increased, and dissolved oxygen content showed a general decline (Table III). It is interesting to note that in Robertson's Spring, a small circular boil on the east bank of the Withlacoochee south of Rutland Bridge several large shellcracker were seen, although the oxygen content of the water was less than 1 p. p. m. (Table III, Station 4). Dendy (1946) found that in Norris Reservoir fish were caught in water containing too little oxygen (1.5 p. p. m. or less) to support them for extended periods, and he predicted (1948) their distribution in depth on the basis of the relation of temperature and dissolved oxygen. However, others factors undoubtedly also were responsible for the presence of the shellcracker in the spring; acidity was much lower and pH was higher than in the adjacent Withlacoochee waters (Table III, Stations 3 and 5). A great deal of fish activity was seen at Station 14, a ditch cut through the swamp to drain a pond a quarter of a mile away from the river. Here, again, pH was higher, and acidity in terms of carbon dioxide slightly lower; but the deciding factor was probably the marked increase in oxygen content over that of nearby river waters (Table III, Stations 3 and 5).

Alkalinities of the river waters consisted, as was expected, of bicarbonates only, 23 to 26 p. p. m., everywhere except in the Backwaters. Fishing in the River from Carlson's Landing to Wynn Haven and southwards had been exceptionally bad since July, 1955; the writer had spent many hours on the River during July-September, 1955 period, and has counted, in all, half a dozen boats, the occupants of none of which had caught fish. At the Withlacoochee Backwaters fishing had been "bad all summer, but was better in July than in August" according to one camp operator. This fits in the general picture of the gradual rise in the Withlacoochee. Chemical and physical data also demonstrate the trend (Table III, Station 1): pH higher than upstream, acidity slightly lower, bicarbonates higher.

The waters of the Withlacoochee progressed in color from coffee to dark-coffee-colored in measure as the level rose, and in its early stages was lighter in color in its northern reaches than in its southern. On August 11 and 24, near the source of Jumper Creek pH was 8.5 and 7.8 respectively, carbon dioxide was absent, the oxygen content was high despite high water temperatures (Table III, Station 12); the water was clear. By September 18 the whole creek, from source to mouth had taken on the same dark-coffee color of river water, was swollen with Withlacoochee flow, and it was deemed unnecessary to sample it chemically or physically. By September 18 the entire River had become a uniform dark coffee shade.

THE OUTLET AND LAKE PANASOFFKEE

Lake Panasoffkee water shows limpidly clear in a glass flask, but nearly all year round exhibits a beautiful, almost emerald-green color because of the presence of abundant phytoplanktal algae. The current in the Outlet River flows slowly on calm days, is almost still during a west wind, and increases slightly with an east wind. It is identical with Panasoffkee water.

Fishing success had been exceptionally good in Lake Panasoffkee near the mouth of the Outlet from August 7, after a period of slowness, according to camp operators, and continued good. Evidence that people were catching fish appeared in the form of many boats fishing at the mouth daily; limits of bass, shellcracker and bluegill were frequently seen and counted. On September 4, 1955, the rising Withlacoochee had backed up into the Outlet and stopped the

flow from the lake. By September 11 coffee-colored water filled the whole length of the Outlet. The water gage reading in Panasoffkee on September 14, after the Outlet had reversed its flow, was 0.78 feet while that of the River at Carlson's Landing was 1.95 feet. Hence, Lake Panasoffkee appears to be normally a foot higher than the level of the Withlacoochee at Carlson's Landing (Table I). Fishing continued good near the mouth of the Outlet. During this period, schools of threadfin shad were observed in the Outlet and bass appeared in schools feeding on them. The author is a poor fisherman, but on September 15 he went fishing with a cane pole and worms at Panavista Lodge at the mouth of the Outlet. He caught twenty bream (three shellcracker and seventeen blue-gill) and two bass. The bass were small (8.0-8.5 inches in length), were light in color, and had apparently been attracted to the mouth of the Outlet by the threadfins there. Thirteen of the bluegill and two of the shellcracker were dark in coloration, while the others were light. While fishing the writer noted several dead bluegill about five inches long floating out of the mouth of the Outlet. They were secured and examined, but no external cause of death was apparent. Numerous dead fish had been reported in the Withlacoochee River north of the Outlet earlier that week. Constant streams of fish were seen moving into Lake Panasoffkee from the mouth of the Outlet as the author sat fishing September 15. He sat anchored at the mouth of the Outlet from 10:00 A. M. until 7:00 P. M. On September 18 good fishing was still concentrated at the mouth of the Outlet, but numerous bass, shellcracker and bluegill were caught trolling farther out in the lake.

A distinct line of demarkation between Outlet water (become Withlacoochee water) and Panasoffkee water was observed September 15 and 18 in the lake, about fifty yards from the mouth of the Outlet. By September 26 the color of the water on about half of the west side of the lake showed evidences of being mixed with River water. Fishing success continued excellent during this time: many of the fish caught were small and dark; most were taken at the mouth of the Outlet in Panasoffkee.

On September 28 the Outlet began again to flow normally, the water at Panavista had become transparent, and a flow was noticeable from the lake. However, at the point midway in the Outlet between the Withlacoochee and Panasoffkee the water was coffee-colored. The next day, September 29, however, the water here was light tea-colored, and chemical analysis showed evidences of the influx of lake water (Table III, Station 7). Water gage readings (Table I) showed the beginnings of receding waters in both the lake and the river. The rainfall in September had been slight (Table II).

Panasoffkee water is soft (Collins, 1928), with less than 50 p. p. m. calcium carbonates. As in all natural Florida waters (Black, 1951) the hydroxide is absent; bicarbonates were found in quantities varying from 23 to 32 p. p. m., and carbonates from 16 to 28 p. p. m. The high dissolved oxygen content of Panasoffkee waters (Table III, Station 10) appears to be due to the great phytoplankton content of the water, as also the absence of carbon dioxide. Pierce (1941) found that the disappearance of free carbon dioxide in the St. Johns River was related to large increases in the blue-green alga, *Raphidiopsis curvata*.

The stations in the Outlet where Panasoffkee waters mingled with river waters (Table III, Stations 7, 8, and 9) exhibited a lower acidity than river waters and a higher pH value, but did not contain carbonates.

CONCLUSIONS

1. Rainfall on the Withlacoochee River Basin caused a fairly rapid rise in its water level in July and August, 1955, which produced an increase in its carbon dioxide content and a decrease in the pH and in dissolved oxygen.

2. The above changes apparently were related to a lack of fishing success in the Withlacoochee River.

3. The changes appeared also to have caused fish from the Withlacoochee River to enter Lake Panasoffkee, about three miles distant, in numbers.

4. Greater rainfall on the Withlacoochee River basin than on Lake Panasoffkee drainage system caused the river to rise to a level higher than the lake, and caused the Outlet River which normally flows from it to flow into the lake.

5. Fishing success apparently increased in Lake Panasoffkee at its meeting with the Outlet River because of conditions brought about by the rise of the Withlacoochee River.

6. It might be possible to predict periods of good fishing success in Lake Panasoffkee by comparing rainfall data in its drainage region with that of the Withlacoochee River Basin.

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TABLE I
WATER LEVEL FLUCTUATIONS ON LAKE PANASOFFKEE AND THE WITHLACOOCHEE RIVER AS RELATED TO DIRECTION OF OUTLET RIVER FLOW

Date	Water Gage Reading in Feet	
	River	Lake
June 5, 1950	Normal: Outlet flows from Lake	1.22
August 1, 1950		0.72
September 19, 1950	Reversed: Outlet flows from River	3.32
March 12, 1951	Normal: Outlet flows from Lake	0.39
_____ 1952		...
_____ 1953		...
April 23, 1954		0.50
July 9, 1955	0.00	0.00
July 31, 1955	0.62	0.00
August 10, 1955		0.00
August 11, 1955	0.75	...
August 17, 1955	0.95	...
August 23, 1955	1.15	...
September 4, 1955	Reversed: Outlet flows from River	...
September 11, 1955	1.85	...
September 14, 1955	1.95	0.78
September 18, 1955	1.95	0.86
September 20, 1955	2.06	0.90
September 26, 1955		1.00
September 28, 1955	Normal: Outlet begins again to flow from Lake	...
September 28, 1955	2.10	1.02
September 29, 1955	2.00	0.98

TABLE II
TOTAL PRECIPITATION IN INCHES AT U. S. RAIN GAGE STATIONS NEAR LAKE PANASOFFKEE AND SOURCE OF THE WITHLACOOCHEE RIVER, RESPECTIVELY

Date	Total Rainfall in Inches	
	Inverness	Lake Alfred
June, 1950	4.07	5.95
August, 1950	8.88	6.34
September, 1950	16.54 (Outlet reverses after hurricane)	12.62
February, 1951	10.21	0.00
March, 1951	5.35	2.07
April, 1951	1.57	8.66
March, 1954	2.69†	1.21‡
	Bushnell	
April, 1954	1.55‡	3.35‡
June, 1955	8.25‡	3.81‡
July, 1955	6.47	...
August, 1955	5.21	...
Sept., 1955 (to Sept. 28 only)	2.59† (Outlet reverses)	Much rainfall (data not available)

* Inverness and Bushnell rainfalls have been approximately equal from June, 1955; because of availability, the data from Bushnell has been used in the latter part of the table.

† Courtesy Mrs. A. H. Nelson: Bushnell Weather Station.

‡ From 1954, Climatological Data, Vols. LVIII, LIX.

TABLE III
 CHEMICAL AND PHYSICAL CHANGES AT SELECTED STATIONS ON
 LAKE PANASOFFKEE AND WITHLACOOCHEE RIVER
 (In Sequence, Mouth Toward Source)

Date	Time	Temperature of*		Parts Per Million		pH	Alkalinities as ppm of Calcium Carbonate		
		Water	Air	O ₂	CO ₂		CO ₃	HCO ₃	
STATION 1 (Withlacoochee Backwaters)									
Sept. 21, 1955	6:30 PM	81	80	2.0	13.0	7.0	..	..
Sept. 26, 1955	6:00 PM	80	82	1.8	14.0	7.0	..	..
Sept. 28, 1955	12:45 PM	83	92	1.8	17.0	7.0	0	47	
STATION 2 (Lake Tsala Apopka at Inverness)									
Sept. 28, 1955	10:30 AM	82	..	5.0	18.0	7.0	0	58	
STATION 3 (One mile above Rutland Bridge)									
Aug. 24, 1955	3:30 PM	90	92	2.0	11.0	6.7	..	..
Sept. 18, 1955	3:00 PM	92	84	2.0	13.0	6.5	..	..
STATION 4 (Robertson's Spring)									
Aug. 24, 1955	3:00 PM	72	93	0.7	7.0	7.5	..	..
Sept. 18, 1955	2:30 PM	72	90	0.6	6.0	7.5	..	..
STATION 5 (Carlson's Landing)									
Aug. 11, 1955	11:45 AM	87	89	1.6	13.0	6.8	..	..
Aug. 24, 1955	2:30 PM	88	93	2.0	15.0	6.3	..	..
Sept. 18, 1955	2:00 PM	92	82	2.2	12.0	6.3	..	..
Sept. 28, 1955	3:00 PM	84	89	1.2	18.0	6.5	0	26	
STATION 6 (Jct. of Withlacoochee and Panasoffkee Rivers [Princess Lake])									
May 1, 1951	2:45 PM	82	82	6.0	..	7.6	..	..
Aug. 10, 1955	1:30 PM	..	..	2.8	8.0	7.0	..	..
Aug. 24, 1955	10:50 AM	85	90	1.2	13.0	6.5	..	..
Sept. 18, 1955	12:45 PM	82	92	2.0	13.0	6.3	..	..
Sept. 29, 1955	2:00 PM	81	88	1.4	18.0	6.3	0	23	
STATION 7 (Halfway between Lake Panasoffkee and Withlacoochee River [in Outlet])									
Sept. 28, 1955	5:00 PM	86	84	2.0	10.0	7.2	0	41	
Sept. 29, 1955	3:15 PM	85	88	3.6	4.0	7.0	0	43	
STATION 8 (Outlet at Panavista)									
Aug. 10, 1955	4:45 PM	94	95	6.8	0.0	8.0	..	..
Aug. 24, 1955	10:00 AM	86	85	4.0	0.0	7.5	..	..
Sept. 18, 1955	11:30 AM	82	88	9.8	0.0	9.0	..	..
Sept. 20, 1955	1:15 PM	84	92	2.0	8.0	7.0	..	..
Sept. 22, 1955	4:00 PM	84	88	0.6	13.0	7.0	..	..
Sept. 26, 1955	11:45 AM	86	83	1.0	13.0	7.0	..	..
Sept. 28, 1955	3:30 PM	90	92	7.6	0.0	9.0	16	32	

TABLE III—Continued
 CHEMICAL AND PHYSICAL CHANGES AT SELECTED STATIONS ON
 LAKE PANASOFFKEE AND WITHLACOOCHEE RIVER (See Fig. 1)

Date	Time	Temperature of*		Parts Per Million		pH	Alkalinities as ppm of Calcium		
		Water	Air	O ₂	CO ₂		Carbonate CO ₃	HCO ₃	
STATION 9 (Mouth Outlet at Lake Panasoffkee)									
Sept. 14, 1955	3:45 PM	89	92	2.0	9.0	7.0	..	..
Sept. 18, 1955	12:15 PM	84	90	3.0	7.0	7.0	..	..
Sept. 26, 1955	11:45 AM	86	83	1.0	13.0	7.0	..	..
Sept. 28, 1955	3:45 PM	89	92	8.0	0.0	9.3	16	32	
STATION 10 (Middle of Lake Panasoffkee)									
April 24, 1951	9:30 AM	76	76	11.6	0.0	8.0	..	..
April 13, 1954	9:40 AM	80	79	7.2	0.0	8.2	..	..
Aug. 26, 1955	3:00 PM	87	88	7.4	0.0	8.5	..	..
Sept. 14, 1955	4:30 PM	91	89	11.2	0.0	8.5	..	..
Sept. 18, 1955	11:30 AM	82	88	9.8	0.0	9.0	..	..
Sept. 20, 1955	1:30 PM	85	89	8.7	0.0	9.0	..	..
Sept. 22, 1955	4:30 PM	89	90	9.0	0.0	9.0	..	..
Sept. 26, 1955	12:30 PM	86	92	9.4	0.0	9.0	..	..
Sept. 28, 1955	3:30 PM	90	92	7.6	0.0	9.0	16	32	
Sept. 28, 1955	4:00 PM	88	92	9.0	0.0	9.3	20	34	
Sept. 28, 1955	4:30 PM	86	90	10.2	0.0	9.5	28	23	
Sept. 29, 1955	3:45 PM	85	89	10.4	0.0	9.2	18	29	
STATION 11 (Mouth of Jumper Creek upstream from mouth of Outlet)									
April 27, 1954	11:00 AM	78	83	3.8	8.0	7.5	..	..
Aug. 11, 1955	2:30 PM	86	..	1.3	18.0	6.4	..	..
Aug. 24, 1955	11:40 AM	88	93	1.0	18.0	6.3	..	..
Sept. 18, 1955	1:15 PM	84	93	2.0	12.0	6.3	..	..
STATION 12 (Near head of Jumper Creek)									
Aug. 11, 1955	3:15 PM	98	96	12.6	0.0	8.5	..	..
Aug. 24, 1955	1:00 PM	92	93	14.6	0.0	7.8	..	..
STATION 13 (At Wynn Haven Lodge)									
May 3, 1951	10:00 AM	78	84	4.0	..	7.0	..	..
Sept. 20, 1955	3:45 PM	82	88	1.5	15.0	6.2	..	..
Sept. 26, 1955	3:30 PM	82	90	0.7	18.0	6.3	..	..
STATION 14 (Schinn's Drainage Ditch)									
Sept. 18, 1955	3:45 PM	88	86	3.4	10.0	6.7	..	..
STATION 15 (Withlatchoochee River at Hernando-Pasco County Line 20 miles south of Wynn Haven)									
Sept. 21, 1955	3:00 PM	82	92	2.0	14.0	6.5	..	..

* Temperatures given in degrees Fahrenheit.