

STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES
Harmon Shields, Executive Director

DIVISION OF INTERIOR RESOURCES
Charles M. Sanders, Director

BUREAU OF GEOLOGY
Charles W. Hendry, Jr., Chief

REPORT OF INVESTIGATIONS NO. 71

CHEMICAL AND BIOLOGICAL CONDITIONS
OF LAKE OKEECHOBEE, FLORIDA, 1969 - 72

By
Boyd F. Joyner

Prepared by the
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
BUREAU OF GEOLOGY
DIVISION OF INTERIOR RESOURCES
FLORIDA DEPARTMENT OF NATURAL RESOURCES
and the
CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL DISTRICT

TALLAHASSEE, FLORIDA
1974

STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES
Harmon Shields, Executive Director

DIVISION OF INTERIOR RESOURCES
Charles M. Sanders, Director

BUREAU OF GEOLOGY
Charles W. Hendry, Jr., Chief

REPORT OF INVESTIGATIONS NO. 71

**CHEMICAL AND BIOLOGICAL CONDITIONS
OF LAKE OKEECHOBEE, FLORIDA, 1969 - 72**

By
Boyd F. Joyner

Prepared by the
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
BUREAU OF GEOLOGY
DIVISION OF INTERIOR RESOURCES
FLORIDA DEPARTMENT OF NATURAL RESOURCES
and the
CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL DISTRICT

TALLAHASSEE, FLORIDA
1974

**DEPARTMENT
OF
NATURAL RESOURCES**

REUBIN O'D. ASKEW
Governor

DOROTHY W. GLISSON
Secretary of State

ROBERT L. SHEVIN
Attorney General

THOMAS D. O'MALLEY
Treasurer

FRED O. DICKINSON, JR.
Comptroller

RALPH D. TURLINGTON
Commissioner of Education

DOYLE CONNER
Commissioner of Agriculture

HARMON W. SHIELDS
Executive Director

LETTER OF TRANSMITTAL

Bureau of Geology
Tallahassee
October 16, 1974

Honorable Reubin O'D. Askew, *Chairman*
Department of Natural Resources
Tallahassee, Florida

Dear Governor Askew:

We are pleased to make available the report, "Chemical and Biological Conditions of Lake Okeechobee, Florida, 1969 - 72" by Boyd F. Joyner. The purpose of this report is to document the present status of Lake Okeechobee with respect to nutrient enrichment. An assessment of the source and status of enrichment of the lake system is necessary for all future studies or action, and for establishing a decision base line for managing water and water quality.

Respectfully yours,

Charles W. Hendry, Jr., *Chief*
Bureau of Geology

Completed manuscript received
May 8, 1974
Printed for the Florida Department of Natural Resources
Division of Interior Resources
Bureau of Geology

Tallahassee
1974

CONTENTS

Summary	1
Introduction	3
Purpose, scope, and sampling procedure	3
Acknowledgments	8
Description of Lake Okeechobee and drainage system	9
History of the lake	9
Physical features	9
Tributaries	10
Drainage	11
Hydrologic characteristics, 1969 - 70	12
Precipitation	12
Inflow	13
Outflow	14
Water budget, January 1969 - July 1970	15
Chemical and physical characteristics of water and sediment, 1969 - 70	17
Lake Okeechobee	17
Physical characteristics of water	17
Major chemical constituents	19
Distribution of nitrogen and phosphorus	22
Trace elements	28
Pesticides	28
Bottom sediments	30
Tributaries	30
Drainage canals	39
Nitrogen and phosphorus in rainfall	40
Water-quality budget, 1969 - 70	43
Biological characteristics of Lake Okeechobee, 1969 - 72	45
Phytoplankton	45
Benthic organisms	50
Chemical, physical, and biological characteristics of water and sediment, 1970 - 72	52
Chemical and physical characteristics of water	52
Physical characteristics and dissolved solids	52
Nitrogen and phosphorus	53
Trace elements	54
Chemical characteristics of bottom sediments	54
Biological characteristics	54
Phytoplankton	54
Benthic organisms	55
Eutrophic assessment	55
Selected references	59
Appendix	63

ILLUSTRATIONS

Figure	Page
1. Map of Lake Okeechobee and drainage system showing location of sampling points	4
1A. Rainfall over Lake Okeechobee, January 1969 - July 1970	13
2. Average seasonal variations of dissolved solids, dissolved oxygen, and water temperature in Lake Okeechobee	21
3. Average distribution of nitrogen (N) in Lake Okeechobee	23
4. Areal and seasonal variations of nitrogen (N) in Lake Okeechobee	24
5. Average distribution of phosphorus (P) in Lake Okeechobee	26
6. Areal and seasonal variations of phosphorus (P) in Lake Okeechobee	27
7. Nitrogen (N) in tributaries	35
8. Phosphorus (P) in tributaries	36

TABLES

Table	Page
1. Locations of routing sampling sites on Lake Okeechobee	5
2. Chemical and biological sampling of Lake Okeechobee	7
3. Water budget for Lake Okeechobee, January 1, 1969, to July 31, 1970 ...	16
4. Trace metal concentrations in Lake Okeechobee	29
5. Pesticide analyses of water and bottom sediment for Lake Okeechobee ...	31
6. Average chemical analyses of bottom sediments in Lake Okeechobee	37
7. Nitrogen and phosphorus in rainfall at Hurricane Gate Structure - 1	41
8. Generalized water and dissolved solids budget for Lake Okeechobee (January 1, 1969 to January 31, 1970)	44

TABLES — Continued

Table	Page
9. Generalized nitrogen (N) budget for Lake Okeechobee, January 1, 1969 to January 31, 1970	46
10. Generalized phosphorus (P) budget for Lake Okeechobee, January 1, 1969 to January 31, 1970	47
11. Phytoplankton observed in Lake Okeechobee	49
12. Average number of bottom organisms per square meter, January, May, August, 1969, and January 1970	51
13. Chemical analyses of water in Lake Okeechobee	65
14. Chemical analyses of water in tributaries to Lake Okeechobee	75
15. Chemical analyses of water in drainage canals of Lake Okeechobee	81
16. Phytoplankton in Lake Okeechobee	85
17. Chemical and biological analyses of water and bottom sediments in Lake Okeechobee, Kissimmee River and Taylor Creek, October 1970 - May 1972	86
18. Phytoplankton observed in Lake Okeechobee, Kissimmee River and Taylor Creek, August 1971 - May 1972	93
19. Average number of bottom organisms per square meter in Lake Okeechobee November 1971 and May 1972	94

CHEMICAL AND BIOLOGICAL CONDITIONS OF LAKE OKEECHOBEE, FLORIDA, 1969 - 72

By
Boyd F. Joyner

SUMMARY

Nutrients are adequate in water in Lake Okeechobee for algal growth. Organic nitrogen averaged 1.3 mg/l (milligrams per liter) and accounted for approximately 86 percent of the total nitrogen, and total phosphorus (P) averaged 0.05 mg/l. The average dissolved-solids content of the lake water was 288 mg/l in 1969 - 72 compared to 190 mg/l in 1940 - 41. Dilution and flushing from greater-than-average rainfall and use by algae, however, decreased dissolved solids from 309 mg/l in January 1969 to 210 mg/l in April 1970, near average value for the 1940 - 41 sampling.

Rainfall contributes significant amounts of nutrients to the lake, and concentrations in rain are at times similar to concentrations in both the lake and its major tributaries. Rainfall contributes 30 percent of the total nitrogen and 21 percent of the total phosphorus load. Major tributary sources include the Kissimmee River, which contributes 39 percent of the total nitrogen and 36 percent of the phosphorus loads, and Taylor Creek, which contributes 26 percent of the total phosphorus load. Twenty-two percent of the nitrogen and 36 percent of the phosphorus entering Lake Okeechobee is retained within the bottom sediments and biota. Water pumped from agricultural areas to the southeast is generally the poorest in quality of all water entering Lake Okeechobee. Trace elements in the lake water are in low concentrations, but are usually adequate for sustaining healthy algal growth. Boron, aluminum, copper, and manganese, are below the probable minimum requirements as given in literature. Low concentrations of nitrite and ammonia indicate an absence of significant organic pollution. Bottom sediments contain appreciable quantities of iron, nitrogen, and phosphorus, with the nitrogen and phosphorus being primarily organic, consistent with the lake behaving as a nutrient sink and reservoir. The number and variety of benthic organisms were well below levels normally considered indicative of highly eutrophic waters. Numbers of nuisance species were generally low.

The warm water (up to 34°C) and adequate nutrient concentrations are conducive to high biologic productivity; however, algal growth may be inhibited by the relatively high turbidity of the lake. Secchi-disc readings were generally less than 1 foot. Turbidity is generally highest during low lake stages. Color of the water is generally less than 50 units but it can run as high as 240 units

because of inflow of highly colored water from tributaries and back pumped water from drainage canals.

Dynamic shifts in phytoplankton population, reflecting a change in environmental conditions within the lake, occurred between January and July 1970. Phytoplankton concentration was generally less than 50 cells/ml (cells per milliliter) before January 1970, and the characteristic organism present was *Pediastrum simplex*, a green alga typical of early eutrophic lakes. Average phytoplankton concentration was 32,300 cells/ml in July 1970, 25,400 cells/ml in October 1970, and 149,630 cells/ml in January 1971, and decreased to 7,956 cells/ml in April 1971. The average phytoplankton concentration was 11,100 cells/ml in August 1971, 38,400 cells/ml in November 1971, 8,400 cells/ml in February 1972, and 24,700 cells/ml in May 1972. The dominant organism after July 1970 was *Aphanizomenon holsaticum*, a blue-green alga typical of eutrophic lakes.

In the northern part of the lake, concentration of phytoplankton increased to bloom levels and dominant species changed from green to blue-green algae after a period of heavy abnormal inflow from tributaries and rainfall (late 1969 to March 1970), with consequent increased influx of nutrients to the lake. Increases in concentrations of nutrients -- such as silica, nitrate, phosphate, iron, and organic material -- were relatively large in the northern part of Lake Okeechobee in January 1970 after heavy runoff. Data indicate decreased concentrations of these nutrients during the subsequent phytoplankton bloom in July 1970.

Increased concentration of phytoplankton to bloom levels (75,000 cells/ml), consisting of the blue-green algae, *Anabaena circinalis*, associated with eutrophic lakes, occurred also in Blue Cypress Lake on the St. Johns River approximately 35 miles north of Lake Okeechobee, in July 1970. There was no evidence, however, that this bloom persisted into 1971 - 72 in Blue Cypress Lake. Blue Cypress Lake is affected by man less than Lake Okeechobee.

The data obtained and evaluated during the investigation suggest that Lake Okeechobee is in an early eutrophic condition; however, regional comparisons suggest that the water quality of Lake Okeechobee, as of 1969 - 72, is not significantly different from that of other water bodies in southern peninsular Florida. Extensive physical, chemical, and biologic variability within the lake system over a short time span have been documented. As no reliable comprehensive nutrient or biologic data are available for historical comparisons, and, as the investigation coincided with a period of abnormal rainfall and runoff resulting in a relatively high nutrient flux to the lake, prediction of long-term trends is not currently possible.

INTRODUCTION

Lake Okeechobee in south central Florida is a major water-storage, flood-retention, recreation, fish, and wildlife area. Its water directly supplies several towns and is used to irrigate extensive agricultural areas to the south. Ft. Myers, by diversion from the Caloosahatchee River, utilizes the water for its public supply, and Lee County plans to divert water for public supply from the Caloosahatchee River, which receives much of its flow from Lake Okeechobee by way of the Caloosahatchee Canal.

At times, for drainage and flood-control needs, flow through the network of canals is reversed; and mineralized, nutrient-rich drainage water from the leached agricultural muckland south of the lake is returned to the lake. Also, increased use of fertilizers and pesticides on farmland and increased land use in the drainage area north of Lake Okeechobee have caused an increase in dissolved solids and nutrients carried to the lake by some tributary streams.

PURPOSE, SCOPE, AND SAMPLING PROCEDURE

Recognizing that the enrichment or eutrophication of lake waters, although a natural process, may be accelerated by man's activities, the present status of the lake, with respect to nutrient enrichment, is the primary concern of this report. An assessment of the source and status of enrichment of the lake system is necessary for all future studies or actions and for establishing a decision base line for managing water and water quality.

Parker and others (1955) generated background chemical data (1940 - 41) used in the present study area, as did Holcomb (1968), and Duchrow (1970), for the period immediately preceding the start of the present investigation.

The U. S. Geological Survey, in cooperation with the Central and Southern Florida Flood Control District, made such an assessment of Lake Okeechobee over a 41-month period, January 1969 through May 1972. The objectives were: (1) to determine the source and quantities of dissolved mineral matter and nutrients entering and leaving the lake, (2) to determine the occurrence and distribution of nitrogen, phosphorus, trace elements, selected key biological factors, and selected physical and chemical parameters pertaining to the lake, and (3) to define the condition of the lake with respect to its present state of eutrophication.

To obtain the data necessary for the assessment, at least some of 18 sites in the lake (fig. 1, table 1) were sampled 13 times. Each sampling run or traverse is called, in this report, a transect. In general, these transects were tied in to

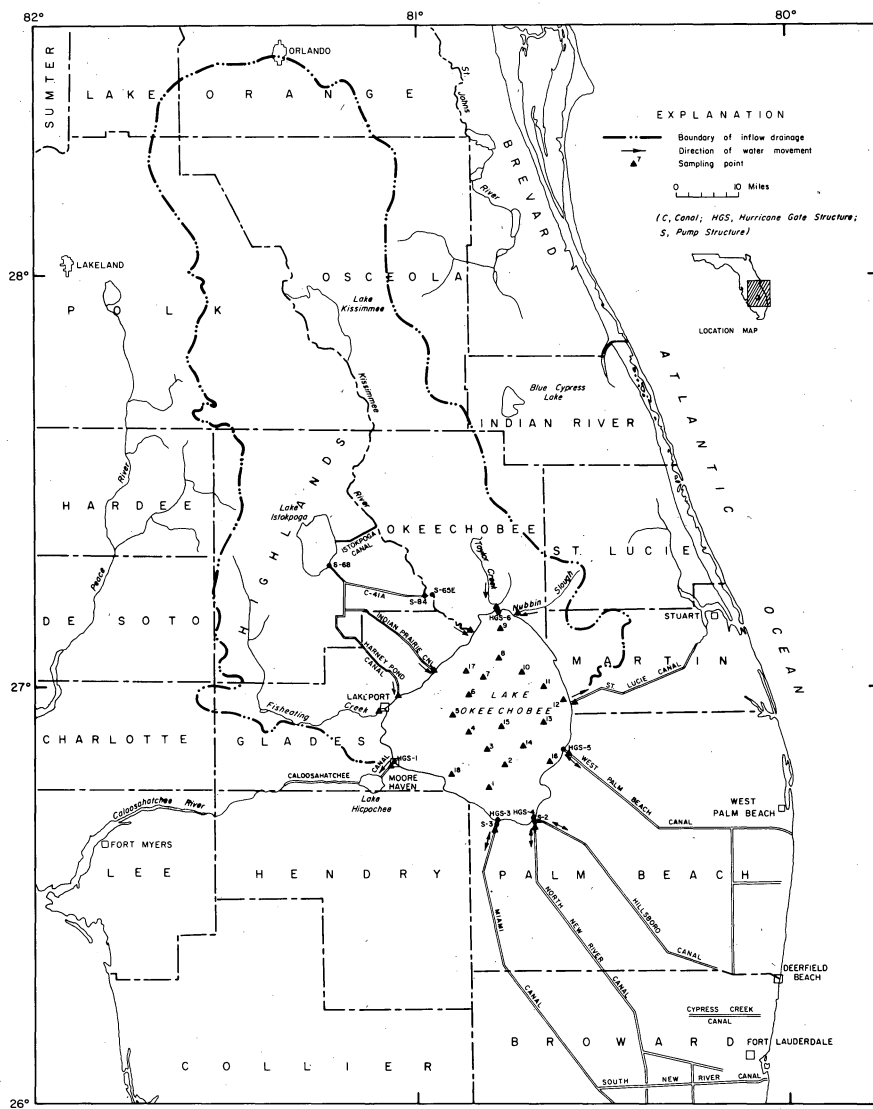


Table 1
Locations of routine sampling sites on Lake Okeechobee

Site	Coordinates	County	Comment
1	26°47'45" N 80°51'10" W	Palm Beach	Okeechobee Waterway Light-FIR 4 sec "2"
2	26°49'30" N 80°47'05" W	do.	Okeechobee Waterway Light-F1 4 sec "7"
3	26°52'05" N 80°51'05" W	do.	
4	26°55'00" N 80°55'00" W	Glades	
5	26°57'45" N 80°58'40" W	do.	Daybeacon - R "2"
6	26°59'45" N 80°55'00" W	do.	
7	27°02'30" N 80°51'05" W	Okeechobee	
8	27°05'05" N 80°47'10" W	do.	Light-F14 Sec
9	27°09'30" N 80°47'10" W	do.	
10	27°03'05" N 80°43'55" W	Martin	
11	27°01'00" N 80°40'15" W	do.	
12	26°59'05" N 80°37'10" W	do.	Okeechobee Waterway Light - F1 4 sec "1"
13	26°55'00" N 80°40'55" W	Palm Beach	Okeechobee Waterway
14	26°52'45" N 80°44'05" W	do.	Okeechobee Waterway

15	26°55'30" N 80°47'55" W	do.
16	26°49'30" N 80°40'05" W	do.
17	27°04'46" N 80°53'23" W	Glades
18	26°48'52" N 80°56'50" W	do.

seasonal criteria, that is, they corresponded to cold—, dry—, and hot (wet)—weather periods. The dates on which the transects were made are listed in the following table:

Transect Number	Date	Sites Sampled	Type of data collected
1	Jan. 1969	1-16	See table 2
2	May	1-16	Do
3	Aug.	1-18	Do
4	Jan. 1970	1-16, 18	Do
5	Apr.	2, 5, 8, 9, 12, 15	In general, data collected same as in table 2 except for pesticides, chlorophyll, and seston. BOD and TOC analyses included (see table 13 and 17)
6	July	Do	Do
7	Oct.	Do	Do
8	Jan. 1971	Do	Do
9	April	Do	Do
10	Aug.	Do	Do
11	Nov.	Do	Do, trace elements (table 17) determined on sample collected from site 15
12	Feb. 1972	Do	Do
13	May	Do	Do, trace elements determined on sample collected from site 15

In addition to these 13 transects, daily measurements of specific conductance and turbidity and monthly analyses for nitrogen species, phosphorus, and major inorganic ions were obtained at site 16. Vertical profiles, which included field measurements and analysis for nitrogen species, phosphorus, and major inorganic ions, were made at sites 1, 6, and 11 during the first four transects.

Table 2
Chemical and biological sampling of Lake Okeechobee

Type of Data	Sampling																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CHEMISTRY OF WATER																		
Surface:																		
Field Measurements <u>1/</u>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Laboratory analysis:																		
Complete analysis (unfiltered) <u>2/</u>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Complete analysis (filtered) <u>2/</u>	x					x					x							
Trace elements <u>3/</u>	x					x					x							
Mid and bottom depths:																		
Field measurements <u>1/</u>	x					x					x							
Laboratory analysis:																		
Complete analysis (unfiltered) <u>2/</u>	x					x					x							
CHEMISTRY OF BOTTOM SEDIMENTS <u>4/</u>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
PESTICIDES (water and sediments)	x					x			x		x			x	x			
BIOLOGY																		
Surface:																		
Plankton	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Chlorophyll	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Seston (suspended material)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Net tow	x			x		x			x		x			x				
Bottom Fauna	x				x	x		x	x		x				x			
SECCHI DISC	x					x					x							

1/ Specific conductance, dissolved oxygen, temperature, pH and alkalinity.

2/ Major inorganic ions + turbidity, ortho and total phosphate and complete nitrogen cycle.

3/ Spectrographic analysis (field filtered and acidified).

4/ Iron, manganese, nitrogen, phosphorus (analyses made by Florida Department of Air and Pollution Control).

Inflow tributaries, and also the inflow and outflow canals (if they were flowing), were generally sampled monthly through 1970. The Kissimmee River and Taylor Creek were sampled again only when transects 5 through 13 were made. Field measurements were made, and samples were analyzed for nitrogen species, phosphorus, and major inorganic ions.

All data collected from transect 1 through 6 and, for phytoplankton data through transect 9, are included in the discussion of conditions for 1969 - 70 (1969 - 71 for phytoplankton). All remaining data are included in the discussion for conditions as of 1970 - 72.

Unless otherwise specified, all field measurements and all water samples for chemical and biological analysis were collected just below the water surface.

Plankton samples were preserved with formaldehyde (3- to 4-percent final concentration), copper sulfate (to help plankton to retain color), and detergent (to prevent coagulation). In addition to a "whole" water sample for quantitative plankton counting, a net sample (No. 12 plankton net) was obtained in some places for qualitative evaluation. Temporary wet mounts of sample concentrates were used for identification. Identification to species was made when possible, and counts are expressed as number of cells per milliliter.

Benthic macroinvertebrate samples were collected with a 6 x 6 - inch Ekman dredge. Two samples were taken at each point. Macroinvertebrates were separated using a 30-mesh sieve and were then preserved in 95 percent ethanol. Most organisms were identified, to generic or specific levels, and counts were expressed as numbers per square meter.

ACKNOWLEDGMENTS

The author gratefully acknowledges the assistance of several agencies and individuals in the collection and analysis of the water, sediment, and biologic samples.

Mr. Lothian A. Ager, fisheries biologist, Florida Game and Fresh Water Fish Commission, Okeechobee, Florida, furnished and piloted the boat for the collection of samples, furnished valuable information on current conditions of the lake, and offered many suggestions for the study. Messrs. William M. Beck, Jr., and James L. Hulbert, biologists, Florida Department of Pollution Control collected, classified, counted, and made interpretations of bottom fauna. Jay R. Carver, chemist, Florida Department of Pollution Control assisted in the collection and chemical analysis of bottom sediments. The Environmental

Protection Agency laboratory in Athens, Georgia, analyzed samples of water and bottom sediments for pesticides.

Phillip Greeson, aquatic biologist, U. S. Geological Survey, counted and identified plankton in the samples obtained from the lake and assisted in the biologic evaluations. The investigation was made and the report was prepared under the general supervision of C. S. Conover, District Chief, U. S. Geological Survey, Tallahassee, Florida.

DESCRIPTION OF LAKE OKEECHOBEE AND DRAINAGE SYSTEM

HISTORY OF THE LAKE

The Lake Okeechobee region was occupied by the Calusa Indians for about two centuries after Ponce de Leon's discovery of Florida in 1513. The Calusas were replaced by the Seminole tribe, which was formed during the 18th century by the amalgamation of immigrants from the Creek and Hitchiti tribes of Georgia and Alabama. Not until after the United States acquired the Territory of Florida in 1821 did white settlers push southward into the region. Military campaigns during the second Seminole Indian War (1835 - 42) led to the exploration of Lake Okeechobee and the Everglades region. Before this, exploration was almost impossible because of Indian resistance and the almost impenetrable Everglades. In 1881 the channel of the Caloosahatchee River was extended to the lake. Drainage canals were later dug through the Everglades to the ocean, and dikes were constructed around the south shore of the lake for protection against floods. To increase the outflow capacity, the construction of the St. Lucie Canal to the ocean was begun in 1916; the canal reached full capacity in 1928.

A low muck levee on the south and east sides of the lake, begun in 1921, was completed in 1924. This levee was overtopped and breached in 1926 and 1928 by hurricane-driven storm surges. The U. S. Army Corps of Engineers began construction of levees in the early thirties. Hurricane gate structures were built, several pumping stations have been completed, and others are near completion. The pumping stations alleviate flooding near the lake by pumping excess water into the lake. The lake stage ranges from about 11 feet during extreme drought to about 17 feet during extremely wet years, but generally fluctuates between 14.0 and 15.5 feet.

PHYSICAL FEATURES

Lake Okeechobee, within the Coastal Lowlands of Florida, is part of a plain, the Pamlico Terrace, that was formed by recession of the sea during the

late Pleistocene. It is the largest fresh-water lake within a single State; only Lake Michigan, of lakes entirely within the United States is larger. It is roughly trapezoidal and has an area of 720 square miles at a stage altitude of 15.0 feet. Its volume at this stage is 4,020,000 acre-feet. It is 35 miles long, north-south, and 30 miles wide.

Currents can be fairly strong; the direction and intensity depend on amount of inflow, outflow, and pumpage into the lake, and on the wind. The average velocity of prevailing winds is approximately 9 mph, creating an average wave height of 1.4 feet. This height would result in effective mixing to a depth of 8.5 feet. The average depth of Lake Okeechobee is less than 9 feet. Wave height in excess of about 2 feet could cause effective mixing to virtually all depths, regardless of stage.

TRIBUTARIES

The streams and canals that are tributary to Lake Okeechobee north of the Caloosahatchee and St. Lucie Canals drain about 4,400 square miles. Of these, the Kissimmee River is the largest. It drains 67 percent of the inflow area and contributes about 75 percent of the tributary inflow to the lake. Fisheating and Taylor Creeks, Nubbin Slough, and Harney Pond and Indian Prairie Canals contribute most of the remaining 25 percent.

The Kissimmee River drains 2,950 square miles, where altitude ranges from about 15 feet at Lake Okeechobee to more than 300 feet in Polk County. The lakes in the northern and western part of the basin constitute about 10 percent of the drainage area. The lower part of the Kissimmee River basin is relatively flat and is used extensively for large cattle ranches and some dairy farming.

Channelization of the Kissimmee River from Lake Kissimmee to Lake Okeechobee began in April 1962 and was completed in July 1971. Several water-control structures have been installed, and the flow of the river is now completely regulated.

Fisheating Creek originates in western Highlands County and flows southward into Glades County and then eastward to enter Lake Okeechobee at Lakeport. The creek meanders through cypress swamps, and the drainage boundaries are often indeterminate in the lower reaches. Runoff is sluggish because of the large amount of natural storage in the basin. Land in the Fisheating Creek basin is used for citrus groves, cattle ranches, and dairy farming.

Taylor Creek, draining less than 200 square miles, enters Lake Okeechobee at its northernmost point. The channel of the lower reaches of Taylor Creek is dredged for navigation to and from the lake through HGS-6 (Hurricane Gate Structure-6). The gate is open except during hurricanes and high lake stages. The land is used for cattle ranches and large dairy farms.

Nubbin Slough is a small tributary originating in southwestern St. Lucie County and enters Lake Okeechobee 2-½ miles southeast of Taylor Creek.

Harney Pond Canal is connected to Lake Istokpoga by Canal 41-A. The flow is from Lake Istokpoga through Canal 41-A into Harney Pond Canal (C-41), which enters Lake Okeechobee, about 4 miles northeast of the mouth of Fisheating Creek. The flow in Harney Pond Canal is completely regulated.

Indian Prairie Canal, similar to Harney Pond Canal, is connected to Lake Istokpoga by Canal 41-A. The canal enters Lake Okeechobee from the northwest about 6 miles northeast of Harney Pond Canal. The flow is completely regulated and is about one-quarter of that of Harney Pond Canal.

DRAINAGE

Before the levees were constructed on the south shore of Lake Okeechobee, natural outflow during wet periods spilled over the south shore into the Everglades, where it drained slowly through dense sawgrass to the sea. The outflow is now controlled through several canals, including the St. Lucie and Caloosahatchee canals. Small quantities of water are discharged through West Palm Beach, Hillsboro, North New River, and Miami Canals.

St. Lucie Canal, the largest outflow canal, heads on the eastcentral shore and flows generally northeastward for about 40 miles to the ocean near Stuart (fig. 1). Its discharge is controlled at a lock and dam about 25 miles downstream from the lake. When the control level is normal, the only flow through the canal is from leakage and lockage and a small amount used for power generation at the lock and dam.

Caloosahatchee Canal heads at HGS-1 on the southwest shore at Moore Haven (fig. 1), flows southwestward through Lake Micpochee, then through two locks in the channelized Caloosahatchee River before entering the estuary near Fort Myers. When the lake storage is at the normal control level, the only flow into the canal is from leakage and lockage through the navigation lock.

West Palm Beach Canal heads at HGS-5 on the southeast shore about 8 miles south of the St. Lucie Canal. It extends southeastward for 19 miles and

then eastward for about the same distance to enter the ocean at West Palm Beach. The canal is constructed through deep muck soil along the northern border of the Everglades. Its water is used extensively for irrigation during the winter vegetable-growing season.

The Hillsboro and North New River Canals originate at S-2 (Pump Structure 2) and HGS-4 on the southeast shore, dividing 800 feet below HGS-4. The Hillsboro Canal flows through the winter vegetable-growing area and extends 51 miles to enter the ocean at Deerfield Beach. The North New River Canal is the longest major canal in the Everglades, extending through its heart 60 miles to enter the ocean at Fort Lauderdale. These canals are used for irrigation and flood control. The North New River Canal is capable of carrying large quantities of water from Lake Okeechobee to the middle Everglades.

Miami Canal heads at HGS-3 and S-3 on the southcentral shore. The canal is a continuous waterway, extending 81 miles south and east to enter the ocean at Miami. The central part of the canal, however, is blocked, and only the upper and lower reaches are effective waterways.

HYDROLOGIC CHARACTERISTICS, 1969 - 70

Water enters Lake Okeechobee from rain falling directly on the lake, from tributaries, and sometimes from reverse, or negative, flow pumped from canals to remove flood water from the agricultural areas. The lake may also receive ground-water effluent: at the lake, the potentiometric surface of water in the Floridan aquifer is about 30 feet above land surface. Water leaves primarily through the St. Lucie and Caloosahatchee Canals and by evapotranspiration. Sometimes substantial quantities leave through West Palm Beach, North New River, Miami, and Hillsboro Canals and a very small amount by seepage through the levee along the south shore.

PRECIPITATION

The normal (median) rainfall over Lake Okeechobee is 45.60 inches per year (1,751,040 acre-feet). It varies from about an inch in November to more than 7 inches in June (U. S. Corps of Engineers, written commun., 1970).

During the 19-month investigation, monthly rainfall was above the monthly normal (median) for 13 months and below for 6. Departures from normal (median) ranged from 2.82 inches below (60 percent of normal) to 9.85 inches above (480 percent of normal) in March 1970 when rainfall totaled 12.44 inches. The total amount of rain falling during the 19 months was 91.61 inches,

20 inches (128 percent of normal) greater than the aggregate of the 19 monthly normals (medians).

Figure 1A shows the rainfall for each month of the 19-month span compared with the monthly normal (median) for each.

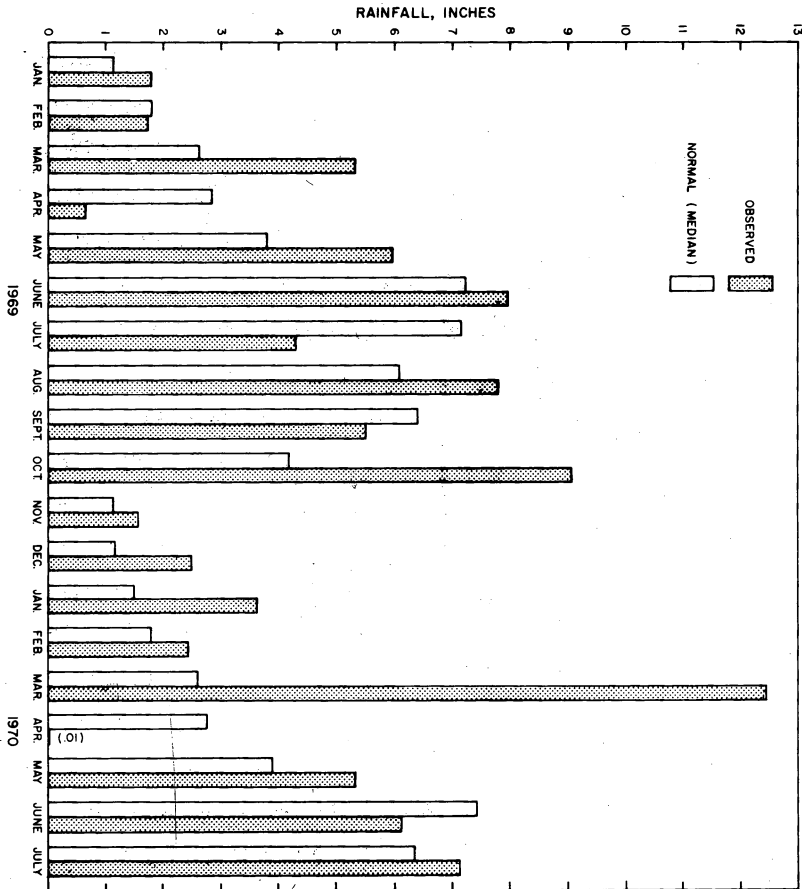


Figure 1A. Rainfall over Lake Okeechobee, January 1969 - July 1970.

INFLOW

Of the streams contributing water to the lake, the Kissimmee River is by far the largest. On the average, its contribution is about eight times greater than that of the next largest, Fisheating Creek, although its maximum daily flow of record is less. The following table lists the average discharge from each of several tributaries.

Tributary	Average Discharge		Base period	Greatest daily average	
	(cfs)	(ac-ft/yr)		(cfs)	(date)
Kissimmee River <u>a/</u>	2,188	1,584,000	1928-62	27,580	Oct. 3, 1969
Fisheating Creek <u>b/</u>	264	191,100	1931-68	31,400	--
Harney Pond Canal	212	153,500	1962-68	2,910	--
Taylor Creek <u>c/</u>	102	73,840	1955-68	6,930	--
Indian Prairie Canal	48.9	35,400	1962-68	1,470	--
Miami Canal	55.2	39,960	1957-68	--	--
Nubbin Slough	(d)	--	--	--	--

a/ Flow gaged at station S-65E; location on figure 1.

b/ Flow gaged 14 miles upstream from State Highway 78.

c/ Flow gaged 7.6 miles upstream from mouth.

d/ Flow not gaged on continuous basis; small except during storms.

OUTFLOW

On the average, outflow from the lake through three major canals is about 2,500 cubic feet per second (1,830,000 acre-feet a year). The distribution, by canal, is as follows

Canal	Average discharge		Base period	Greatest daily average	
	(cfs)	(ac-ft/yr)		(cfs)	(date)
St. Lucie	1,300	940,000	1952-68	11,430	March 27, 1970
Caloosahatchee	1,024	740,000	1938-68	8,290	April 10-11, 1970
West Palm Beach	173	125,200	1939-68	1,610 <u>a/</u>	

a/ At times water flows into the lake from the canal; the daily maximum reverse flow in the period of record is 1,760 cfs.

Seepage from the lake along its south shore is small in comparison with outflow through other means. According to Meyer (1971), the seepage along a 50-mile reach of shoreline is 22 cfs (cubic feet per second) at a lake stage of 14 feet and 50 cfs at a stage of 16.5 feet.

The only remaining outflow element considered in this report is evaporation from the lake's surface. According to the U. S. Corps of Engineers (written commun., 1970) the normal (median) is 55.70 inches per year. Visser

and Hughes (1969) report that in the vicinity of the lake the difference between rainfall and potential evaporation ranges from about zero or slightly less than zero (potential evaporation greater than rainfall) to 9 inches per year.

WATER BUDGET, JANUARY 1969 - JULY 1970

Rainfall during the investigation was considerably greater than normal (median), and for this reason the values of all the elements of inflow and outflow cited in the foregoing 2 tables, were substantially different from those of the 19-month study period.

Inflow and outflow are summarized in table 3. Change of storage was computed by subtracting the capacity of the lake at the end of the study from that at the start. The lake was at a stage of 15.2 feet at the start and 14.1 feet at the end. On the basis of a rating table supplied by the U. S. Corps of Engineers, the difference was 480,000 acre feet.

The "other sources" of table 3 represent unmeasured inflow and about 4 percent of the total budget. The amount, 359,000 acre-feet, is considered to have been contributed by sources not specifically known or determined, perhaps upward seepage from the Floridan aquifer (Parker and others, 1955). The amount could be represented, in part, by inaccuracies in the identified outflows or inflows.

The average inflow from each stream during the 19-month period was substantially greater than the long-term average inflow because of the above-normal rainfall. A partial comparison follows:

Source	Percentage of average
Fisheating Creek	142 <u>a/</u>
Harney Pond Canal	130
Indian Prairie Canal	178
Kissimmee River	138
Taylor Creek	193 <u>b/</u>

a/ On basis of flows at gaging station, 14 miles upstream from State Highway 78.

b/ On basis of flows at gaging station, 7.6 miles upstream from mouth.

Outflows, similarly, were greater than the long-term averages. The flow in the St. Lucie Canal was 151 percent of the long-term average, in the Caloosahatchee Canal 282 percent, and in the West Palm Beach 121 percent of average.

Table 3
Generalized Water Budget for Lake Okeechobee
January 1, 1969 to July 31, 1970

INFLOW			OUTFLOW		
Source	Q cfs	Total acre-feet	Source	Q cfs	Total acre-feet
Fisheating Creek	562	643,000	St. Lucie Canal	1,960	2,240,000
Harney Pond Canal	275	315,000	West Palm Beach Canal	210	240,000
Indian Prairie Canal	87	99,200	Miami Canal	111	127,000
Kissimmee River	3,030	3,470,000	Calooshatchee Canal	2,890	3,310,000
Taylor Creek	279	320,000	Evaporation	88.0 1/	3,420,000
Nubbin Slough	40	45,700	Change in Storage	-1.1 3/	-480,000 4/
North New River Canal	31	35,000			
Precipitation	91.6 1/	3,570,000 2/			
Other Sources	187	359,000			
	TOTAL	8,857,000		TOTAL	8,857,000

1/ Inches; data supplied by U. S. Corps of Engineers.

2/ Based on a lake area of 730 sq mi

3/ Feet; data supplied by U. S. Corps of Engineers

4/ Computed from stage-volume rating table supplied by U. S. Corps of Engineers

Usually, the Miami Canal contributes water to the lake on a long-term basis, but, during the 19-month period of investigation, it carried more water from the lake than into it.

CHEMICAL AND PHYSICAL CHARACTERISTICS OF WATER AND SEDIMENT, 1969 - 70

LAKE OKEECHOBEE

The quality of the water in Lake Okeechobee varies with both location and time. Factors such as rainfall patterns, evaporation rates, and water use cause changes in the quality of the water with time. Probably the greatest factors influencing the areal variation in water quality are water movement and circulation patterns caused by varying amounts of inflow, outflow, and back pumpage of water into the lake from flooded agricultural areas. Characteristics of the water and bottom sediments of the lake are discussed under the following sections. The analyses on which the discussion is based are listed in table 13 (Appendix). Both physical and chemical parameters are tabulated, for samples collected during six sampling transects over a 19-month span from January 1969 through July 1970. Because chemical analyses by Holcomb (1968) and Duchrow (1970) extend the analytical record back to 1967, some of their analytical data are summarized in this report.

PHYSICAL CHARACTERISTICS OF WATER

In describing the water quality of Lake Okeechobee, specific conductance, temperature, dissolved oxygen, turbidity, pH, and color are classified as physical characteristics.

Specific conductance is a measure of the ability of water to conduct an electrical current and is reported in micromhos per centimeter at 25°C. It is a rapid determination and may be used to estimate dissolved solids or individual major chemical constituent in the water. For Lake Okeechobee, the ratios of eight chemical parameters to specific conductance are as follows:

Dissolved solids (calculated from sum of dissolved constituents; see table 13 for explanation)	0.56
Calcium (Ca)	.09
Magnesium (Mg)	.03
Sodium (Na)	.08
Potassium (K)	.01
Bicarbonate (HCO ₃)	.29
Sulfate (SO ₄)	.08
Chloride (Cl)	.12

From these ratios the dissolved solids (calculated) or concentrations of the listed constituents can be estimated by multiplying a measured specific conductance by the ratio.

For the six sampling transects, average specific conductance ranged from 409 to 541 micromhos. The following table, prepared from data recorded by Holcomb (1968) and Duchrow (1970), summarized specific conductance extremes for 1967 - 70, on samples collected from the center of the lake:

	Micromhos	Date	Lake Stage (feet)
Maximum	590	Feb., 1968	13.0
Minimum	330	Feb., 1970	15.5

During the present investigation, a sample from point 8, about 8 miles north of the center of the lake, at a stage of 15.9 feet, had a specific conductance of 199 micromhos, well below the 1967 - 70 minimum.

Average water temperatures ranged from 12°C in January 1970 to 30°C in April 1970. The extremes were 9.0°C and 34°C (table 13). Vertical profiles at sites 1, 6, and 11 on each sampling date showed no thermal stratification.

Dissolved oxygen (DO) in water is derived from the atmosphere and from oxygen given off by aquatic plants. Solubility of oxygen in water varied inversely with temperature. Oxygen is removed from water by the respiratory process, by decomposition of organic material, by oxidation, and by release to the atmosphere when the water becomes supersaturated. During heavy biologic activity, DO may vary considerably diurnally.

All DO measurements were made in-place during daylight. In general, concentration was lowest in the early morning and highest in mid-afternoon. DO was usually near saturation, and vertical profiles showed no DO stratification. A few measurements during periods of high biologic activity showed supersaturation. Extremes in DO were 5.9 and 11.2 mg/l.

Average seasonal variation in DO, which is partly dependent on temperature, ranged narrowly from 7.1 mg/l (92 percent saturation) in July 1970 to 9.9 mg/l in January 1970 (92 percent saturation). Average areal variations in DO were low, ranging from 8.5 mg/l (92 percent saturation) to 9.1 mg/l (99 percent saturation), except at site 12 near the mouth of the St. Lucie Canal where average concentration was 7.4 mg/l (81 percent saturation). Figure 2 shows how water temperature and DO varied seasonally.

The lake water becomes very turbid during storm periods and is noticeably turbid even during extended periods of relative clam. Turbidity varied markedly with wind action. Apparently turbid water during storms is historical. Heilprin (1887) reported the water to be fairly clear when not disturbed but "...generally, however, it is tossed into majestic billows, which rake up the bottom, and bring to the surface a considerable infusion of sand, rendering the surface murky." For the lake transects, turbidity ranged from 7 to 56 JTU (Jackson turbidity units). Daily measurements at site 16 ranged from 1 to 59 JTU.

The pH of a solution is a measure of the effective hydrogen-ion concentration. A pH value of 7.0 represents neutrality, whereas alkaline water has a pH greater than 7.0 and acidic water has a pH less than 7.0.

The water in Lake Okeechobee is in a natural carbonate environment, which causes it to always be alkaline; field pH ranged from 7.8 to 9.0, with a median of 8.4. The pH was highest when photosynthetic activity in the lake was greatest, resulting in greater carbon dioxide uptake.

Color of water gives a rough indication of the amount of dissolved organic material. Also, higher color usually indicates recent heavy inflow from streams and high lake stages. Color, as does turbidity, reduces light penetration in water and consequently has a regulatory effect over biologic processes.

Water in the lake is generally much less colored than that of the tributary streams, possibly because of adsorption and flocculation of the colored organic matter by suspended material in the lake and by biochemical and photochemical oxidation. During normal lake stages, water color usually ranges from about 30 to 50 units on the Platinum-Cobalt scale, but the range is much wider from drought to flood periods. Average color intensity for the six lake transects ranged from 20 units in August 1969 and July 1970 to 70 units in January 1970. Color ranged from 5 to 120 units. The high color, at site 8, was caused by heavy inflow from the Kissimmee River.

MAJOR CHEMICAL CONSTITUENTS

Calcium, magnesium, sodium, bicarbonate, sulfate, and chloride are major dissolved chemical constituents in the water of Lake Okeechobee. Silica and potassium occur in lesser amounts. Figure 2 shows the average calculated dissolved-solids content for each of eight lake transects, two in 1940 - 41, and six in 1969 - 70.

The lake water is generally more highly mineralized than inflowing water from any of the tributary streams. For example, calculated dissolved solids in the lake are two to three times higher than those in the Kissimmee River. Taylor Creek is probably the only exception; it at times contributes water much higher in mineralization than that in the lake. In February 1969 the calculated dissolved solids of Taylor Creek water was 605 mg/l, about double the concentration of the lake.

In 1940 - 41 Parker, Ferguson, and Love (1955) also noted that dissolved solids in the lake were about three times as great as those in the major tributary streams, and hardness was five to seven times as great as that of inflowing water. They mentioned several explanations for the higher mineralized water from the artesian Floridan aquifer, concentration from evaporation, and discharge into the lake of highly mineralized water from the West Palm Beach, Hillsboro, North New River, and Miami Canals during short rainy periods. They concluded, however, that the difference could be accounted for by dilute inflow water dissolving limestone formations on the bottom of the lake. This explanation is partly correct; although dissolved solids in the lake are concentrated somewhat from evaporation and there is a strong possibility that upward leakage from the Floridan aquifer occurs. The average potentiometric surface of the aquifer is more than 30 feet above the lake surface. A composition diagram of Lake Okeechobee, Kissimmee River and Floridan aquifer waters suggest that some higher mineralized water from the Floridan aquifer may be entering the lake. The dissolution of limestone from the lake bottom would not account for the excess chloride, sodium, and sulfate, but a small input from the Floridan aquifer would. The flow of water into the lake by pumping from agricultural canals is small compared with the overall water budget for the lake, but this highly mineralized water does cause some increase in dissolved solids.

This study shows that mineralization of the lake water varies inversely with lake stage and the amount of flushing from heavy runoff. As shown in figure 2, the average calculated dissolved-solids content in 1940 - 41 was less than 190 mg/l, as compared with about 260 mg/l in 1969 - 70. Increases in the concentrations of calcium, magnesium, sodium, chloride, sulfate, and bicarbonate were accordant. The smallest increase was in magnesium (2 mg/l), and the greatest was in chloride (20 mg/l). Sodium and sulfate increased 19 and 14 mg/l, respectively. In 1940 - 41, when calculated dissolved-solids were less than 200 mg/l, annual average lake stages were 16.03 and 15.90 feet, respectively, whereas average lake stage from January 1969 to July 1970 was only about 15 feet. The highest average dissolved-solids content for the six transects of this investigation was during January 1969 (fig. 2) after a prolonged drought during which the lake stage had been below 12 feet. During the drought, evaporation and below-normal inflow and outflow concentrated dissolved solids

remaining in the lake. After the above-average rainfall and flushing of the lake during this investigation, dissolved solids decreased significantly, from 309 mg/l in January 1969 to 210 mg/l in April 1970, near average for the 1940-41 sampling. Also, the July 1940 and July 1970 dissolved solids compare reasonably well.

Areal variations in dissolved solids are generally smallest at low lake stages, when water movement is slow. At a lake stage of 14.2 feet in August 1969, calculated dissolved solids ranged from 253 mg/l at point 7 to 298 mg/l at site 15. For the five sites sampled in July 1970, also at a lake stage of 14.2 feet, calculated dissolved solids ranged from 227 mg/l at site 12 to 270 mg/l at site 5.

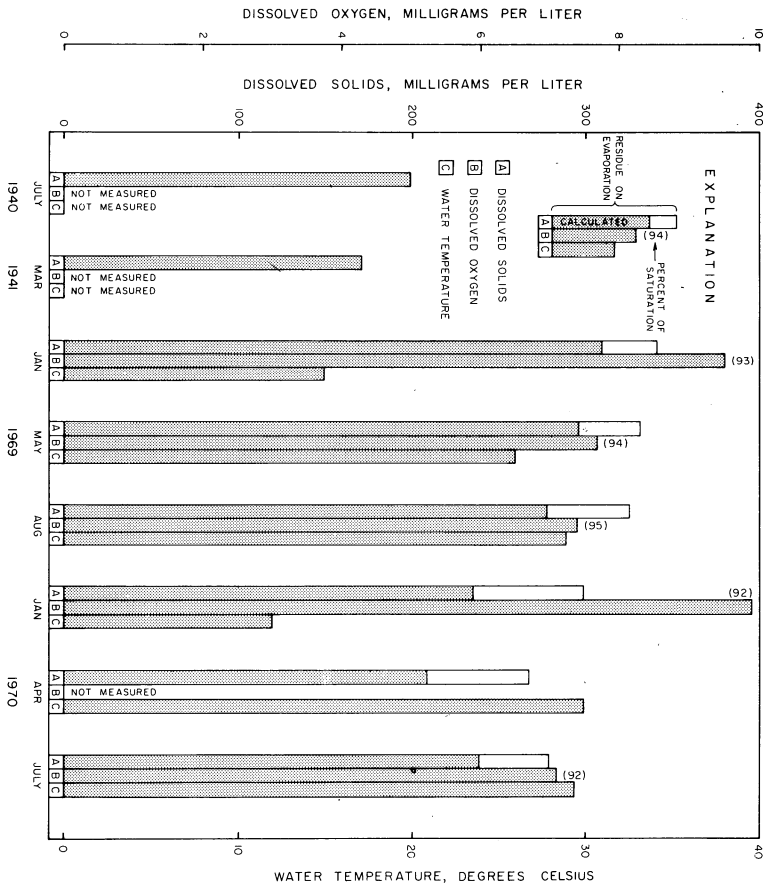


Figure 2. Average seasonal variations of dissolved solids, dissolved oxygen, and water temperature in Lake Okeechobee.

Areal variation in dissolved solids are greatest at high lake stages, when water movement is fast. In January 1970 at a lake stage of 15.9 feet, calculated dissolved solids ranged from 110 mg/l at site 8 to 284 mg/l at site 13. Heavy inflow from the Kissimmee River largely influenced quality at site 8. The dissolved solids estimated from four specific conductance measurements of water collected from the center of the lake, reported by Holcomb (1968) and Duchrow (1970) from August 1967 to February 1970, ranged from 185 mg/l at lake stage 15.5 feet in February 1970 to 330 mg/l at lake stage 13.0 feet in February 1968. In this study the dissolved solids were 110 mg/l at point 8 in January 1970. Site 8, as mentioned earlier, is about 8 miles north of the center of the lake.

DISTRIBUTION OF NITROGEN AND PHOSPHORUS

Nitrogen and phosphorus have long been considered to be key elements contributing to accelerated eutrophication of lakes. The concentrations of these two nutrients are vitally important in controlling the rate of biologic productivity; however, many other elements, some in trace quantities, are necessary for plant growth. When concentrations of inorganic nitrogen and phosphorus are high, algal blooms generally occur.

Figure 3 shows the average concentrations for the various nitrogen species for the six lake transects made from January 1969 to July 1970.

Total nitrogen (N) includes all forms of organic and inorganic nitrogen. Inorganic nitrogen in column A of figure 3 includes that from nitrate, nitrite, and ammonia. Average total nitrogen (N) concentration of 1.4 mg/l was exactly the same for the three transects made in 1969. Inorganic nitrogen, however, was highest in January, but decreased in May and August when biologic activity in the lake increased.

A major part of the nitrogen in the lake is in organic form. During the six transects (fig. 3) organic nitrogen accounted for 71 to 93 percent of the total nitrogen and averaged 85 percent. Organic nitrogen is also the major nitrogen form in adjacent drainage basins. On the upper St. Johns River basin it accounts for about 90 percent of the total nitrogen (Goolsby and McPherson, 1970).

The higher concentration of nitrogen in January and April 1970 to 1.7 mg/l was caused by increased heavy inflow and abnormal rainfall. Table 8 shows that a considerable load of nitrogen can be contributed to the lake by rainfall. The rainfall over Lake Okeechobee was above normal from October 1969 through March 1970, when 12.44 inches (almost 10 inches above normal) fell. Average concentration of nitrogen in rainfall during January 1969 to January

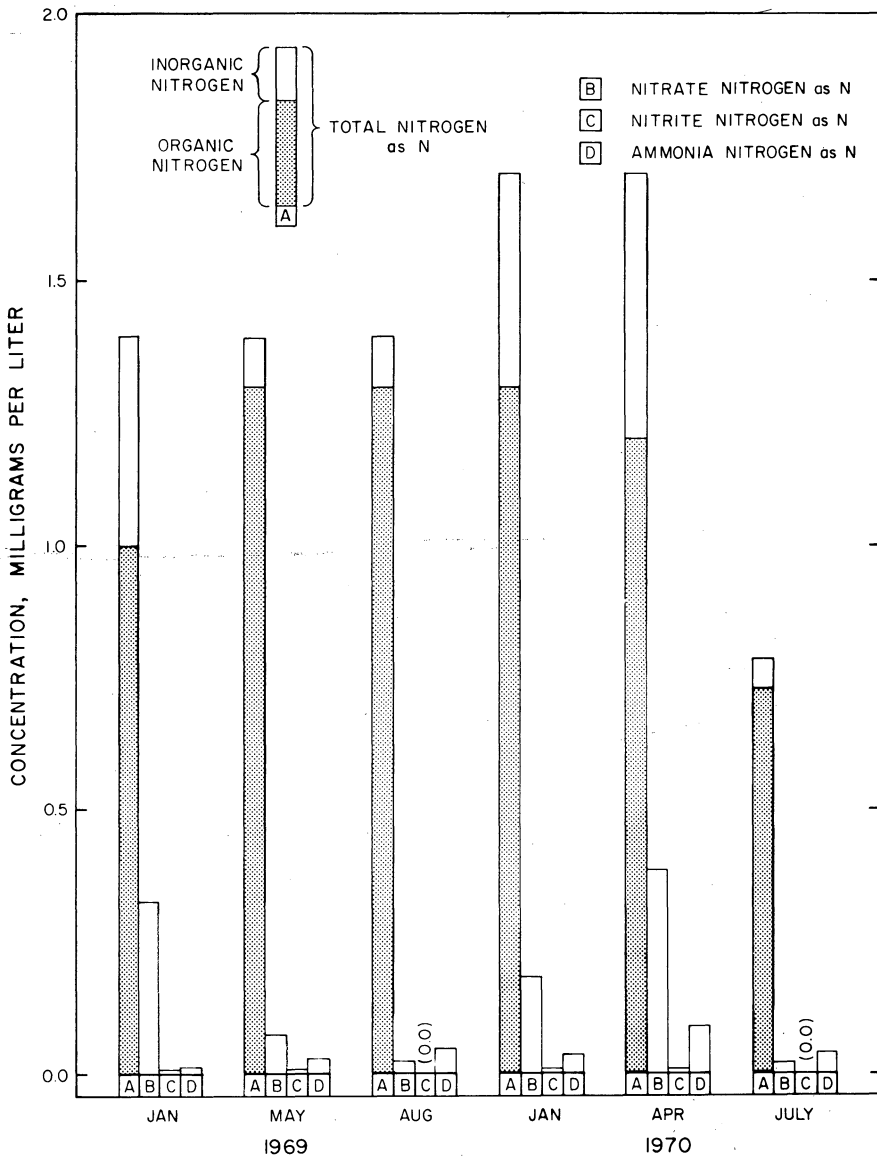


Figure 3. Average distribution of nitrogen (N) in Lake Okeechobee.

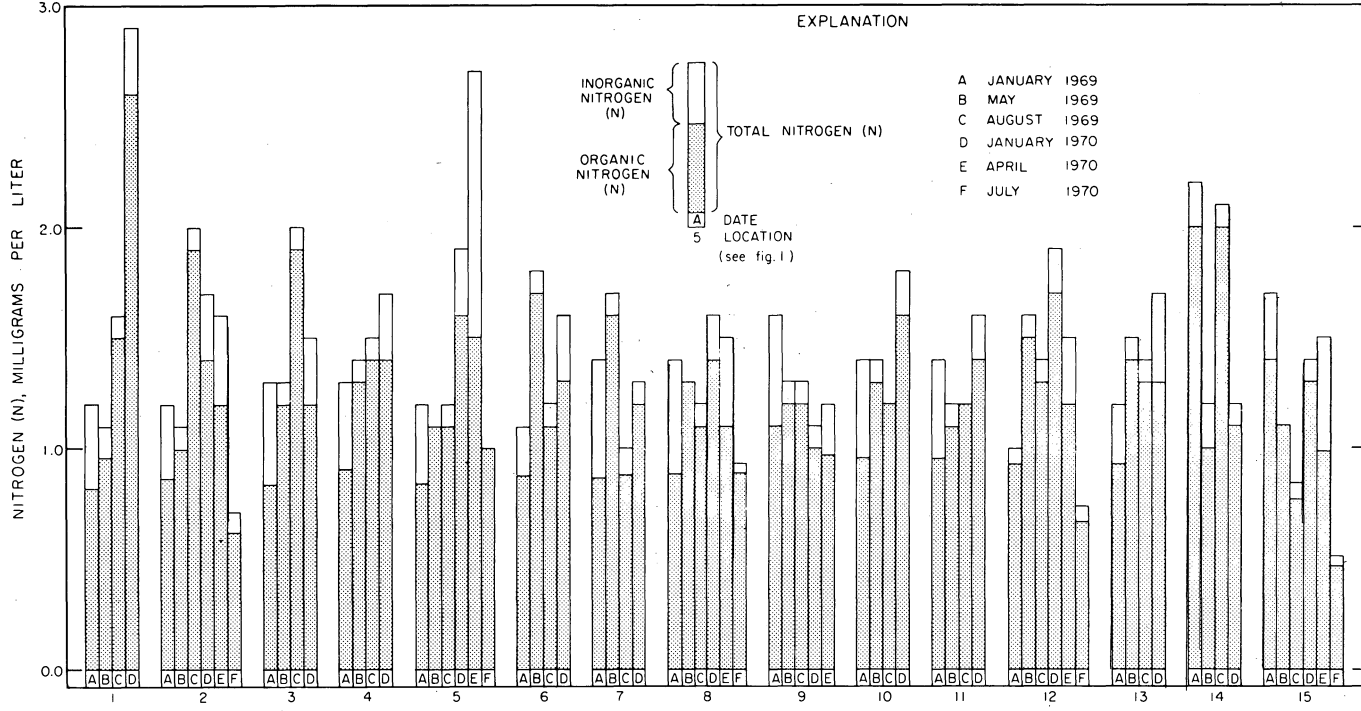


Figure 4. Areal and seasonal variations of nitrogen (N) in Lake Okeechobee.

1970 was 0.90 mg/l. Nitrogen in rainfall will be discussed in more detail in a later section. The low nitrogen concentration of 0.79 mg/l was caused by a phytoplankton bloom.

Average nitrite and ammonia concentrations were generally low, (fig. 3) which indicates either the absence of gross cultural pollution or the effectiveness of DO in the lake to oxidize pollutants and to prevent the reducing condition necessary for in-place formation of nitrite and ammonia. In general, nitrogen concentration was lowest in the northern part of the lake, a little higher in the eastern part of the lake, and highest in the southern and western parts, as indicated by figure 4. Nitrogen concentration ranged from 0.51 to 2.9 mg/l. In general, inorganic nitrogen was highest during the winter and lowest during the summer, when biologic productivity was greatest. Inorganic nitrogen concentration ranged from zero to 1.1 mg/l. The high of 1.1 mg/l, at site 5 in April 1970, along with adequate phosphate and other essential nutrients, may have triggered the large algae bloom at site 5 in July 1970, by which time inorganic nitrogen was zero, all having been utilized by the growing algae. Probably there is less circulation at site 5 than at any other place in the lake.

The following table lists extremes in nutrient content of water samples collected from the center of the lake at four intervals, August 1967, February 1968, August 1969, and February 1970 (Holcomb, 1968; Duchrow, 1970).

Constituent	Date	Minima	Date	Maxima
		Milligrams per liter		Milligrams per liter
Nitrate nitrogen	Aug. 1967	0	Feb. 1968	0.1
Ammonia nitrogen	Feb. 1968	0	Aug. 1969	.04
Organic nitrogen	Aug. 1967	.74	Aug. 1969	1.4
Orthophosphate (PO ₄ -P)	Feb. 1968	.003	Feb. 1970	.052
Total phosphorus	Aug. 1967	.016	Feb. 1970	.150

Average phosphorus concentration in the lake usually is lower than in the tributary streams, which indicates phosphorus uptake in the lake. Large quantities of both nitrogen and phosphorus are assimilated by the large amount of vegetation in the lake. Much of the shallow part, especially in the west and northwest, contains heavy concentrations of grass and other aquatic vegetation. The vegetation releases the nutrients to the lake water or to bottom sediments on death. Dying vegetation, however, is continuously being replaced by new growth, which again requires large quantities of nutrients. Recycling of nutrients

between water and bottom sediments is a complex process, and further studies of the process are needed in Lake Okeechobee for a more definitive statement.

In 1969 average total phosphorus concentration was low, from slightly less than 0.02 to 0.03 mg/l (fig. 5). Orthophosphate ($\text{PO}_4\text{-P}$) concentration ranged from 0.01 to slightly more than 0.02 mg/l and averaged 65 percent of the total phosphorus. Phytoplankton concentration for the 1969 lake transects was highest in May, resulting in assimilation of most of the orthophosphate. By January 1970, average total phosphorus (P) and orthophosphate ($\text{PO}_4\text{-P}$) had

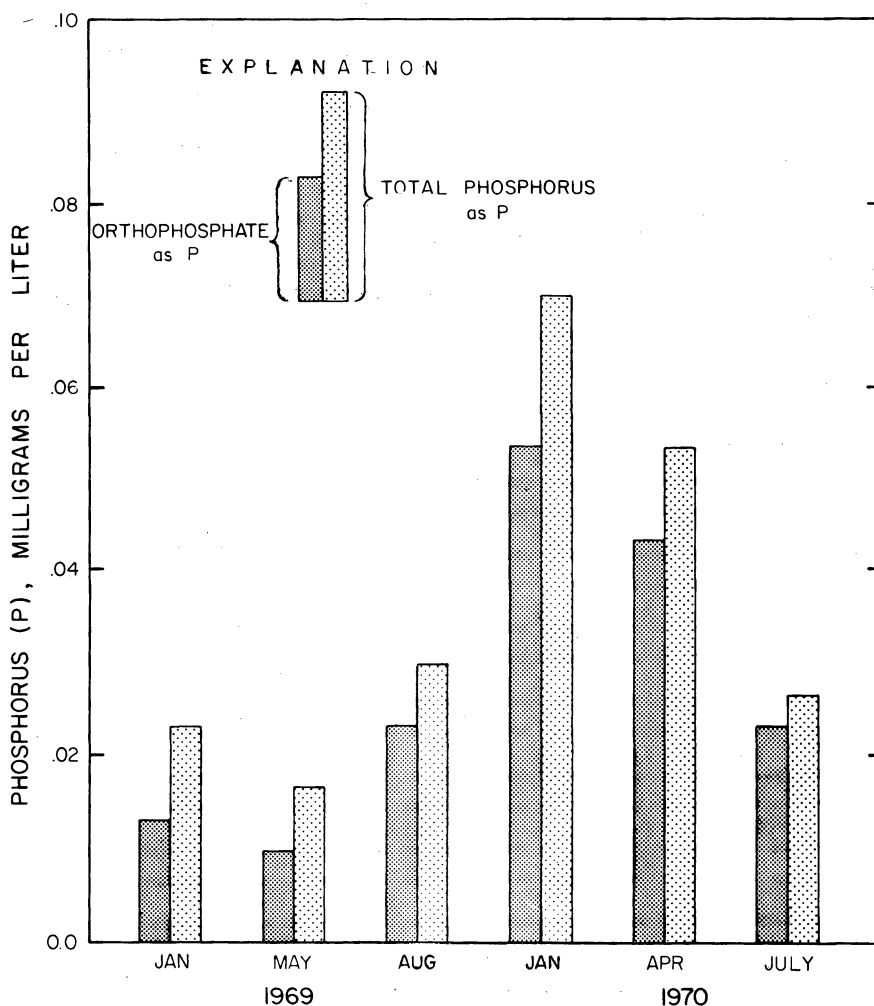


Figure 5. Average distribution of phosphorus (P) in Lake Okeechobee.

increased, to 0.07 and 0.05 mg/l, respectively. The increased phosphorus concentration was in line with the increased nitrogen concentration in January 1970 and was also caused by abnormal rainfall and increased inflow to the lake in the fall and winter of 1969. The above-normal rainfall and inflow to the lake through March 1970 continued to contribute large loads of nutrients. Rain decreased in April, when only 0.01 inch fell on Lake Okeechobee. Areal and seasonal variations in phosphate concentrations are wide, as shown by figure 6. Areal variations are mostly caused by water-inflow changes and movement in the lake, and seasonal variations are caused by changes in biologic activity. Heavy inflow to the lake caused increased phosphate concentration and increased biologic activity causes decreased orthophosphate concentration.

Total phosphorus concentration ranged from 0.01 to 0.15 mg/l; orthophosphate ($\text{PO}_4\text{-P}$) from 0.00 to 0.14 mg/l. The low and high concentrations of both orthophosphate and total phosphorus occurred at sites 7 and 8.

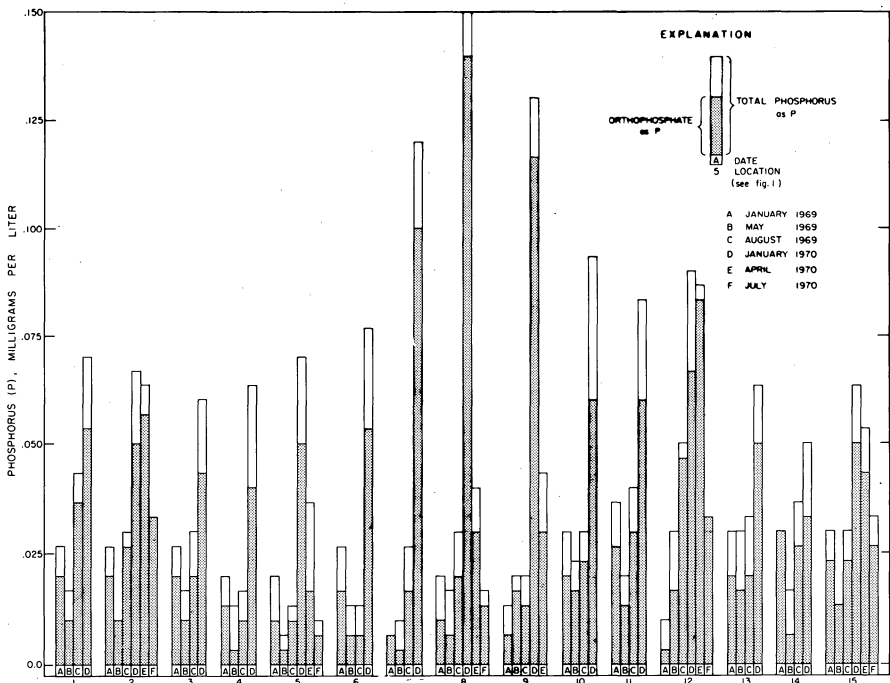


Figure 6. Areal and seasonal variations of phosphorus (P) in Lake Okeechobee.

Phosphorus concentration was low in January 1969 because of low inflow rates to Lake Okeechobee before and during the sampling period, whereas high inflow rates in the fall and winter of 1969 flushed large loads of phosphorus into the lake. Sites 7, 8, and 9, where the concentrations were highest in January 1970, were directly influenced by heavy inflow from the Kissimmee River and Taylor Creek.

On June 22, 1952, at a low lake stage of 12.81 feet, Odum (1953) reported phosphorus concentrations of 0.003 ppm (parts per million) and 0.007 ppm near the south shore of Lake Okeechobee and 0.03 ppm near the mouth of Taylor Creek. In February 1970 (p. 37) phosphorus in water from the center of the lake was the same as at site 8 in January of that year, 0.150 mg/l, the maximum for the present study.

TRACE ELEMENTS

In addition to nitrogen and phosphorus, many elements, some in trace quantities, are essential for plant growth.

For the four lake transects from January 1969 to January 1970, samples were collected for spectrographic analyses for 25 trace elements at sites 1, 6, and 11. The results are given in table 4.

Of the trace elements listed in table 4, nine (aluminum, boron, cobalt, copper, iron, manganese, molybdenum, vanadium, and zinc) have been listed by various investigators as essential for algal growth (Eyster, 1965; Provasoli, 1953, 1958; Walker, 1953; Gerloff and Skogg, 1957). All these elements are present, at least periodically, in Lake Okeechobee in varying concentrations, ranging from 1 $\mu\text{g/l}$ (microgram per liter) for molybdenum to 320 $\mu\text{g/l}$ for iron. All but three were present in more than adequate quantities for algal growth. The mean concentrations of boron (47 $\mu\text{g/l}$), copper (4 $\mu\text{g/l}$), and manganese ($< 3.3 \mu\text{g/l}$) were less than minimum requirements for healthy algae growth of 100, (Eyster, 1965; Provasoli, 1958); 6 (Walker, 1953); and 5 $\mu\text{g/l}$ (Gerloff and Skogg, 1957), respectively.

According to Holcomb (1968) a sample collected from the center of the lake in August 1967 contained zero chromium, manganese, nickel, and cobalt.

PESTICIDES

About 34 million pounds of pesticides were used in Florida in 1966 (Hifer and Kolipinski, 1970). Approximately 26 million pounds were applied on citrus fruits, vegetables, and melons. Less was used on other crops, on lawns, in homes,

Table 4
Trace metal concentrations in Lake Okeechobee
(ND, not detected; <, concentration less than value indicated)
(Results in micrograms per liter)

Sampling Point	Date	Aluminum (Al)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Gallium (Ga)	Germanium (Ge)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Manganese (Mn)	Molybdenum (Mo)	Nickel (Ni)	Rubidium (Rb)	Silver (Ag)	Strontium (Sr)	Tin (Sn)	Titanium (Ti)	Vanadium (V)	Zinc (Zn)	Zirconium (Zr)
1	1-16-69	10	35	< 2	< 7	50	< 70	< 7	< 4	4	-	< 7	13	< 7	3	< 3	2	< 7	3	< .7	820	< 7	< 7	< 7	ND	-
1	5-15-69	20	45	< 2	< 3	55	< 75	< 8	< 8	3	-	< 8	35	< 3	4	< 3	2	< 11	4	< .8	910	< 8	< 8	< 8	< 300	-
1	8-27-69	30	55	< 3	< 9	57	< 130	< 7	< 7	2	< 3	< 13	18	< 7	3	< 3	2	< 7	4	< .7	810	< 9	< 7	< 7	< 380	> 13
1	1-15-70	10	41	< 6	< 3	53	< 60	< 6	< 6	2	ND	< 3	19	< 3	.3	< 3	2	4	-	< .6	700	< 6	< 6	< 3	< 240	ND
6	1-14-69	30	34	< 2	< 7	47	< 70	< 7	< 4	4	-	< 7	40	< 7	3	< 3	1	< 7	3	< .7	930	< 7	< 7	< 7	ND	-
6	5-13-69	25	35	< 2	< 3	50	< 60	< 6	< 6	7	-	< 6	75	< 3	3	3	3	< 9	4	< .6	670	< 6	< 6	< 6	< 250	-
6	8-27-69	14	55	< 3	< 9	51	< 130	< 7	< 7	3	< 3	< 13	6	< 7	4	< 3	2	< 7	4	< .7	830	< 9	< 7	< 7	< 390	> 13
6	1-13-70	20	55	< 6	< 3	64	< 60	< 6	< 6	4	ND	< 3	320	< 3	.3	5	2	8	-	< .6	750	< 6	< 6	< 3	< 250	ND
11	1-14-69	120	43	< 2	< 8	54	< 80	< 8	< 5	9	-	< 8	160	< 8	4	5	2	< 8	3	< .8	960	< 8	< 8	< 8	ND	-
11	5-14-69	15	40	< 2	< 3	50	< 70	< 7	< 7	3	-	< 7	70	< 3	4	< 3	2	< 10	5	< .7	800	< 7	< 7	< 7	< 280	-
11	8-26-69	60	55	< 3	< 9	52	< 130	< 7	< 7	2	< 3	< 13	14	< 7	3	< 3	2	< 7	4	< .7	830	< 9	< 7	< 7	< 370	> 13
11	1-13-70	80	41	< 6	< 3	54	< 55	< 6	< 6	3	ND	< 3	210	3	.3	5	2	6	-	< .6	650	< 6	6	< 3	< 230	ND

and for mosquito control. Citrus-fruit farming is intensive in the Lake Okeechobee inflow area, but the total amount of pesticides that enters the lake drainage is unknown. Winter vegetable farming and sugarcane growing is extensive south of the lake. As previously mentioned, excess water from these areas is pumped into Lake Okeechobee at HGS-3 and 4 to alleviate floods.

DDT is applied to sweet corn for controlling army worms. Large acreage on the east and southeast shores of Lake Okeechobee is used for growing sweet corn in the winter. Toxaphene, another chlorinated hydrocarbon, is also applied to sweet corn for controlling corn earworms.

Water and bottom-sediment samples from sites 1, 6, 9, 11, 14, and 15 were analyzed for pesticides including seven chlorinated hydrocarbons, eight organophosphates, and the carbamate, sevin (table 5). The highest concentration of DDT series in the water was $0.09 \mu\text{g/l}$ and in bottom sediments $2,900 \mu\text{g/kg}$ (micrograms per kilogram).

The highest concentration of toxaphene in bottom sediments was $1,400 \mu\text{g/l}$. All the organophosphates and the carbamate listed in table 5 are used in the Lake Okeechobee area, but none were found in any of the water and bottom sediment samples, probably because of the nonpersistence of these pesticides.

BOTTOM SEDIMENTS

In the bottom sediments of Lake Okeechobee at most of the 15 sampling sites, appreciable quantities of iron, nitrogen, and phosphorus were present, but very little manganese (table 6). In general, the concentrations of nitrogen and phosphorus were lowest in the bottom sediments in the western part of the lake. This may be because of poor water circulation there or possible because of heavy vegetation that can assimilate these nutrients and prevent deposition to the sediments.

Iron in the sediments ranged in concentration from 0.50 to 8.1 mg/g (milligrams per gram), total nitrogen ranged from 0.39 to 11 mg/g. The organic nitrogen was usually greater than 90 percent of the total nitrogen. The total phosphorus as PO_4 ranged from 0.08 (0.03 P) to 2.1 mg/g (0.69 P).

TRIBUTARIES

Nitrogen and phosphorus contents of streams and canals tributary to Lake Okeechobee are shown in figures 7 and 8, respectively and all data are shown in table 14. Figures 7 and 8 do not include data for Harney Pond and Indian Prairie Canals because water from them was usually not flowing into the lake during the

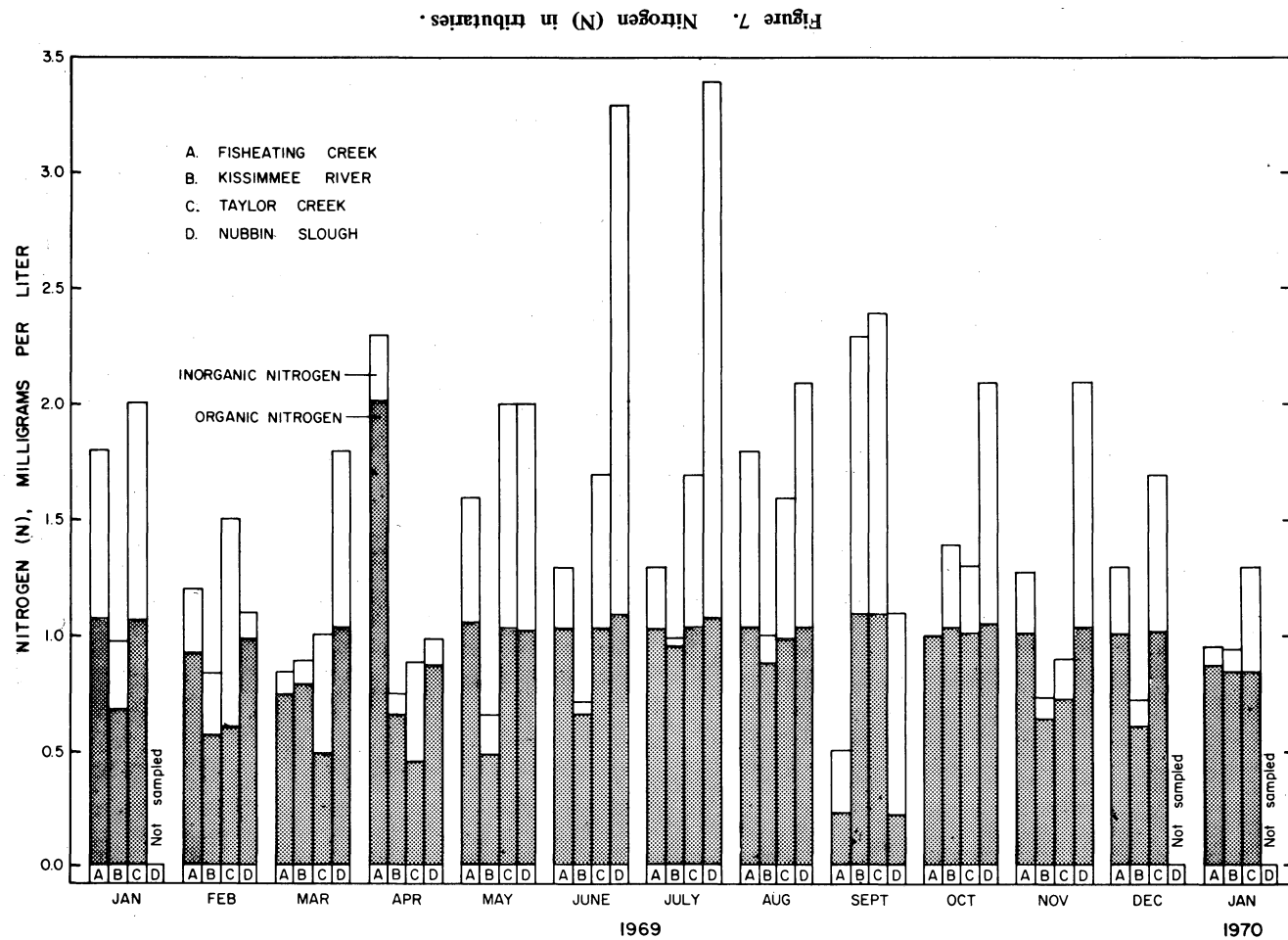
REPORT OF INVESTIGATIONS NO. 71

31

(Results for water samples in $\mu\text{g}/\text{l}$ (micrograms per liter), Bottom sediments $\mu\text{g}/\text{kg}$ (micrograms per kilogram))

REPORT OF INVESTIGATIONS NO. 71

33



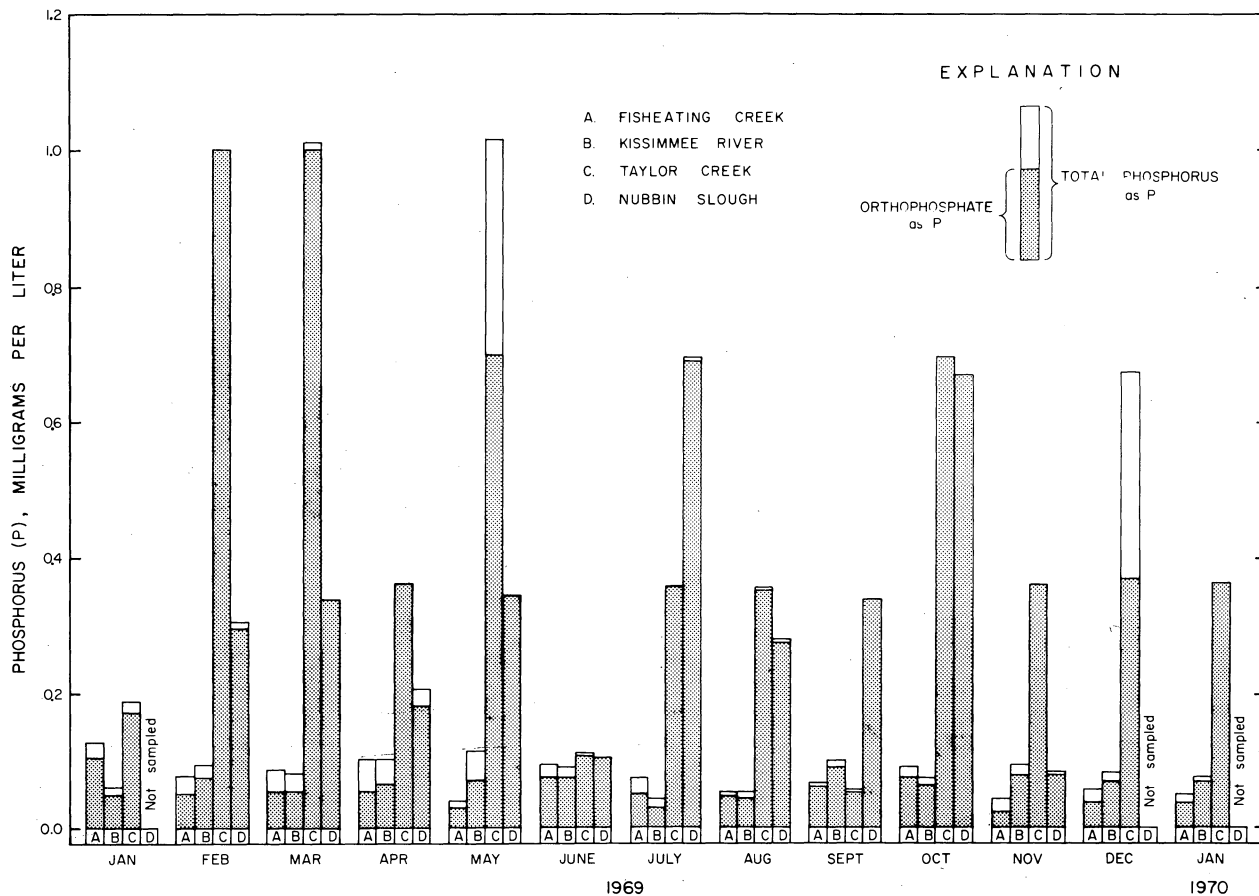


Table 6
Average chemical analyses of bottom sediments in Lake Okeechobee

(Results in milligrams per gram, dry weight)

	Iron (Fe)	Nitrite & Nitrate (N)	Ammonia (N)	Organic Nitrogen (N)	Total Nitrogen (N)	Total Phosphorus (PO ₄)	Manganese (Mn)
1	4.8	0.12	0.36	6.2	6.7	2.1	0.04
2	3.3	.50	.16	3.1	3.8	.83	.04
3	1.7	.00	.19	.48	.67	.13	.01
4	1.0	.00	.04	.40	.44	.27	.00
5	.50	.01	.04	.34	.39	.13	.00
6	.85	.01	.05	.44	.50	.08	.00
7	2.4	.01	.06	2.0	2.1	1.0	.00
8	1.0	.01	.04	.66	.71	.36	.08
9	7.2	.01	.14	9.2	9.4	.93	.00
10	6.7	.01	.15	10	10	.50	.02
11	6.3	.08	.14	8.7	8.9	.81	.01
12	4.0	.08	.17	4.2	4.4	1.0	.01
13	7.8	.14	.31	9.4	9.8	1.6	.00
14	.8	.02	.18	11	11	1.0	.00
15	8.1	.03	.22	7.5	7.8	1.8	.01

monthly sampling periods. Analyses of water standing in the channels of both are included in table 14.

The high color of the water in Fisheating Creek is caused by organic material contributed by the dense swamps through which the stream flows. Dissolved solids (calculated) ranged in concentration from 51 to 119 mg/l. Generally the difference between dissolved solids (calculated) and dissolved solids (residue) represents organic material (table 14). The low mineral content of the water is caused by a lack of soluble mineral matter in the drainage basin. The total nitrogen load (N) contributed to Lake Okeechobee by Fisheating Creek from January 1969 through January 1970 is estimated to have averaged 2.0 tons per day. Average concentration was 1.4 mg/l. The average total phosphorus concentration (P) was 0.069 mg/l and the load averaged 0.09 ton per day.

There was a tendency for the DO in water of Fisheating Creek to sag during high flow, probably because of oxidation of organic materials that were washed in by flood waters. The low DO concentration of 3.3 mg/l (43 percent of saturation) in August (table 14) was probably caused both by oxidation of

organic material in the stream and high water temperature. Most of the DO measurements for Fisheating Creek were made in mid or late afternoon.

In water from Harney Pond Canal, average concentration of total nitrogen was 1.2 mg/l, daily load 0.92 ton. Average total phosphorus concentration was 0.072 mg/l and the daily load averaged 0.06 ton per day.

The total nitrogen (N) concentration in water of Indian Prairie Canal averaged 1.6 mg/l. The average daily load was 0.42 ton per day, less than half that of the Harney Pond Canal because of the smaller discharge of the Indian Prairie Canal. The sample collected in March (table 14) contained 0.058 mg/l nitrite-nitrogen and 0.76 mg/l ammonia-nitrogen, which may indicate some form of pollution. Average total phosphorus concentration was 0.081 mg/l, and the average daily load was 0.02 ton, less than half that of the Harney Pond Canal.

Water in the Kissimmee River (although colored) is less mineralized than that of any other stream and canal tributary to Lake Okeechobee except Fisheating Creek, and is of excellent chemical quality. Calculated dissolved solids average 108 mg/l. Even though the mineral content is low, the river contributes the greatest load of dissolved solids to Lake Okeechobee, 1,010 tons per day. This, of course, is because of the large discharge of the Kissimmee.

The total nitrogen (N) concentration in water of the Kissimmee River averaged 0.99 mg/l, lower than in any other stream and canal tributary to Lake Okeechobee. Because of the large discharge, however, the total nitrogen load of 9.22 tons per day was the highest. Average total phosphorus concentration was 0.078 mg/l, and the daily load averaged 0.73 ton, which was the greatest load entering Lake Okeechobee. DO ranged from 4.9 mg/l (66 percent saturation) to 10.1 (103 percent saturation). The lower concentrations occurred in the summer, when both water temperature and flow were seasonally high.

Odum (1953) reported for a sample collected from the Kissimmee River on June 22, 1952, a total phosphorus (P) concentration of 0.012 ppm. The average discharge of the river on that date was 1,450 cfs. These measurements indicate that the total phosphorus load of the Kissimmee River on June 22, 1952, was only 0.052 ton per day.

The water contributed to Lake Okeechobee by Taylor Creek is often high in dissolved solids, sodium, sulfate, and chloride and is almost always high in nutrients, especially phosphorus. The high color of the water, ranging from 40 to 220 units, is probably caused by the natural swampy environment through which the stream flows.

Average dissolved-solids content (calculated) for the 13 monthly samples collected was 249 mg/l. At other times, dissolved-solids content (calculated) of water in Taylor Creek has been much greater because of contributions from Williamson Ditch, a tributary.

Total nitrogen (N) concentration in water from Taylor Creek averaged 1.6 mg/l, and the load contributed to Lake Okeechobee averaged 1.39 tons per day. Ammonia-nitrogen concentration was always high, ranging from 0.086 to 0.44 mg/l.

Average phosphorus concentration in water from Taylor Creek was higher than that in any other water in the Lake Okeechobee drainage system during the period of study. Average total phosphorus concentration was 0.62 mg/l, and the daily load was 0.54 ton per day. Taylor Creek contributed less than 10 percent as much water to Lake Okeechobee as the Kissimmee River during the investigation, but its contribution of phosphorus was 75 percent of that discharged by the Kissimmee. Odum (1953) reported a total phosphorus concentration of only 0.057 mg/l in water from Taylor Creek on June 22, 1952.

Nubbin Slough contributed only about one-half percent of the total inflow to the lake during the investigation, but its nitrogen and phosphorus contribution was high, relatively. Total nitrogen (N) concentration averaged 2.0 mg/l, highest observed in the drainage system, excepting the North New River Canal. Total nitrogen load, however, averaged only 0.25 ton per day because of the small discharge. Most of the inorganic nitrogen in Nubbin Slough water was in the form of ammonia nitrogen, averaging 0.66 mg/l.

Total phosphorus concentration in Nubbin Slough water averaged 0.36 mg/l, second only to Taylor Creek. The average daily load of 0.05 ton per day, however, was relatively low because of the small discharge.

Average DO concentration in Nubbin Slough water ranged from 1.0 mg/l (11 percent of saturation) to 9.4 mg/l (124 percent of saturation). The low concentrations were caused by the use of large quantities of oxygen for decomposition of organic substances. The supersaturated concentrations were caused by oxygen-producing photosynthesis triggered by the availability of nutrients for biological activity.

DRAINAGE CANALS

The drainage canals were sampled only when water was moving to or from the lake. Excellent data were obtained from the St. Lucie Canal and relatively good data from West Palm Beach, North New River, and Caloosahatchee Canals

(table 15). Only three samples, however, two where flow was positive and one where flow was negative, were obtained from Miami Canal.

The quality of water in the drainage canals is generally similar to that of the lake water during positive flow (flow from the lake). During negative-flow, when water is either flowing or being pumped into the lake through HGS-3 at pump structure 3 or HGS-4 at pump structure 2, the quality of the water in the North New River and Miami Canals deteriorates rapidly. Dissolved solids, nutrients, and other major constituents increase to concentrations often exceeding State water-quality standards. Also, dissolved oxygen concentration frequently sags to below 5.0 mg/l and less than 50 percent saturation. Water pumped into the lake from the agricultural areas is the poorest in quality of any other entering Lake Okeechobee.

Dissolved solids ranged from 163 mg/l in the Caloosahatchee Canal during positive flow to 1,160 mg/l in the North New River Canal during negative flow. The negative-flow sample from the North New River Canal also contained high concentrations of sodium (239 mg/l) and chloride (332 mg/l), in excess of the State standards of 250 mg/l. Dissolved oxygen was 4.0 mg/l, or 43 percent of saturation. Total nitrogen concentration was 3.8 mg/l, of which 2.0 mg/l, or 53 percent, was organic nitrogen. The 1.8 mg/l inorganic nitrogen consisted of 1.0 mg/l $\text{NO}_3\text{-N}$, 0.08 mg/l $\text{NO}_2\text{-N}$, and 0.72 mg/l $\text{NH}_4\text{-N}$. The high concentrations of nitrite and ammonia may indicate pollution. The highest phosphorus concentration was in a positive-flow sample from the North New River Canal in January 1970. Orthophosphate was 0.19 mg/l as P, and total phosphorus was 0.20 mg/l. Water in the drainage canals has a high color, exceeding 150 units, during negative flow, which indicates that large quantities of organic matter are pumped from the agricultural areas into the lake. The color of water flowing directly from the lake was usually no more than 30 units.

NITROGEN AND PHOSPHORUS IN RAINFALL

Rainfall contributes large quantities of nutrients to Lake Okeechobee. In order to assess nitrogen and phosphorus contributed by rainfall, samples were collected at HGS-1 (Moore Haven Lock) from January to December 1969. An aliquot from each period of rain was collected to obtain an adequate sample for one analysis each month. The results of the analyses are given in table 7. The results do not include dry fallout inasmuch as the sample-collection apparatus was covered except during rainfall periods. About 75 percent of the total rainfall during 1969 was sampled. The rainfall at HGS-1 was about 10 inches greater than the average rainfall of 54.47 inches measured for the lake in 1969.

Table 7

Nitrogen and Phosphorus in Rainfall at Hurricane Gate Structure-1

(Results in milligrams per liter except for rainfall which is in inches and specific conductance which is in micromhos at 25°C)

DATES 1969	Rainfall (inches)	Specific Conductance (micromhos 25° C.)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)
January 4, 5, 6	1.19	25	0.07	0.009	0.10	0.25	0.43	0.007	0.007
February 16	1.51	26	.05	.003	.00	.20	.25	.007	.029
March 3, 8	1.06	21	.11	.003	.09	.24	.44	.003	.007
March 8, 9, 13, 17	3.70	29	.1	.006	.12	.25	.48	.003	.013
March 26, 31; April 2, 11, 29 and May 2, 3, 15	2.33	47	.3	.000	.12	.45	.87	.036	.055
June 14, 15, 16, 17, 20	5.89	60	.02	.000	.41	.24	.67	.020	.029
June 21, 28; July 3, 11, 14, 18 20, 21, 22, 27, 28, 29	5.38	80	.02	.003	.06	.40	.48	.013	.020
August 2, 4, 5, 6, 7, 8, 11, 12, 13, 14, 16, 18, 25	7.54	80	.1	.006	.12	.35	.58	.007	.026
September 24, 27, 29, 30; October 1, 2, 3, 6, 19, 20, 22, 23, 24	12.17	17	.2	.000	.85	.58	1.6	.11	.13
October 30; November 10, 14	3.93	29	.07	.009	.85	.52	1.4	.055	.091
December 8, 10, 11	3.40	14	.0	.003	.04	.58	.62	.000	.016
Rainfall weighted averages <u>1/</u>	48.10	43	.10	.003	.38	.42	.90	.040	.056

1/ Total rainfall in samples analyzed.

Table 7 shows wide variations in the measured constituents. Specific conductance ranged for 14 to 80 micromhos, total nitrogen from 0.25 to 1.6 mg/l, and total phosphorus ranged from 0.007 mg/l in January and March to 0.13 mg/l in September and October. The rainfall in the summer and fall apparently contains higher nutrient concentrations than it does in winter and spring.

At times the concentrations of nitrogen and phosphorus in rainfall are comparable to concentrations found in tributary inflow and in the lake. The concentration of total phosphorus in rainfall average 0.056 mg/l, equivalent to the average concentration in Lake Okeechobee during 1969 - 70. The concentration of total nitrogen in rainfall averaged 0.90 mg/l, which was approximately 50 percent of the average concentration in Lake Okeechobee during 1969 - 70.

The average nitrogen and phosphorus values reported in table 7 compare favorably with results from other studies (see table below):

Analyses of Rainfall
(Results in Milligrams per liter except specific conductance)

Source	A	B	C	D
Specific conductance (micromhos at 25°C)	43	10-30	--	--
Nitrate (NO ₃ -N)	0.10	0.20	0.09	0.13
Nitrite (NO ₂ -N)	.003	.006	--	.00
Ammonia (NH ₄ -N)	.38	.21	.18	.07
Organic nitrogen (N)	.42	.32	--	--
Total nitrogen (N)	.90	.74	.43	--
Orthophosphate (PO ₄ -P)	.040	.026	--	--
Total phosphorus (P)	.056	.033	.059	--

- A. Hurricane Gate Structure 1, Lake Okeechobee (average of 11 analyses, January to December 1969).
- B. Brezonik, P. L., Morgan, W. H., Shannon, E. E., and Putnam, H. D., 1969 (Average rainfall analyses in north central Florida, 1968).
- C. Schneider, Robert F., and Little, John A., 1969 (Average of 3 rainfall samples in central Florida, 1969).
- D. Gambell, Arlo W., and Fisher, Donald W., 1966 (Average monthly analyses of rainfall in eastern North Carolina and southeastern Virginia, August 1962 to July 1963).

WATER-QUALITY BUDGET, 1969 - 70

A water budget for Lake Okeechobee for the 19-month span January 1, 1969 to July 31, 1970 is presented in table 3. A water and dissolved-solids budget for the 13-month span January 1, 1969, to January 31, 1970 is shown in table 8. The dissolved-solids budget could not be extended to July 1970 because data collection for tributaries and drainage canals was terminated in January 1970.

Inflow water from major water sources for the 13-month period failed to balance the measured outflow by 180,800 acre feet, 2.8 percent of the total water budget. This amount is indicated under the "inflow" column (table 8) as being from other sources and, as mentioned in the 19-month budget, may be from upward seepage from the Floridan aquifer.

The dissolved-solids budget shown in table 8 was computed from average dissolved-solids content in the inflow and outflow water. Average dissolved-solids content in precipitation was computed by multiplying the average specific conductance of 43 (table 7) by 0.65, which is considered to be the average factor for conversion of specific conductance of rainfall to dissolved solids (U. S. Geological Survey, Water Resources Data for Florida, 1968, part 2, water quality records, p. 8). The computed factor for the lake water was 0.56. The change in storage for dissolved solids was computed from the difference in the total tons in the lake in January 1969 and January 1970.

The inflow of dissolved solids in table 8 failed to balance the outflow by more than 250,000 tons, or approximately 20 percent of the dissolved-solids budget. This 250,000-ton residual may result, in part, from cumulative errors in measurements and, in part, from pickup of dissolved solids by the outflow waters.

The most probable explanation for pickup of dissolved solids in the outflow water is solution of limestone from the lake bottom and resolution of dissolved solids previously trapped in the sediments. Most lakes act as sinks to trap part of the dissolved solids entering from tributaries, especially at low flow, as part of natural eutrophication. For example, Oneida Lake in New York State traps 11 percent of the dissolved solids (Greeson, 1971).

TABLE 8
Generalized water and dissolved solids budget for Lake Okeechobee,
January 1, 1969 to January 31, 1970

INFLOW						OUTFLOW					
Source	Q cfs	Total Acre-ft.	Dissolved Solids		Total tons	Source	Q cfs	Total Acre-ft.	Dissolved Solids		Total tons
			Mg/l	tons/day					mg/l	tons/day	
Fisheating Creek	529	415,000	73	104	41,000	St. Lucie Canal	1,700	1,340,00		1,330	525,000
Harney Pond Canal	286	224,000	151	116	46,000	W.P. Beach Canal	218	171,000	310	182	72,000
Indian Prairie Canal	84	66,100	169	37	14,700	N. New River Canal	311	244,000	451	378	150,000
Kissimmee River	3,450	2,710,000	108	1,010	398,000	Miami Canal	351	276,000	356	337	134,000
Taylor Creek	322	253,000	249	214	84,800	Caloosahatchee Cnl	2,386	1,870,000	246	1,584	627,000
Nubbin Slough	46	36,100	167	20	7,940	Evaporation <u>1/</u>	57.14	2,220,000	--	-	-
N. New River Canal	213	167,000	893	512	203,000	Change in Storage <u>3/</u>	0.5	240,000 <u>4/</u>	-	-833	-330,000
Miami Canal	62	49,000	642	108	42,800						
Precipitation <u>1/</u>	58.09	2,260,000 <u>2/</u>									
Other Sources	49	180,000									
TOTALS		6,361,000		2,978	1,178,000	TOTALS		6,361,000		2,978	1,178,000

1/ Inches; data supplied by U. S. Corps of Engineers

2/ Based on a lake area of 730 sq mi

3/ Feet; data supplied by U. S. Corps of Engineers

4/ Computed from stage-volume rating table supplied by U.S. Corps of Engineers

BUREAU OF GEOLOGY

Interestingly, precipitation during the 13 months contributed 30 percent of the nitrogen entering Lake Okeechobee, second only to the Kissimmee River, which contributed 39 percent. The concentration of nitrogen in water from the Kissimmee was only a little greater than that in rainfall (table 9). Catfish bait used by commercial fishermen was thought to be an important source of nutrients to the lake, but only 0.20 percent of the 6.75 tons per day of the cottonseed and soybean meal cake used for bait is soluble nitrogen. Nitrogen in catfish bait and the commercial fish harvest is small compared with the total nitrogen budget. Ager (1970) estimated that the annual commercial fish harvest could be increased to 34,200,000 pounds per year, dressed weight. The rough weight (undressed) would be about double, or 94 tons per day, which would increase the estimated nitrogen removal from the lake from 0.02 ton per day to 0.56 ton per day, or 222 tons for the 13-month budget and the amount retained in the lake would decrease to about 20 percent of the total nitrogen budget.

Table 9 shows that 2,080 tons or 22 percent, of the nitrogen was trapped in the lake. Lakes naturally act as sinks and trap nitrogen. For example, approximately 20 percent of the nitrogen entering Oneida Lake, New York, is trapped, (Greeson, 1971).

Taylor Creek contributes only 4 percent of the water to Lake Okeechobee (table 8) but contributes 26 percent of the total phosphorus load, the second largest source (table 10). The Kissimmee River contributes 36 percent of the total phosphorus load. Precipitation, the third major source, contributes 21 percent.

The largest value on the outflow side of the phosphorus budget was 295 tons, or 36 percent, trapped in the lake for the 13-month period. In Oneida Lake, New York, 62 percent of the phosphorus entering is trapped (Greeson, 1971). The change in storage of 277 tons of phosphorus was the second largest value on the outflow side of the budget. The phosphorus concentration in January 1969 was 0.02 mg/l and in January 1970 was 0.07 mg/l.

BIOLOGICAL CHARACTERISTICS OF LAKE OKEECHOBEE, 1969 - 71

PHYTOPLANKTON

Of about 90 samples collected between January 1969 and April 1971 for determination of phytoplankton content, 14 had more than 5,000 cells/ml and 5 had more than 100,000 cells/ml, as shown in the following table and table 16 in the appendix. The estimated average number of cells per milliliter for 6 sites in January 1971 was 149,630 cells/ml, and the maximum number was 473,700 cells/ml from site 5.

Table 9
Generalized nitrogen (N) budget for Lake Okeechobee
January 1, 1969 to January 31, 1970

INFLOW					OUTFLOW				
Source	Q cfs	mg/l	Nitrogen tons/day	total tons	Source	Q cfs	mg/l	Nitrogen tons/day	total tons
Fisheating Creek	529	1.4	2.00	792	St. Lucie Canal	1,700	1.2	5.53	2,190
Harney Pond Canal	286	1.2	.93	367	West Palm Beach Canal	218	1.3	.76	302
Indian Prairie Canal	84	1.6	.36	144	N. New River Canal	311	1.5	1.26	498
Kissimmee River	3,450	.99	9.22	3,650	Miami Canal	351	1.1	1.04	413
Taylor Creek	322	1.6	1.39	551	Caloosahatchee Canal	2,396	1.1	7.07	2,800
Nubbin Slough	46	2.0	.25	98	Change in Storage	--	--	2.65	1,050
N. New River Canal	213	3.8	2.18	864	Commercial Fish H. <u>4/</u>	3.0 <u>5/</u>	.6	.02	8
Miami Canal	62	1.6	.27	107	Trapped in lake	--	--	5.25	2,080
Precipitation <u>1/</u>	58.09	.90	6.98	2,760					
Catfish Bait <u>2/</u>	6.75 <u>3/</u>	.20	.01	4					
TOTALS			23.59	9,340	TOTALS			18.33	7,261

1/ Inches

2/ Tons per day

3/ Percent of soluble nitrogen (N)

4/ Dressed weight 1.45 T/day

5/ Percent nitrogen (N)

Table 10
Generalized Phosphorus (P) Budget for Lake Okeechobee
January 1, 1969 to January 31, 1970

INFLOW					OUTFLOW				
Source	Q cfs	mg/l	Phosphorus tons/day	total tons	Source	Q cfs	mg/l	Phosphorus tons/day	total tons
Fisheating Creek	529	0.068	0.09	39	St. Lucie Canal	1,700	0.062	0.29	113
Harney Pond Canal	286	.072	.06	22	West Palm Beach Canal	218	.033	.02	8
Indian Prairie Canal	84	.082	.02	7	N. New River Canal	311	.026	.02	9
Kissimmee River	3,450	.078	.73	289	Miami Canal	351	.020	.02	8
Taylor Creek	322	.62	.54	213	Caloosahatchee Canal	2,390	.039	.25	99
Nubbin Slough	46	.36	.05	18	Change in Storage	-	-	.70	277
N. New River Canal	213	.18	.10	40	Commercial Fish Har <u>2/</u>	3.0	-	-	-
Miami Canal	62	.036	.01	3	Trapped in Lake	-	-	.74	295
Precipitation <u>1/</u>	58.09	.056	.43	170					
Catfish Bait <u>2/</u>	6.75 <u>3/</u>	.29	.02	8					
TOTALS			2.04	809	TOTALS			2.04	809

1/ Inches

2/ Tons per day

3/ Percent of soluble phosphorus (P)

Numbers of phytoplankters in cells per milliliter in Lake Okeechobee,
January 1969 to April 1971.

Maximum and minimum not determined when cells per milliliter were less than 50.

Date	Average Number	Maximum	Minimum	No. of sites
January 1969	Less than 50	Less than 50	Less than 50	15
May 1969	1,220	4,600	100	15
August 1969	Less than 50	Less than 50	Less than 50	15
January 1970	Less than 50	Less than 50	Less than 50	15
April 1970	1,560	7,500	Less than 50	7
July 1970	32,300	106,800	60	6
October 1970	25,400*	108,500*	2,100	6
January 1971	149,630*	473,700*	960*	6
April 1971	7,956*	37,400*	80*	8

* Estimated.

In general, the highest concentrations of phytoplankton were observed in the western and northern parts of the lake. Concentration was high at site 5 in the western part of the lake except in April 1970 and April 1971. In April 1970 a sample was taken from the Kissimmee River in addition to those collected from the lake. The phytoplankton count in the sample from the Kissimmee was greater (7,700 cells/ml) than in any of the lake samples of that month. Possibly algal blooms were then occurring in one or more of the lakes drained by the Kissimmee. At site 12, also in April 1970, at the mouth of the St. Lucie Canal, the count was 7,500 cells/ml. In April 1971 the maximum count was at site 8 (37,400 cells/ml) and 9 (15,900 cells/ml), both in the northern part of the lake. Genera and species of phytoplankton observed in Lake Okeechobee are listed in table 11.

Pediastrum simplex, a green alga typical of very early *eutrophic* lakes, was abundant in Lake Okeechobee in January, May, and August 1969 and in January 1970. Other codominant species present with *Pediastrum simplex* during this period were: *Oscillatoria cortina* (January 1969, August 1969); *Melosira* sp. (January 1969 and 1970); *Mongeotia* sp. (January 1969 and 1970); *Merismopedia elegans* (May 1969); *Microcystis aeruginosa* (August 1969); and *Aphanizomenon holsaticum* (August 1969).

Microcystis aeruginosa and *Aphanizomenon holsaticum* are both potential nuisance forms of blue-green algae that often grow abundantly during late summer when temperatures are at a maximum. When conditions are favorable, these species form dense growths that tend to float and thus interfere with recreational utility of lakes. Both forms can spoil water for domestic uses, swimming, and recreation, and often cause the death of fish in heavily infested

Table 11
Phytoplankton observed in Lake Okeechobee

(A, abundant; P, present; -, not present)

[illegible]

lakes. When detected during August 1969, however, concentrations of both forms in the lake were far below nuisance levels.

After January 1970, *Pediastrum simplex* was replaced as the dominant alga at most points by *Aphanizomenon holsaticum*. The increased concentration of phytoplankton to bloom levels and the change of dominant species from green to blue-green algae after January 1970 followed a period of heavy inflow from rainfall and tributaries, with consequent increased influx of nutrients. The rapid seasonal changes in phytoplankton population reflect a change in the environmental conditions within the lake. In April 1970 and 1971, *Aphanizomenon holsaticum* dominated samples collected from the northern part of the lake. In July 1970 and January 1971, *Aphanizomenon holsaticum* was the most numerous alga at all except site 2, and in October 1970 it was the dominant species at half the sites.

Other dominant alga included: the diatoms (*Cyclotella* sp. April 1970 at sites 2, 5, and 15 and July 1970 at site 2) and *Stephanodiscus niagarae* (April 1971 at site 2); the green algae, *Closterium* sp. (codominant in January 1971 at site 2 with *Aphanizomenon holsaticum*) and *Pediastrum simplex* (April 1971 at site 5); and the blue-green algae *Merimopidia elegans* (October 1970 at sites 2 and 12); *Spirulina* sp. (October 1970 at site 8 and April 1971 at sites 12 and 15); and *Anabaena flos-aquae* (April 1971 in the Kissimmee River). Concentrations of *Aphanizomenon holsaticum* far exceed the numbers of other alga, with the exception of a single sample collected by the Florida Game and Fresh Water Fish Commission in a plankton bloom on June 29, 1970. The phytoplankters in this bloom were represented almost exclusively by *Anabaena flos-aquae*, which numbered 595,600 cells/ml.

Although large blooms of *Aphanizomenon holsaticum* occurred during July and October 1970 and January 1971, most specimens were small. This may indicate that nutrient conditions in the lake were favorable for reproduction but unfavorable for optimum growth.

Growth of phytoplankton in the lake may be limited by high turbidity. Secchi disc readings were generally less than 1.0 foot. The high turbidity results from finely suspended sediment. Lake Okeechobee has an average depth of about 9 feet, and mixing, in which sediment is constantly resuspended from the bottom, is effective.

BENTHIC ORGANISMS

Average number of benthic macroinvertebrates in sediment samples collected in January, May, and August 1969 and in January 1970 at seven sites

Table 12
Average number of bottom organisms per square meter
January, May, August 1969, and January 1970

(Determinations made by Florida Department of Air and Water Pollution Control)

Organisms	Point						
	1	5	6	8	9	11	15
Oligochaeta	935 ...X	494 XX..	226 XXX.	301 XXX.	602 XX..	150 XXXX	898
<i>Gammarus</i> sp.	37 -XXX	10 XX-	48 -X	43 -X	16 -X-	5 -X	10 X-X
<i>Hyaella azteca</i>	-X-	---	---	---	---	---	---
<i>Cyathura polita</i>	---	199 ..XX	75 -XX	118 XX-X	32 -XXX	---	16 -X
<i>Taphromysis</i> sp.	---	16 -X-X	5 -X-	---	---	5 -X-	---
<i>Coelotanypus</i> sp.	124 X-X.	59 XXXX	166 -X	252 XXX	269 X-X	640 XXXX	399 XXXX
<i>Procladius</i> sp.	---	5 X-	---	---	---	---	---
<i>Chironomus</i> <i>crassicaudatus</i>	210 -X-	5 -X-	---	215 -X-	575 -X-	220 -XX	---
<i>Glyptotendipes</i> <i>lobiferus</i>	---	5 X-	---	---	---	---	---
<i>Glyptotendipes</i> <i>paripes</i>	---	---	---	---	11 X-	---	---
<i>Tanytarsus</i> sp.	---	102 X-X-	16 -X-	16 X-	---	16 X-	---
<i>Cladotanytarsus</i> sp.	---	48 -X-	---	---	---	---	---
<i>Polypedilum</i> sp.	---	11 -X-	---	---	---	---	---
<i>Chaoborus</i> sp.	---	---	5 X-	5 -X-	---	---	5 X-
<i>Viviporus</i> sp.	21 -XX	---	---	---	64 XXXX	5 -X	11 -X
<i>Melanoides</i> sp.	---	---	---	---	---	4,392	328 -XX
Unid. snail	---	---	---	---	---	---	107 -XXX
Totals	1,332	954	541	950	1,569	5,433	1,774

Dominant species sampled at site for date indicated. ; Present X ; Not present - ;

Position indicates date of collection: January, May, August, January

in Lake Okeechobee ranged in number from 541 per m² (square meter) at site 6 to 5,433 m² at site 11 (table 12). The average for all sites was 1,794 per m². Highly enriched lakes in central Florida support numbers ranging from thousands to tens of thousands per square meter. Numbers in excess of 10,000 are often indicative of organic pollution.

Macroinvertebrates were most numerous in the northern, eastern and central parts of the lake, at sites 9, 11, and 15, respectively. At these sites bottom samples were mud; at other sites, samples were sand, or shell mixed with mud. Mud usually supports larger standing crops of benthic animals than sand or shell because of the greater amount of available organic food.

The highest numbers of benthic macroinvertebrates were collected in August 1969, with an average for all sites of 3,754 per m². Intermediate numbers were recorded in January 1969 (961 per m²) and January 1970 (1795 per m²), and the lowest average number was recorded in May 1969 (664 per m²).

Oligochaetes and chironomid, *Coelotanypus* sp. were the most widely distributed benethic macroinvertebrates collected (table 12). The other chironomids collected in the lake and *Chaoborus* sp. are potential nuisance species. Their numbers, however, were far below nuisance levels.

CHEMICAL, PHYSICAL AND BIOLOGICAL CHARACTERISTICS OF WATER AND SEDIMENT, 1970 - 72

CHEMICAL AND PHYSICAL CHARACTERISTICS OF WATER

PHYSICAL CHARACTERISTICS AND DISSOLVED SOLIDS

The average specific conductance of the water samples from Lake Okeechobee for the seven monitoring transects ranged from 451 micromhos in October 1970 to 633 micromhos in May 1972. The average calculated dissolved solids ranged from 256 mg/l in October 1970 to 365 mg/l in May 1972. The dissolved solids and major dissolved constituents can easily be related to specific conductance. The increase in specific conductance, dissolved solids, and major constituents during the monitoring period was caused by back pumping of highly mineralized water into the lake, flow into the lake from drainage canals during the drought of 1971, and concentration of water in the lake caused by high evaporation rates. The lake stage averaged only about 13 feet for the time span October 1970 - May 1972 as compared to an average of 15 feet for January 1969 to July 1970. The average dissolved solids during the later period, was 312 mg/l, and for the earlier period, 260 mg/l.

Average dissolved oxygen concentrations in the lake for each transect ranged from 6.7 mg/l (84 percent of saturation) to 9.4 mg/l (107 percent of saturation). A low dissolved oxygen concentration of 3.5 mg/l (41 percent of saturation) occurred in Taylor Creek in November 1971.

Because the lake stage was 2 feet lower October 1970 - May 1972 than January 1969 - July 1970, the lake was generally more turbid during the later period. The average measurements for the seven lake transects ranged from 9 to 48 JTU. The Kissimmee River and Taylor Creek were usually less turbid than the lake (table 17).

The color of the lake water was generally less than 50 units but tended to increase beginning about in November 1971 because of pumpage and inflow of highly colored water from tributaries and drainage canals. In November, 1971 the color was 240 units at point 12 near the St. Lucie Canal and 100 units at point 5 in western part of the lake. These high colors were probably caused by inflow of highly colored water from the St. Lucie Canal (reverse flow), Fisheating Creek, Indian Prairie and Harney Pond Canals. The color of the water was not as high, only 80 units, at point 15 in the middle of the lake in May 1972.

Most field and laboratory pH measurements in the lake were greater than 8.0. The pH of lake water was lowest in November 1971, after a period of heavy inflow of water of lower pH from tributaries and drainage canals. The lowest pH was 5.7 for the Kissimmee River and the next lowest was 6.0 for Taylor Creek, both in November, 1971.

NITROGEN AND PHOSPHORUS

The average total nitrogen (N) concentrations in Lake Okeechobee on the basis of data collected from transects 7 through 13 ranged from 0.66 to 3.0 mg/l. Most of the nitrogen was in the organic form, ranging from 81 to 96 percent of the total, and averaging 91 percent. Average inorganic nitrogen concentrations ranged from 0.06 to 0.40 mg/l. The average total nitrogen concentration for all 7 transects were higher (1.6 mg/l) than for transects 1 - 6 (1.4 mg/l). The average inorganic nitrogen, however, was lower (0.14 mg/l) than for transects 1 - 6 (0.30 mg/l).

On the basis of samples of river water collected 1970 - 72, the average total nitrogen concentration of the Kissimmee River was 1.1 mg/l as compared to 0.99 mg/l for those collected 1969 - 70. For Taylor Creek, the values are 1.9 and 1.6 mg/l. As during the project study, the ammonia nitrogen continued high in Taylor Creek, as much as 0.50 mg/l. For the last sampling in May 1972, however, the concentration was 0.04 mg/l.

The average total phosphorus (P) concentrations in the lake for the seven transects (numbers 7 - 13) ranged from 0.03 mg/l in May 1972 (transect 13) to 0.06 mg/l in November 1971 (transect 11). The average total phosphorus for lake transects 7 - 13 was 0.05 mg/l as compared to 0.04 mg/l for transects 1 - 6.

The average total phosphorus concentrations for the Kissimmee River and Taylor Creek were lower after October 1970 than before. The average for the Kissimmee River for the monitoring period was 0.07 mg/l and before October 1970 was 0.08 mg/l. Similarly for Taylor Creek the values are 0.54 mg/l after and 0.62 mg/l before.

TRACE ELEMENTS

The quantities of dissolved trace elements were very low in samples collected from site 15 in the center of Lake Okeechobee in November 1971 and May 1972 (table 17) (See also table on p. 5). Of the trace elements listed in table 17, five (aluminum, copper, iron, manganese, and zinc) have been cited by various investigators as essential for algal growth. For healthy algal growth, trace quantities of aluminum and 5 micrograms per liter of manganese are essential. In neither of the two samples analyzed was aluminum or manganese detected.

CHEMICAL CHARACTERISTICS OF BOTTOM SEDIMENTS

The analyses of the bottom sediment samples that were collected from transects 11 and 13 indicate that the sediments at sites 9 and 15 contain the highest percentage of organic material - 16.87 and 15.57 percent of carbon, respectively, and sites 5 and 8 the least, 0.08 and 0.12 percent. This was as expected as the bottom material at sites 5 and 8 is mostly sand. As shown in table 17 the nitrogen, phosphorus, and iron were lowest at points 5 and 8. The bottom material at point 2 was marly, which accounted for the relatively small quantity of carbon, nitrogen, and iron present.

BIOLOGICAL CHARACTERISTICS

PHYTOPLANKTON

Table 17 lists phytoplankton concentrations at each sampling point for transects 7 - 13. Table 18 lists the species of phytoplankton observed and average total concentrations in cells per millimeter for all sampling points during four transects from August 1971 to May 1972. The average lake concentrations during the last four transects were 11,100 cells/ml; 38,400/cells/ml; 8,400 cells/ml; and 24,700 cells/ml.

Concentrations of phytoplankton into 1972 continued highest in the western and northern parts of the lake. Average concentration of phytoplankton decreased from 149,630 cells/ml in January 1971 to 38,400 cells/ml in November 1971.

The concentrations of phytoplankton in the Kissimmee River and Taylor Creek, especially the Kissimmee, were surprisingly low. Not a single algal cell was observed in the Kissimmee River in August 1971 and only one species (*Microcystis aeruginosa*) with a concentration of 200 cells/ml, was observed in November 1971. A maximum concentration of 2,450 cells/ml was observed in the Kissimmee River in February 1972 during a no-flow period. The maximum concentration observed in Taylor Creek was 4,800 cells/ml in May, 1972 of which *Aphenizonmenon holsaticum* constituted 90 percent.

Aphanizomenon holsaticum continued to be the dominant alga in the lake. It was dominant at all sites in November (transect 11), and May (transect 13), sites 8, 9, 12, and 15 in August (transect 10), and sites 5, 8, 9, and 15 in February (transect 12). In August *Spirulina* sp. was the dominant alga at sites 2 and *Merismopedia elegans* was dominant at site 5. A total concentration of only 150 cells/ml was observed at site 2 in February; 50 cells/ml each for *Spirulina* sp., *Stephanodiscus niagarae* and *Synedra* sp. In February the total concentrations at sites 12 consisted of 200 cells/ml *Spirulina* sp and 50 cells/ml *Stephanodiscus niagarae*.

BENTHIC ORGANISMS

The number of benthic organisms collected ranged from 129/m² (square meter) at sites 2 in November 1971 to 12,837 m² at site 12 in May 1972 (table 19). The average counts for all six sites was 1,376/m² in November and 3,318 m² in May 1972.

In general, the number of organisms was highest at site 15 in the center of the lake and at site 12 near the St. Lucie Canal. The counts at site 12 were high, probably because the mucky bottom is rich in organic material and nutrients. The counts at site 2 were low, probably because the marly bottom is low in organic material and nutrients. At sites 5 and 8 the lake bottom is sandy.

EUTROPHIC ASSESSMENT

Eutrophication is part of the aging process of lakes from one life stage to another, ending in extinction. In the youngest stage of the life cycle, a lake is called oligotrophic and is characterized by low biologic productivity, low amounts of nutrients, and little sediment. Because a lake serves as a trap for

nutrients originating in the surrounding drainage basin and entering through streams, with rainfall, and with ground-water inflow, in time the oligotrophic lake becomes mesotrophic, or partly enriched with nutrients. As aging continues, the shore encroaches upon the water, the nutrient content increases, plants grow abundantly, and silt and organic matter accumulate on the bottom. The lake then becomes eutrophic, or enriched, and is characterized by high biologic productivity, high nutrient content, and extensive sedimentation. The final stage before extinction is a pond, marsh, or swamp. The lake may eventually become dry land. Eutrophication may be accelerated by the cultural activities of man, such as altering of drainage basins, agricultural practices, deforestation, mine development, and urbanization.

The chemical, physical, and biological data indicate that, in general, adequate nutrients were available for algal growth in Lake Okeechobee during 1969 - 72. With respect to the nutrients nitrogen and phosphorus, the average nitrate ($\text{NO}_3\text{-N}$) concentration for each transect ranged from 0.02 to 0.38 mg/l, and the average organic nitrogen (N) from 0.60 to 2.8 mg/l; organic nitrogen accounted for approximately 86 percent of the total nitrogen in the lake. The average orthophosphate ($\text{PO}_4\text{-P}$) and total phosphorus (P) concentrations for all transects were 0.03 and 0.04 mg/l, respectively. These values are comparable to those found during an investigation in 1969 - 70 (Goolsby and McPherson, 1970) of the chemical and biological characteristics of the upper St. Johns River basin immediately north-northeast of Lake Okeechobee and its drainage system. Results of the latter study indicated that organic nitrogen averaged 1.0 mg/l and accounted for more than 90 percent of the total nitrogen and that total phosphorus (P) averaged 0.05 mg/l on the main stem.

The filtering action of marshes may remove large quantities of nutrients. The nutrient concentrations were very low in samples collected from Lake Okeechobee at sites 17 and 18 in areas of dense emergent marsh vegetation in August 1969. Also, no phytoplankters were observed at site 18; only four filaments of *Oscillatoria cortina* were observed at site 17.

The greater than normal inflow from tributaries and rainfall from late 1969 to March 1970 contributed increased loads of nutrients, which, in turn, triggered increased concentration of phytoplankton to bloom levels and a change in dominant species from green (*Pediastrum simplex*) to blue-green algae (*Aphanizomenon holsaticum*). These changes began in the northern part of the lake. The dynamic shifts in phytoplankton population reflect a change in the environmental conditions, at least temporarily, within the lake.

Goolsby and McPherson (1970) report increased concentration of phytoplankton to bloom levels (approximately 75,000 cells/ml), consisting of

the blue-green algae, *Anabaena Circinalis*, associated with eutrophic lakes, in Blue Cypress Lake in July 1970. There was no evidence of bloom conditions, however, in 1971 - 72. Blue Cypress Lake is affected by man less than Lake Okeechobee.

Increases in concentrations of nutrients, such as silica, nitrate, phosphate, iron, and organic material (as approximated by color determinations) were relatively large in the northern part of Lake Okeechobee in January 1970 (table 13) after the period of heavy runoff. Available data indicate decreased concentrations of these nutrients during the subsequent phytoplankton bloom in July 1970. Phytoplankton concentration in Lake Okeechobee had significantly decreased by April 1971.

Examples of changes in selected nutrient concentrations associated with the high nutrient flux into the lake in January and April 1970 and the subsequent algal bloom in July 1970 follow:

Site No. and Nutrient	Aug. 1969 (Prior inflow)	Jan. 1970 (During and Following inflow)	Apr. 1970	July 1970 (During algal bloom)
5-Silica mg/l	6.6	11	6.2	2.8
Nitrate (NO ₃ -N) mg/l	.07	.3	1.1	.0
Orthophosphate (PO ₄ -P) mg/l	.010	.049	.016	.007
Color Units	15	50	60	25
6-Silica mg/l	5.8	10	--	--
Nitrate (NO ₃ -N) mg/l	.02	.3	--	--
Orthophosphate (PO ₄ -P) mg/l	.007	.052	--	--
Color Units	15	60	--	--
7-Nitrate (NO ₃ -N) mg/l	0.02	0.09	--	--
Orthophosphate (PO ₄ -P) mg/l	.016	.098	--	--
Color Units	30	60	--	--
Iron mg/l	.04	.12	--	--
8-Silica mg/l	6.1	3.1	5.9	1.1
Nitrate (NO ₃ -N) mg/l	0.02	0.05	0.2	0.0
Orthophosphate (PO ₄ -P) mg/l	.020	.14	.029	0.013
Color units	20	120	60	10
Iron mg/l	.02	.16	--	--
9-Orthophosphate (PO ₄ -P) mg/l	0.013	0.11	0.029	--
Color Units	15	100	60	--
Iron mg/l	.03	.12	--	--

Lake Okeechobee is effectively mixed, and dissolved oxygen and temperature are not stratified. Dissolved-oxygen values are high, whereas the low values of ammonia and nitrite indicate the absence of organic pollution. The average numbers of benthic organisms were well below levels normally considered indicative of highly eutrophic waters. Although the warm water (as much as 34°C) and adequate nutrient concentrations are conducive to high biologic productivity, algal growth may be inhibited by the high turbidity of the lake.

The data collected and evaluated suggest that Lake Okeechobee is in an early eutrophic condition. The investigation coincided with a period of greater than normal rainfall and runoff, resulting in a relatively high nutrient flux into the lake. The data document extensive physical, chemical, and biological variability within the lake system over a short-time span and cannot be utilized for predicting long-term trends. No reliable comprehensive nutrient or biological data are available for historical comparisons; however, phosphorus concentration was relatively high near the mouth of Taylor Creek in 1952 (Odum, 1953), similar to the concentration during the present investigation. Regional comparisons, although sparse, suggest that water quality of Lake Okeechobee, as of 1969 - 70, was not significantly different than that of other water bodies in southern peninsular Florida.

SELECTED REFERENCES

Ager, Lothian

- 1970 *Annual report, Lake Okeechobee project*: Florida Game and Fresh Water Fish Commission (unpublished).

Brenzonik, P. L., Morgan, W. H., Shannon, E. E., and Putnam, H. D.

- 1969 *Eutrophication factors in north central Florida lakes*: Florida Univ. Eng. and Indus. Expt. Sta.

Buddhari, W.

- 1960 *Cobalt as an essential element for blue-green algae*: Unpublished PhD dissertation, Univ. of California, 163 p.

Clayton, B. S., Neller, J. R., and Allison, R.V.

- 1942 *Water control in the peat and muck soils of the Florida Everglades*: Florida Agr. Expt. Sta., Bull. 378.

Cobb, H. D., and Meyers, J.

- 1964 *Comparative studies of nitrogen fixation and photosynthesis in Anabaena cylindrica*: Am. Jour. Botany, 51:753-762.

Cooke, C. W.

- 1939 *Scenery of Florida*: Florida Geol. Survey Bull. No. 17, 118 p.

Davis, J. H., Jr.

- 1943 *The natural features of southern Florida*: Florida Geol. Survey Bull. no. 25, 311 p.

Davis, J. H., Jr.

- 1946 *The peat deposits of Florida*: Florida Geol. Survey Bull. no. 30, 247 p.

Duchrow, Richard M.

- 1970 *Annual progress report for investigation project as required by Federal Aid in Fish Restoration, Dingell-Johnson Project F-21-4, 1969 - 70*: Florida Game and Fresh Water Fish Commission.

Eyster, C.

- 1964 *Micronutrient requirements for green plants, especially algae*: in *Algae and Man*, D. F. Jackson (ed.), p. 86 - 119.

Frey, D. G. (Ed.)

- 1966 *Limnology in North America*: Univ. of Wisc. Press, Madison, 734 p.

Gambell, A. W., and Fisher, D. W.

- 1966 *Chemical composition of rainfall, eastern North Carolina and southeastern Virginia*: U. S. Geol. Survey Water - Supply Paper 1535-K.

Gerloff, G. C., and F. Skoggs

- 1957 *Availability of iron and manganese in southern Wisconsin lakes for the growth of *Microcystis aeruginosa**: Ecology 38 (4): 551-556.

Goolsby, D. A. and McPherson, B. F.

- 1970 *Preliminary evaluation of chemical and biological characteristics of the upper St. Johns River Basin, Florida*: U. S. Geol. Survey open-file report.

Greeson, Philip E.

- 1971 *Limnology of Oneida Lake with emphasis on factors contributing to algal blooms*: New York State Dept. Environmental Conserv., open-file report.

Heilprin, Angelo

- 1887 *Explorations on the west coast of Florida and in the Okeechobee Wilderness*: Wagner Free Inst. Sci.

Higer, Aaron L., and Kolipinski, Milton C.

- 1970 *Sources of pesticides in Florida waters*: U. S. Geol. Survey open-file report.

Holcomb, Dennis E.

- 1968 *Annual progress report for research project as required by Federal Aid and Fish Restoration, Dingell-Johnson Project F-21-R-2*: Florida Game and Fresh Water Fish Commission, 1967 - 68.

Hutchinson, G. Evelyn

- 1957 *A treatise of limnology, v. 1, geography, physics, and chemistry*: John Wiley and Sons, N. Y., 1015 p.

Joyner, Boyd F., and Greeson, Phillip E.

- 1971 *Appraisal of biological condition and nutrient content of Lake Okeechobee, Florida*: Presented at International Symposium on Manmade Lakes, Knoxville, Tenn., May 3 - 7, 1971.

Loveless, C. M.

- 1959 *A study of the vegetation in the Florida Everglades*: Ecology 40: 1 - 9.

Meyer, B. S., Anderson, D. B., and Bohning, R. H.

- 1964 *Introduction to plant physiology*: D. Van Nostrand Co., Princeton, N. J., 541 p.

Meyer, F. W.

- 1971 *Seepage beneath Hoover Dike, southern shore of Lake Okeechobee, Florida:* Florida Dept. Nat. Resources, Bur. Geol., Rept. Inv. 58 (in press).

Odum, Howard T.

- 1953 *Dissolved phosphorus in Florida Waters:* Florida Geol. Survey, Rept. Inv. 9.

Parker, G. G., Ferguson, G. E., and Love, S. K., and others

- 1955 *Water resources of southeastern Florida, with special reference to the geology and ground water of the Miami area:* U. S. Geol. Survey Water - Supply Paper 1255.

Provasoli, L.

- 1958 *Nutrition and ecology of protozoa and algae:* Ann. Rev. Micro Biol., 12:279-303.

Provasoli, L., and Pinter, J. J.

- 1953 *Ecological implications of in vitro nutritional requirements of algal flagellates:* New York Acad. Sci. Annuals, 56:839-851.

Rainwater, F. H., and Thatcher, L. L.

- 1960 *Methods for collection and analysis of water samples:* U. S. Geol. Survey Water - Supply Paper 1454.

Reid, G. K.

- 1961 *Ecology of inland waters and estuaries:* New York, Rheinhold Publ. Co., 375 p.

Ryther, J. H., and Kramer, D. D.

- 1961 *Relative iron requirements of some coastal and offshore plankton algae:* Ecology 42 (2): 444-446.

Schelske, C. L.

- 1962 *Iron, organic matter, and other factors limiting primary productivity in a marl lake:* Science 136 (3510):45-46.

Schneider, R. F., and Little, J. A.

- 1969 *Characterization of bottom sediments and selected nitrogen and phosphorus sources in Lake Apopka, Florida:* Athens, Georgia, Federal Water Pollution Control Admin.

Shannon, J. E.

- 1965 *Nutrient requirements for aquatic plants, Part 1:* Water Chemistry Seminar, Wisconsin Univ.

Smith, D. B.

- 1965 *A study of the hydrologic characteristics of the Caloosahatchee River basin:*
Cent. Dist. Misc. Publ.

Visher, F. N., and Hughes, G. H.

- 1969 *The difference between rainfall and potential evaporation in Florida:* Florida
Dept. Nat. Resources, Bur. Geol., Map Ser. 32.

Walker, J. B.

- 1953 *Inorganic micronutrient requirements of Chlorella 1. Requirements for
calcium (or strontium), copper and molybdenum:* Arch. Biochem. 46:1-11.

APPENDIX

Table 13
Chemical Analyses of Water in Lake Okeechobee
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Sampling Point (fig. 1)	Date	Time	Lake Stage (ft)	Lake Depth (ft)	Sample Depth (ft)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Carbonate (CO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
													Field	Laboratory	Field	Laboratory						
1/1	1969																					
1	Jan-16	0925	15.3	13	0	15	4.6	0.03	47	13	40	3.0	—	152	—	—	45	62	0.3	0.3	0.003	0.03
1	Jan-16	0925	15.3	13	0	15	5.1	.07	47	13	39	2.7	160	152	—	—	46	60	.3	.3	.009	0.01
1	Jan-16	0926	15.3	13	3	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	Jan-16	0927	15.3	13	6	15	5.5	.07	47	13	39	2.8	168	148	—	—	44	66	.3	.3	.009	.00
1	Jan-16	0928	15.3	13	9	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	Jan-16	0929	15.3	13	12	15	4.7	.08	47	13	39	2.7	172	152	—	—	44	62	.2	.3	.006	.01
1/1	May-15	0930	14.2	11.5	0	25	6.2	.02	50	14	43	2.9	—	164	—	—	42	65	.4	.2	.003	.04
1	May-15	0930	14.2	11.5	0	25	8.1	.02	50	14	43	2.9	—	162	—	—	49	63	.3	.2	.003	.02
1	May-15	0931	14.2	11.5	6	24	6.2	.03	50	14	43	2.9	—	162	—	—	47	64	.3	.3	.006	.01
1	May-15	0932	14.2	11.5	11.5	24	6.2	.02	49	15	43	2.9	—	162	—	—	48	63	.4	.2	.006	.05
1/1	Aug-27	1545	14.4	10	0	30	6.2	.02	38	13	42	3.0	—	122	—	12	45	63	.3	.02	.000	.04
1	Aug-27	1545	14.4	10	0	30	6.3	.03	39	13	43	2.9	104	136	18	—	44	66	.3	.00	.000	.05
1	Aug-27	1546	14.4	10	5	30	5.9	.02	40	13	42	3.5	102	136	18	—	42	64	.3	.1	.009	.05
1	Aug-27	1547	14.4	10	10	30	6.6	.07	41	13	42	2.9	108	136	16	—	44	64	.3	.05	.000	.04
1/1	1970																					
1	Jan-15	1430	15.9	12.5	0	12.5	9.2	.02	42	11	34	2.4	—	132	—	—	34	53	.3	.3	.000	.06
1	Jan-15	1430	15.9	12.5	0	12.5	10	.00	43	12	34	2.6	146	132	4	—	41	53	.4	.2	.000	.05
1	Jan-15	1431	15.9	12.5	6	12.5	—	—	—	—	—	—	140	—	6	—	—	—	—	—	—	—
1	Jan-15	1431	15.9	12.5	7.5	12.5	9.5	.03	43	11	33	2.6	—	134	—	—	34	52	.3	.2	.006	.00
1	Jan-15	1432	15.9	12.5	12	12.5	9.5	.00	42	11	33	2.6	142	132	6	—	40	53	.4	.2	.006	.01
2	1969																					
2	Jan-16	1015	15.3	13	0	15.5	5.1	.08	47	13	39	2.7	160	152	—	—	45	62	.3	.3	.009	.00
2	May-15	1005	14.2	13	0	25	6.4	.02	52	15	44	3.0	—	170	—	—	51	64	.4	.09	.006	.01
2	Aug-28	1000	14.4	—	0	29	7.2	.03	44	13	43	3.0	126	152	14	—	41	64	.3	.02	.000	.05
2	1970																					
2	Jan-14	1600	15.9	14.5	0	12	10	.11	44	12	37	2.7	168	138	0	—	44	55	.4	.2	.009	.00
2	Apr-21	1230	15.6	—	—	34	9.1	—	40	10	30	2.4	—	122	—	—	28	45	.3	.2	.009	.07
2	Jul-16	1015	14.2	—	—	29.5	1.8	—	41	10	29	2.4	—	132	—	—	35	45	.4	.05	.003	.04

Table 13
Chemical Analyses of Water in Lake Okeechobee
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Sample Point (fig. 1)	Date	Sample Depth	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (P _{0.4} -P)	Total Phosphorus (P)	Dissolved Solids		Suspended Solids	Hardness as Ca CO ₃		Specific Conductance Microhms at 25 °C		pH value		Color (Units)	Turbidity (J T U)	Secchi Disc. (ft)	Chlorophyll ug/l			Total	Dissolved Oxygen	
							Calculated	Residue at 180 °C		Calcium Magnesium	Non Carbonate	Field	Laboratory	Field	Laboratory				a	b	c		Concentration	Percent Saturation
1/1	1969																							
1	Jan-16	0	0.89	1.2	0.000	0.006	291	318	—	171	46	—	520	—	7.6	35	—	—	—	—	—	—	—	—
1	Jan-16	0	.83	1.2	.020	.026	290	316	152	171	46	520	510	8.2	7.4	40	—	0.70	19	27	67	113	9.7	95
1	Jan-16	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9.5	93
1	Jan-16	6	.83	1.2	.016	.026	292	341	—	171	50	520	520	8.2	7.4	35	—	—	—	—	—	—	9.5	93
1	Jan-16	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9.5	93
1	Jan-16	12	.93	1.3	.013	.020	289	318	—	171	46	520	510	8.0	7.4	40	—	—	—	—	—	—	9.5	93
1/1	May-15	0	.99	1.2	.003	.006	305	341	—	183	48	—	556	—	8.1	20	—	—	—	—	—	—	—	—
1	May-15	0	.96	1.1	.010	.016	311	348	80	183	50	540	556	—	7.9	20	14	1.50	7	5	16	28	8.0	95
1	May-15	6	.87	1.2	.010	.016	309	347	—	183	50	540	556	—	7.9	20	16	—	—	—	—	—	7.2	85
1	May-15	11.5	1.2	1.4	.010	.013	308	354	—	184	51	545	556	—	7.9	20	16	—	—	—	—	—	10.3	121
1/1	Aug-27	0	.94	1.0	.006	.013	283	329	—	149	49	—	490	—	8.8	20	—	—	—	—	—	—	—	—
1	Aug-27	0	1.5	1.6	.036	.042	282	354	354	151	40	438	510	8.9	7.5	10	15	1.75	55	37	23	115	7.7	101
1	Aug-27	5	1.3	1.5	.020	.023	279	306	—	154	42	498	520	8.9	7.5	10	22	—	—	—	—	—	7.2	95
1	Aug-27	10	1.6	1.7	.016	.026	281	318	—	156	45	491	525	8.9	7.6	10	13	—	—	—	—	—	5.7	75
1/1	1970																							
1	Jan-15	0	1.4	1.8	.016	.029	252	289	—	150	42	—	453	—	8.1	30	—	—	—	—	—	—	—	—
1	Jan-15	0	2.6	2.9	.052	.068	262	290	169	157	49	410	468	8.4	8.0	60	29	.50	10	0	1.5	12	10	93
1	Jan-15	6	—	—	—	—	—	—	—	—	—	410	—	8.4	—	—	—	—	—	—	—	—	9.8	92
1	Jan-15	7.5	1.3	1.5	.055	.068	253	285	—	153	43	—	450	—	8.0	31	—	—	—	—	—	—	—	—
1	Jan-15	12	1.0	1.3	.050	.062	258	289	—	150	42	408	456	8.4	8.1	60	29	—	—	—	—	—	8.0	75
2	1969																							
2	Jan-16	0	.87	1.2	.020	.026	291	321	—	171	46	525	510	8.0	7.5	35	—	—	8	6	11	25	9.9	98
2	May-15	0	1.0	1.1	.010	.010	320	351	141	191	52	565	570	—	7.9	20	32	—	5	5	7	17	7.7	93
2	Aug-28	0	1.9	2.0	.026	.029	291	339	356	164	39	452	540	8.8	7.8	10	18	—	71	54	0	125	6.8	87
2	1970																							
2	Jan-14	0	1.4	1.7	.050	.065	274	305	237	160	47	488	486	8.2	7.8	60	32	—	8	0	4	12	9.8	91
2	Apr-21	—	—	—	.055	.062	226	266	—	141	41	410	408	8.5	8.1	60	—	—	—	—	—	—	—	—
2	Jul-16	—	.62	—	.033	.033	230	265	—	144	36	415	410	8.7	8.1	20	25	—	—	—	—	—	7.2	94

Table 13
Chemical Analyses of Water in Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Sample Point (fig. 1)	Date	Time	Lake Stage (ft)	Lake Depth (ft)	Sample Depth (ft)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Carbonate (CO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
													Field	Laboratory	Field	Laboratory						
3	1969																					
3	Jan-16	1350	15.3	11.5	0	16	6.1	0.09	47	14	41	2.8	172	152	-	-	47	63	0.3	0.4	0.009	0.01
3	May-15	1030	14.2	10	0	26	6.0	.02	51	15	44	2.9	-	162	-	-	50	66	.3	.09	.003	.02
3	Aug-28	1100	14.4	12	0	29	7.0	.03	42	13	43	3.1	116	140	14	-	42	64	.3	.02	.000	.07
3	1970																					
3	Jan-15	1530	15.9	15.5	0	13	8.8	.05	43	12	35	2.5	138	134	5	-	38	53	.3	.2	.006	.08
4	1969																					
4	Jan-16	1430	15.3	12	0	16	5.0	.06	48	13	41	2.8	168	154	-	-	48	63	.4	.4	.006	.02
4	May-15	1100	14.2	10	0	27	6.1	.01	50	14	43	2.7	-	160	-	-	48	65	.4	.09	.003	.03
4	Aug-28	1130	14.4	12	0	29	6.5	.04	43	13	42	2.2	112	144	16	-	42	62	.2	.05	.000	.05
4	1970																					
4	Jan-15	1600	15.9	12.5	0	13.5	9.4	.06	43	12	35	2.5	143	138	5	-	39	53	.3	.2	.006	.01
5	1969																					
5	Jan-14	1100	15.3	10	0	14	4.1	.07	46	13	38	2.6	156	148	-	-	45	60	.4	.3	.006	.02
5	May-13	1130	14.2	-	0	26	5.8	.00	51	14	44	2.7	172	162	-	-	50	66	.4	.02	.006	.01
5	Aug-27	0920	14.4	10	0	29	6.6	.02	40	14	44	3.0	118	140	12	-	45	66	.3	.07	.006	.04
5	1970																					
5	Jan-13	1210	15.9	11.5	0	11	11	.02	45	12	37	2.6	164	142	0	-	42	57	.3	.3	.006	.02
5	Apr-21	1450	15.6	-	-	30	6.2	-	56	16	41	3.2	-	174	-	-	56	60	.5	1.1	.006	.11
5	Jul-16	1115	14.2	-	-	31	2.8	-	44	13	34	2.6	-	148	-	-	45	55	.5	.00	.003	.04
6	1969																					
6	Jan-14	1145	15.3	12	0	14.5	4.2	.05	47	13	40	2.7	160	152	-	-	46	62	.3	.2	.006	.02
6	Jan-14	1146	15.3	12	3	14	-	-	-	-	-	-	160	-	-	-	-	-	-	-	-	-
6	Jan-14	1147	15.3	12	6	14.3	3.7	.09	48	13	40	2.7	160	154	-	-	46	63	.2	.2	.003	.02
6	Jan-14	1148	15.3	12	9	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Jan-14	1149	15.3	12	12	14	3.7	.04	48	13	40	2.7	160	152	-	-	42	62	.3	.3	.006	.01
1/6	May-13	1030	14.2	9	0	25	5.1	.03	42	11	32	2.4	-	138	-	-	37	48	.3	.00	.003	.02
6	May-13	1030	14.2	9	0	25	4.8	.03	43	10	31	2.2	146	136	-	-	38	50	.4	.00	.006	.09
6	May-13	1030	14.2	9	4.5	25	-	-	-	-	-	-	152	-	-	-	-	-	-	-	-	-
6	May-13	1030	14.2	9	5	25	4.9	.03	44	10	32	2.2	-	136	-	-	38	51	.4	.05	.003	.07
6	May-13	1032	14.2	9	9	25	5.0	.07	44	10	32	2.2	152	138	-	-	38	50	.4	.02	.003	.05
1/6	Aug-27	0830	14.4	11	0	29	6.8	.02	42	13	41	2.8	-	142	-	-	43	64	.3	.02	.006	.02
6	Aug-27	0830	14.4	11	0	29	5.8	.03	42	13	43	2.9	120	144	12	-	42	63	.3	.02	.000	.03
6	Aug-27	0831	14.4	11	5	29	5.6	.02	41	13	43	2.9	124	140	12	-	44	67	.3	.02	.006	.02
6	Aug-27	0832	14.4	11	11	29	5.6	.02	42	13	42	2.9	124	144	12	-	40	64	.3	.02	.000	.15

Table 13
Chemical Analyses of Water in Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Sample Point (fig. 1)	Date	Sample Depth	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Suspended Solids	Hardness as Ca CO ₃			Specific Conductance Microhmhos at 25 °C	pH value		Color (Units)	Turbidity (J T U)	Secchi Disc. (ft)	Chlorophyll ug/l				Dissolved Oxygen	
							Calculated	Residue at 180°C		Calcium Magnesium	Non Carbonate	Field		Laboratory	Field				Laboratory	a	b	c	Total	Concentration
3	1969 Jan-16	0	.84	1.3	0.020	0.026	298	334	—	125	50	542	530	7.9	7.5	40	—	—	11	11	9	31	8.6	86
3	May-15	0	1.2	1.3	.010	.016	316	351	118	189	56	555	560	—	8.0	20	16	—	7	6	11	24	8.2	100
3	Aug-28 1970	0	1.9	2.0	.020	.029	283	346	368	159	44	448	530	8.8	7.7	20	17	—	75	21	72	168	7.4	95
3	Jan-15 1969	0	1.2	1.5	.042	.059	260	300	232	157	47	408	452	8.4	7.9	60	26	—	7.5	0	3	10	10.2	96
4	Jan-16	0	.91	1.3	.013	.020	299	328	—	174	48	538	530	7.9	7.4	35	—	—	4	12	9	25	8.9	89
4	May-15	0	1.3	1.4	.003	.013	309	349	116	183	52	545	550	—	8.1	25	16	—	12	4	20	36	8.0	99
4	Aug-28 1970	0	1.4	1.5	.010	.016	279	340	396	161	43	488	520	8.9	7.7	20	17	—	132	260	370	762	8.2	105
4	Jan-15 1969	0	1.4	1.7	.039	.062	263	309	214	157	44	475	468	8.4	7.9	50	31	—	10	0	1.5	12	9.5	90
5	Jan-14	0	.85	1.2	.010	.010	283	312	—	164	43	520	500	6.8	7.4	35	—	—	12	13	16	41	10.1	97
5	May-13	0	1.1	1.1	.003	.006	314	351	162	185	52	545	560	8.2	7.8	30	18	—	12	7	18	37	7.6	93
5	Aug-27 1970	0	1.1	1.2	.010	.013	288	327	565	158	43	490	540	8.7	8.0	15	11	—	18	22	84	124	8.1	104
5	Jan-13	0	1.6	1.9	.050	.068	278	322	123	162	46	491	481	8.1	7.8	50	32	—	9	1.5	7.5	18	9.5	85
5	Apr-21	0	1.5	—	.016	.036	330	372	—	206	63	580	570	8.9	8.2	60	—	—	—	—	—	—	—	—
5	Jul-16 1969	0	1.0	—	.026	.010	270	333	—	164	42	478	480	9.0	8.1	25	18	—	—	—	—	—	7.7	103
6	Jan-14	0	.88	1.1	.016	.026	291	319	173	171	46	555	510	8.3	7.4	35	—	.92	10	9	11	30	10.0	97
6	Jan-14	3	—	—	—	—	—	—	—	—	—	—	—	8.3	—	—	—	—	—	—	—	—	10.2	98
6	Jan-14	6	.81	1.1	.013	.023	294	321	—	174	48	555	520	8.0	7.5	40	—	—	—	—	—	—	10.0	97
6	Jan-14	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.2	98
6	Jan-14	12	.81	1.1	.016	.026	288	318	—	174	49	555	510	8.1	7.5	40	—	—	—	—	—	—	10.1	97
1/6	May-13	0	.73	.75	.000	.006	246	272	—	150	37	—	442	—	8.0	20	—	—	—	—	—	—	—	—
6	May-13	0	1.7	1.8	.006	.013	246	281	223	149	37	430	439	8.2	7.5	40	35	.75	22	8	18	48	7.5	89
6	May-13	4.5	—	—	—	—	—	—	—	—	—	430	—	8.2	—	—	—	—	—	—	—	—	7.5	89
6	May-13	5	1.6	1.7	.006	.016	250	284	—	151	40	—	441	—	7.6	50	35	—	—	—	—	—	—	—
6	May-13	9	2.0	2.1	.006	.039	250	291	—	151	38	435	448	8.2	7.4	50	35	—	—	—	—	—	—	—
1/6	Aug-27	0	0.95	1.0	.006	.013	283	324	—	159	42	—	520	—	8.2	5	—	—	—	—	—	—	—	—
6	Aug-27	0	1.1	1.2	.006	.013	283	340	304	159	41	498	515	8.7	7.9	15	7	—	33	36	87	156	7.7	99
6	Aug-27	5	1.1	1.2	.010	.016	286	324	—	156	42	442	515	8.7	8.0	30	7	2.83	—	—	—	—	7.4	95
6	Aug-27	11	1.1	1.1	.016	.023	281	328	—	159	41	498	510	8.7	7.9	20	8	—	—	—	—	—	9.8	126

Table 13
Chemical Analyses of Water in Lake Okeechobee - Continued
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Sample Point (fig. 1)	Date	Time	Lake Stage (ft)	Lake Depth (ft)	Sample Depth (ft)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Carbonate (CO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrite Nitrogen (NO ₂ -N)	Nitrate Nitrogen (NO ₃ -N)	Ammonia Nitrogen (NH ₄ -N)
													Field	Laboratory	Field	Laboratory						
1/6	1970																					
6	Jan-13	1100	15.9	13.5	0	-	9.5	0.02	42	11	34	2.6	-	130	-	-	40	53	0.3	0.2	0.000	0.02
6	Jan-13	1100	15.9	13.5	0	10.5	10	.00	42	11	34	2.6	146	132	-	-	40	52	.4	.5	.006	.01
6	Jan-13	1101	15.9	13.5	6	11	10	.03	43	11	34	2.6	142	130	-	-	40	52	.3	.5	.009	.00
6	Jan-13	1102	15.9	13.5	13.5	10	11	.00	43	11	34	2.6	156	134	4	6	39	54	.3	.2	.006	.02
1/7	1969																					
7	Jan-14	1300	15.3	12	0	14	4.6	.02	48	13	42	2.8	-	156	-	-	42	66	.3	.4	.003	.07
7	Jan-14	1300	15.3	12	0	14	-	-	-	-	-	-	162	-	-	-	-	-	-	-	-	-
7	May-13	0900	14.2	11	0	25	5.5	.02	49	13	38	2.6	170	156	-	-	45	61	.5	.02	.003	.10
7	Aug-27	0800	14.4	10	0	29	5.2	.04	38	12	38	2.6	104	124	10	-	38	58	.2	.02	.000	.15
7	1970																					
7	Jan-13	1030	15.9	13	0	11	6.0	.12	32	6.7	20	1.9	88	95	2	-	24	32	.3	.09	.009	.00
1/8	1969																					
8	Jan-13	1715	15.3	12	0	15	5.3	.02	51	15	45	3.0	-	164	-	-	50	69	.3	.5	.000	.01
8	Jan-13	1715	15.3	12	0	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	May-12	1500	14.2	11	0	27	5.7	.02	48	12	40	2.6	176	154	-	-	45	60	.4	.00	.003	.00
8	Aug-25	1340	14.4	12	0	30	6.1	.02	39	12	39	2.7	114	136	12	-	42	59	.3	.02	.000	.06
8	1970																					
8	Jan-12	1340	15.9	13	0	14	3.1	.16	29	3.3	11	1.6	76	65	0	-	14	19	.3	.05	.006	.09
8	Apr-21	0930	15.6	-	-	-	5.9	-	37	9.4	27	2.2	-	114	-	-	32	41	.3	.2	.006	.09
8	Jul-16	0810	14.2	-	-	29	1.1	-	41	10	29	2.4	-	136	-	-	35	46	.4	.00	.000	.04
1/9	1969																					
9	Jan-13	1600	15.3	12	0	15	6.2	.02	52	15	47	3.2	-	172	-	-	54	72	.4	.5	.003	.02
9	Jan-13	1600	15.3	12	0	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	May-12	1415	14.2	11	0	26	6.1	.03	46	13	39	3.0	172	152	-	-	42	59	.4	.07	.003	.01
9	Aug-25	1500	14.4	12.5	0	30	5.2	.03	41	12	40	2.7	122	148	8	-	42	60	.3	.02	.000	.06
9	1970																					
9	Jan-12	1500	15.9	13	0	14	3.6	.12	28	5.0	16	1.7	74	79	0	-	18	28	.2	.05	.006	.05
9	Apr-21	1530	15.6	-	-	32	5.1	-	35	8.7	25	2.1	-	112	-	-	18	38	.3	.09	.006	.11
10	1969																					
10	Jan-14	1700	15.3	13.5	0	15	6.7	.07	50	15	46	3.0	190	170	-	-	52	72	.3	.5	.009	.01
10	May-14	0840	14.2	12	0	25	7.0	.04	51	14	44	2.8	172	168	4	-	48	65	.5	.09	.006	.01
10	Aug-26	0800	14.4	13	0	28	6.3	.01	44	13	40	2.8	128	152	12	-	42	58	.3	.05	.003	.01
10	1970																					
10	Jan-13	1645	15.9	15	0	11.5	8.4	.02	37	9.0	26	2.2	124	112	0	-	32	41	.3	.02	.009	.00

Table 13
Chemical Analyses of Water in Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Sample Point (fig. 1)	Date	Sample Depth	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Suspended Solids	Hardness as Ca CO ₃		Specific Conductance Micromhos at 25 °C		pH value		Color (Units)	Turbidity (J T U)	Secchi Disc. (ft)	Chlorophyll				Dissolved Oxygen	
							Calculated	Residue at 180°C		Calcium magnesium	Non Carbonate	Field	Laboratory	Field	Laboratory				a	b	c	Total	Concen- tration	Percent Saturation
1/6	1970																							
6	Jan-13	0	.7	.97	0.020	0.029	258	282	—	150	44	—	452	—	8.1	30	—	—	—	—	—	—	—	
6	Jan-13	0	1.3	1.6	.052	.075	258	285	113	150	42	455	459	8.4	8.1	60	33	50	10	0	1.5	12	11.2	100
6	Jan-13	6	1.7	2.0	.068	.085	258	287	—	153	46	400	458	8.4	7.8	60	32	—	—	—	—	—	11.1	100
6	Jan-13	13.5	1.6	1.9	.055	.068	262	292	—	153	43	402	451	8.3	7.8	60	34	—	—	—	—	—	11.0	97
1/7	1969																							
7	Jan-14	0	.87	1.4	.000	.006	298	332	—	174	46	—	530	—	7.5	40	—	—	—	—	—	—	—	—
7	Jan-14	0	—	—	—	—	—	—	76	—	—	585	—	8.2	—	—	—	—	7	6	5	18	10.1	97
7	May-13	0	1.6	1.7	.003	.010	292	326	234	176	48	505	520	8.2	7.6	40	12	—	8	1	0	9	7.8	93
7	Aug-27	0	.88	1.0	.016	.026	253	305	282	145	43	445	470	8.7	7.4	30	11	—	32	13	53	98	7.3	94
7	1970																							
7	Jan-13	0	1.2	1.3	.098	.12	171	202	118	108	30	300	309	8.3	7.8	60	37	—	12	0	6	18	10.2	92
1/8	1969																							
8	Jan-13	0	.89	1.4	.010	.020	322	353	—	188	54	—	560	—	7.6	40	—	—	—	—	—	—	—	—
8	Jan-13	0	—	—	—	—	—	—	165	—	—	545	—	—	—	—	—	—	10	11	15	36	10.1	99
8	May-12	0	1.3	1.3	.006	.016	290	330	208	170	44	508	520	8.2	7.9	30	56	—	5.5	.5	3	9	—	—
8	Aug-25	0	1.1	1.2	.020	.029	267	322	393	147	36	482	500	8.8	7.9	20	10	—	0	0	0	0	7.7	101
8	1970																							
8	Jan-12	0	1.4	1.6	.14	.15	110	152	87	76	23	210	199	8.2	7.5	120	23	—	9	0	1.5	10	9.8	94
8	Apr-21	0	1.1	—	.029	.039	212	251	—	131	38	385	388	8.3	7.6	60	—	—	—	—	—	—	—	—
8	Jul-16	0	.89	—	.013	.016	232	265	—	144	32	408	420	8.2	8.1	10	19	—	—	—	—	—	7.5	96
1/9	1969																							
9	Jan-13	0	1.1	1.6	.006	.013	337	368	—	191	50	—	580	—	7.6	35	—	—	—	—	—	—	—	—
9	Jan-13	0	—	—	—	—	—	—	110	—	—	375	—	—	—	—	—	—	5	2	0	7	9.0	88
9	May-12	0	1.2	1.3	.016	.020	284	309	168	169	44	505	515	8.2	7.9	20	35	—	9	1	2	12	7.8	95
9	Aug-25	0	1.2	1.3	.013	.020	276	306	375	152	31	500	500	8.7	7.8	15	9	—	0	0	0	0	7.3	96
9	1970																							
9	Jan-12	0	1.0	1.1	.11	.13	140	179	82	91	26	238	250	8.2	7.6	100	21	—	9	3	3	15	10.5	101
9	Apr-21	0	.97	—	.029	.042	188	234	—	124	32	370	359	8.9	7.6	60	—	—	—	—	—	—	—	—
10	1969																							
10	Jan-14	0	.96	1.4	.020	.029	329	361	—	186	47	596	570	8.0	7.5	35	—	—	5	2	0	7	10	98
10	May-14	0	1.3	1.4	.016	.023	316	355	188	185	47	545	560	8.5	8.0	30	23	—	9	1	13	23	7.6	91
10	Aug-26	0	1.2	1.2	.023	.029	282	299	340	164	39	498	520	8.8	7.9	5	9	—	32	26	18	76	7.3	92
10	1970																							
10	Jan-13	0	1.6	1.8	.059	.091	212	241	218	130	38	380	378	8.4	7.8	60	34	—	—	—	—	—	—	—

Table 13
Chemical Analyses of Water in Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

1/- Filtered

Sample Point (fig. 1)	Date	Time	Lake Stage (ft)	Lake Depth (ft)	Sample Depth (ft)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Carbonate (CO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
													Field	Laboratory	Field	Laboratory						
11	1969																					
11	Jan-14	1600	15.3	13	0	15	6.3	0.07	50	15	45	3.0	188	166	-	-	50	70	0.3	0.4	0.003	0.01
11	Jan-14	1601	15.3	13	3	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	Jan-14	1602	15.3	13	6	15	6.4	.07	50	15	44	3.0	188	168	-	-	50	68	.3	.5	.012	.01
11	Jan-14	1603	15.3	13	9	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	Jan-14	1604	15.3	13	12	14	6.8	.07	51	15	45	3.0	190	166	-	-	51	70	.5	.5	.012	.01
1/11	May-14	0910	14.2	12	0	25	6.0	.01	48	12	39	2.6	-	152	-	-	43	60	.5	.07	.003	.00
11	May-14	0910	14.2	12	0	25	6.7	.05	48	12	39	2.5	164	152	4	-	45	59	.4	.07	.006	.02
11	May-14	0911	14.2	12	6	25	6.0	.07	48	12	38	2.6	166	152	-	-	45	59	.4	.07	.002	.01
11	May-14	0912	14.2	12	12	25	6.3	.07	48	12	38	2.6	166	150	-	-	42	59	.5	.09	.002	.00
11	Aug-26	0830	14.4	13	0	28	5.2	.03	44	12	37	2.7	-	138	-	8	38	55	.3	.00	.000	.05
11	Aug-26	0845	14.4	13	0	28	5.9	.03	43	12	37	2.8	118	144	14	-	41	54	.4	.02	.002	.02
11	Aug-26	0846	14.4	13	6	28	5.4	.03	42	11	37	2.7	120	144	14	-	37	56	.3	.02	.000	.01
11	Aug-26	0847	14.4	13	13	29	6.3	.03	43	12	37	2.7	124	144	12	-	40	54	.3	.05	.009	.03
1/11	1970																					
11	Jan-13	1545	15.9	15	0	11	9.4	.03	40	9.7	31	2.4	-	124	-	-	36	47	.3	.2	.000	.00
11	Jan-13	1545	15.9	15	0	11	10	.18	41	10	30	2.5	138	122	0	-	36	48	.3	.2	.009	.00
11	Jan-13	1546	15.9	15	7.5	9	9.9	.05	40	10	30	2.4	144	124	0	-	36	48	.3	.2	.009	.01
11	Jan-13	1547	15.9	15	15	9	9.6	.07	42	11	32	2.5	140	126	0	-	38	50	.3	.2	.009	.05
1/12	1969																					
12	Jan-14	1530	15.3	8	0	15.5	5.9	.02	51	15	47	3.2	-	170	-	-	52	70	.4	.00	.000	.14
12	Jan-14	1530	15.3	8	0	15.5	-	-	-	-	-	-	192	-	-	-	-	-	-	-	-	-
12	May-14	1005	14.2	7	0	25	5.3	.02	44	11	34	2.5	148	138	-	-	33	52	.4	.05	.006	.06
12	Aug-26	0930	14.4	8	0	30	5.3	.02	42	11	36	2.7	128	140	6	-	37	54	.3	.07	.006	.03
12	1970																					
12	Jan-13	1515	15.9	10	0	12	7.8	.11	40	9.4	29	2.3	132	124	0	-	33	45	.3	.2	.006	.03
12	Apr-21	1045	15.6	-	-	27.5	5.2	-	33	7.2	21	2.0	-	94	-	-	20	31	.3	.1	.012	.16
12	Jul-16	0900	14.2	-	-	29	2.2	-	41	10	29	2.4	-	128	-	-	35	44	.4	.00	.003	.05
13	1969																					
13	Jan-16	1225	15.3	14	0	15.5	6.1	.07	50	15	45	3.0	180	168	-	-	50	68	.4	.2	.009	.01
13	May-14	1145	14.2	13.5	0	25	6.0	.03	46	12	36	2.5	148	146	-	-	40	55	.4	.07	.006	.04
13	Aug-28	0945	14.4	14	0	29	5.6	.02	41	13	42	3.0	124	148	14	-	39	62	.3	.07	.000	.03
13	1970																					
13	Jan-14	1515	15.9	16.5	0	13.5	11	.10	46	12	38	2.7	144	142	0	-	44	59	.3	.3	.006	.08

Table 13
Chemical Analyses of Water in Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Sample Point (fig. 1)	Date	Sample Depth	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Suspended Solids	Hardness as Ca CO ₃		Specific Conductance Microhmhos at 25 °C		pH value		Color (Units)	Turbidity (JTU)	Secchi Disc. (ft)	Chlorophyll				Dissolved Oxygen	
							Calculated	Residue at 180°C		Calcium Magnesium	Non Carbonate	Field	Laboratory	Field	Laboratory				a	b	c	Total	Concen- tration	Percent Saturation
11	1969 Jan-14	0	.96	1.4	0.026	0.036	324	355	110	186	50	610	560	8.0	7.5	35	-	.50	5	3	4	12	10.0	98
11	Jan-14	3	-	-	-	-	-	-	-	186	49	620	560	8.0	7.4	35	-	-	-	-	-	-	10.0	98
11	Jan-14	6	.95	1.4	.026	.036	322	353	-	186	49	620	560	8.0	7.4	35	-	-	-	-	-	-	10.0	98
11	Jan-14	9	-	-	-	-	-	-	-	188	52	620	560	8.1	7.5	35	-	-	-	-	-	-	9.3	91
11	Jan-14	12	1.0	1.5	.26	.036	327	358	-	188	52	620	560	8.1	7.5	35	-	-	-	-	-	-	8.0	87
J/11	May-14	0	1.1	1.2	.000	.003	286	325	-	170	45	-	510	-	8.1	40	-	-	-	-	-	-	-	-
	May-14	0	1.1	1.2	.013	.020	288	322	173	170	45	500	520	8.4	7.8	40	35	1.00	11	2	15	28	7.7	92
	May-14	6	1.2	1.3	.010	.026	286	324	-	170	45	500	510	8.2	7.9	45	30	-	-	-	-	-	7.4	88
	May-14	12	1.2	1.3	.006	.020	283	327	-	170	46	500	510	8.2	7.8	40	30	-	-	-	-	-	10.5	125
J/11	Aug-26	0	.78	.83	.006	.013	270	306	-	160	47	-	480	-	8.5	30	-	-	-	-	-	-	-	-
	Aug-26	0	1.2	1.2	.029	.039	268	301	360	157	39	470	480	8.8	8.2	25	11	-	74	76	154	304	7.1	90
	Aug-26	6	1.2	1.2	.029	.036	259	329	-	150	32	470	490	8.8	7.9	20	12	-	-	-	-	-	6.8	86
	Aug-26	13	.76	.85	.033	.033	267	287	-	157	39	420	485	8.7	7.9	5	11	-	-	-	-	-	6.0	77
J/11	1970 Jan-13	0	.59	.75	.020	.029	238	258	-	140	39	-	420	-	7.7	40	-	-	-	-	-	-	-	-
	Jan-13	0	1.4	1.6	.059	.082	239	272	232	144	44	370	425	8.2	7.9	60	34	.58	9	1.5	7.5	18	-	-
	Jan-13	7.5	1.9	2.1	.078	.095	239	266	-	141	40	381	415	8.2	8.0	60	35	-	-	-	-	-	8.5	73
	Jan-13	15	2.5	2.8	.059	.088	249	278	-	150	47	380	440	8.2	7.9	70	36	-	-	-	-	-	10.2	88
J/12	1969 Jan-14	0	.93	1.0	.003	.010	339	361	-	188	49	-	580	-	7.6	35	-	-	-	-	-	-	-	-
	Jan-14	0	-	-	-	-	-	-	113	-	-	630	-	8.0	-	-	-	-	9	7	13	29	8.0	79
	May-14	0	1.5	1.6	.016	.029	250	297	107	155	42	460	462	8.1	7.7	40	16	-	9	4	15	28	7.0	83
	Aug-26	0	1.3	1.4	.046	.050	258	295	309	150	36	474	470	8.6	7.8	25	12	-	20	16	27	63	5.9	78
12	1970 Jan-13	0	1.7	1.9	.065	.088	229	275	210	139	37	370	400	8.2	7.7	80	32	-	12	0	6	18	8.8	81
	Apr-21	0	1.2	-	.082	.085	167	214	-	112	35	310	310	8.4	7.1	60	-	-	-	-	-	-	-	-
	Jul-16	0	.67	-	.033	.033	227	263	-	144	39	400	410	8.5	8.0	20	21	-	-	-	-	-	6.6	85
	1969 Jan-16	0	.93	1.2	.020	.029	321	355	-	186	49	580	560	8.0	7.6	35	-	-	1	0	0	1	9.5	94
13	May-14	0	1.4	1.5	.016	.029	270	308	136	165	45	497	482	8.3	7.8	40	25	-	6	0	12	18	7.6	91
13	Aug-28	0	1.3	1.4	.020	.033	279	345	396	156	35	548	530	8.8	7.8	10	16	-	-	-	-	-	7.5	96
13	1970 Jan-14	0	1.3	1.7	.050	.059	284	323	217	165	48	460	492	8.2	7.6	33	11	-	10	3	12	25	10.5	100

Table-13
Chemical Analyses of Water in Lake Okeechobee - Continued
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Sample Point (fig. 1)	Date	Time	Lake Stage (ft)	Lake Depth (ft)	Sample Depth (ft)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Carbonate (CO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
													Field	Laboratory	Field	Laboratory						
14	1969																					
14	Jan-16	1305	15.3	14.5	0	16	5.0	0.07	49	14	41	2.9	172	156	-	-	46	63	0.3	0.2	0.003	0.08
14	May-14	1215	14.2	13	0	26	6.7	.02	50	13	41	2.8	166	160	-	-	48	64	.4	.07	.003	.09
14	Aug-28	0830	14.2	14	0	29	6.1	.03	43	13	43	3.0	124	148	14	-	42	64	.3	.02	.000	.05
14	1970																					
14	Jan-14	1500	15.9	16	0	12	6.6	.05	42	11	33	2.5	144	136	0	-	34	49	.4	.09	.003	.05
15	1969																					
15	Jan-16	1045	15.3	15	0	15	5.7	.05	50	15	44	3.0	188	164	-	-	48	66	.3	.2	.003	.03
15	May-14	1310	14.2	14.5	0	26	6.7	.01	52	14	45	2.8	170	168	8	-	50	68	.5	.02	.006	.01
15	Aug-28	1030	14.4	15	0	29	6.2	.03	47	14	43	3.1	140	156	14	-	42	65	.3	.02	.000	.05
15	1970																					
15	Jan-13	1300	15.9	16	0	11	7.2	.04	42	10	30	2.5	140	128	0	-	33	48	.3	.1	.006	.01
15	Apr-21	1200	15.6	-	-	31	8.7	-	40	10	31	2.4	-	126	-	-	33	45	.3	.4	.009	.12
15	Jul-16	0945	14.2	-	-	29	1.4	-	41	10	29	2.4	-	136	-	-	36	46	.4	.00	.000	.05
16	1969																					
16	Feb-18	0920	-	-	0	16	9.0	.18	59	1.9	68	3.9	215	202	-	-	72	100	.5	.3	.006	.09
16	Mar-26	1200	-	-	0	20	5.2	.04	51	15	46	3.1	185	168	-	-	48	69	.5	.2	.000	.03
16	Apr-16	1050	-	-	0	24	6.2	.05	51	15	47	3.2	172	172	-	-	51	68	.4	.2	.000	.07
16	May-15	1550	-	-	0	30	6.7	.02	48	15	49	3.4	-	164	-	-	52	72	.3	.1	.003	.06
16	Jun-10	1450	-	-	0	33	2.6	.03	45	12	35	2.6	132	144	3	-	40	54	.5	.02	.003	.03
16	Jul-17	1100	-	-	0	32	7.6	.02	69	14	48	3.0	150	156	8	-	52	70	.5	.02	.003	.05
16	Aug-29	0930	14.4	-	0	29	17	.06	69	24	82	4.5	244	236	0	-	101	115	.5	.7	.079	.23
16	Sep-22	1515	-	-	0	28	12	.04	49	15	49	3.1	172	164	-	-	52	72	.4	.2	.018	.27
16	Oct-28	1000	-	-	0	25	15	.02	46	14	45	3.1	168	152	-	-	47	70	.4	.2	.009	.03
16	Nov-20	1600	-	-	0	19	13	.04	50	16	51	3.2	194	170	-	-	60	76	.5	.3	.003	.09
16	1970																					
16	Jan-15	1043	15.9	-	0	12	7.1	.04	45	12	37	2.7	155	146	0	-	40	55	.3	.05	.003	.12
17	1969																					
17	Aug-27	1000	14.4	4	0	29	3.5	.04	35	11	40	1.8	130	140	2	-	24	60	.3	.00	.000	.07
18	1969																					
18	Aug-28	1200	14.4	3	0	30	5.4	.03	38	19	59	3.6	116	136	8	-	69	88	.3	.00	.000	.05
18	1970																					
18	Jan-15	1630	15.9	-	0	16	6.8	.01	40	10	30	2.3	121	126	6	-	35	46	.3	.02	.006	.06

Table 13
Chemical Analyses of Water in Lake Okeechobee - Continued
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Sample Point (fig. 1)	Date	Sample Depth	Organic Nitrogen (N)		Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Suspended Solids	Hardness as Ca CO ₃		Specific Conductance Micromhos at 25° C	pH value		Color (Units)	Turbidity (J T U)	Secchi Disc. (ft)	Chlorophyll ug/l				Dissolved Oxygen	
								Calculated	Residue at 180° C		Calcium	Magnesium		Non Carbonate	Field	Laboratory	Field	Laboratory					Concen- tration	Percent Saturation
14	1969 Jan-16	0	2.0	2.2	0.029	0.029	299	328	-	-	180	52	540	525	8.1	7.6	40	-	-	-	-	-	9.4	94
14	May-14	0	1.0	1.2	.006	.016	305	337	195	179	48	535	550	8.3	7.8	30	30	-	5	0	0	5	7.5	92
14	Aug-28 1970	0	2.0	2.1	.026	.036	287	331	420	161	40	548	530	8.8	7.8	10	19	-	46	3	96	145	7.0	90
14	Jan-14 1969	0	1.1	1.2	.033	.050	246	285	190	150	39	400	440	8.2	7.7	60	23	-	7	1	5	13	10	93
15	Jan-16	0	1.4	1.7	.023	.029	314	350	-	186	52	567	555	8.1	7.7	30	-	-	5	2	0	7	9.6	94
15	May-14	0	1.1	1.1	.013	.010	322	368	103	187	50	555	570	8.6	8.0	30	37	-	3	0	0	3	8.2	100
15	Aug-28 1970	0	.77	.84	.023	.029	298	339	357	175	47	538	550	8.8	7.9	20	18	-	3	0	0	3	7.7	99
15	Jan-13	0	1.3	1.4	.050	.062	236	262	196	146	41	378	428	7.8	7.8	60	32	-	12	4	14	30	8.5	77
15	Apr-21	0	.99	-	.042	.052	234	270	-	141	38	420	420	8.6	7.9	60	-	-	-	-	-	-	-	-
15	Jul-16 1969	0	.46	-	.026	.033	233	267	-	144	32	422	420	8.7	8.1	20	17	-	-	-	-	-	6.6	85
16	Feb-18	0	.77	1.2	.042	.050	433	467	-	225	60	680	730	8.1	7.7	45	-	-	-	-	-	-	9.5	95
16	Mar-26	0	.94	1.2	.006	.029	322	360	-	189	51	570	579	8.2	7.7	40	-	-	-	-	-	-	8.5	92
16	Apr-16	0	.85	1.2	.006	.026	328	353	-	189	48	580	585	8.2	7.9	30	-	-	-	-	-	-	7.0	82
16	May-15	0	.87	1.1	.026	.042	328	367	-	182	47	573	590	-	7.8	20	-	-	-	-	-	-	7.5	99
16	Jun-10	0	1.0	1.1	.020	.029	263	313	-	162	44	488	455	8.6	7.2	20	-	-	-	-	-	-	9.8	134
16	Jul-17	0	1.1	1.2	.020	.029	321	379	-	180	52	620	550	8.5	7.6	30	-	-	-	-	-	-	6.5	88
16	Aug-29	0	2.0	3.0	.042	.050	532	596	-	271	77	870	925	8.0	7.9	60	-	-	-	-	-	-	5.3	68
16	Sep-22	0	1.9	2.4	.042	.050	334	380	-	184	50	575	600	7.5	7.6	20	-	-	-	-	-	-	5.0	63
16	Oct-28	0	1.0	1.2	.050	.055	316	346	-	173	48	540	550	7.8	8.0	20	-	-	-	-	-	-	7.0	83
16	Nov-16 1970	0	1.2	1.6	.052	.062	355	389	-	191	52	530	624	7.9	8.2	45	-	-	-	-	-	-	8.5	90
16	Jan-15 1969	0	1.3	1.5	.033	.036	271	310	-	162	43	445	481	8.2	7.8	50	-	-	-	-	-	-	9.8	91
17	Aug-27 1969	0	1.0	1.1	.020	.029	246	293	582	133	18	458	460	8.3	7.7	40	7	-	19	0	74	93	7.2	92
18	Aug-28 1970	0	1.2	1.2	.006	.010	349	404	294	173	62	563	650	8.6	7.8	30	10	-	0	0	0	0	7.3	96
18	Jan-15	0	.91	1.0	.023	.033	233	271	-	141	38	370	419	8.5	7.9	50	18	-	-	-	-	-	8.7	87

Table 14
Chemical Analyses of Water in Tributaries to Lake Okeechobee
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Time	Discharge (cfs)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
											Field	Laboratory						
Fisheating Creek	1969																	
	Jan-15	1215	48	16	1.4	.19	8.8	3.5	20	5.9	-	25	1.6	40	0.2	0.02	0.003	0.09
	Feb-17	1700	72	18	1.2	.15	15	3.8	25	3.1	37	41	2.0	48	.3	.02	.015	.38
	Mar-25	1435	680	24	1.7	.21	7.9	3.3	15	1.6	16	16	4.8	29	.3	.02	.006	.06
	Apr-15	1615	44	26	2.3	.30	9.4	3.6	17	.5	26	26	.4	31	.2	.02	.015	.16
	May-16	0925	7.6	27	2.8	.18	12	4.2	16	.3	34	35	6.8	31	.5	.00	.009	.09
	Jun-10	1745	31	31	2.6	.20	14	3.1	14	.8	38	42	4.0	24	.3	.00	.012	.06
	Jul-16	1600	74	32	5.1	.41	5.7	2.5	10	.2	14	14	.0	20	.4	.00	.009	.08
	Aug-27	1345	225	30	4.3	.24	7.7	2.4	11	.2	18	20	4.0	18	.2	.4	.009	.09
	Sep-23	0900	320	28	5.1	.29	8.2	2.7	13	.4	24	23	.0	24	.3	.02	.006	.24
	Oct-27	1620	1600	25	6.1	.51	7.3	2.3	9.7	1.0	24	17	.0	17	.2	.00	.009	.03
	Nov-21	0930	1100	15	3.5	.22	6.4	2.4	12	.5	14	14	.0	26	.2	.5	.012	.11
	Dec-9	1650	125	19	2.8	.13	7.7	2.7	14	1.1	42	18	.8	30	.3	.2	.006	.03
	1970																	
	Jan-14	1050	1150	12	2.7	.12	4.8	2.2	13	1.3	6	10	.0	24	.6	.00	.003	.09
	1969																	
	Jan-15	1200	0	15	2.9	.30	36	8.8	24	2.5	-	78	44	43	.2	.1	.003	.03
Harney Pond Canal	Feb-17	1620	0	18	1.2	.12	19	9.1	26	2.7	100	102	39	42	.4	.09	.018	.09
	Mar-25	1420	0	23	2.7	.10	26	5.3	13	2.1	24	22	46	22	.4	.09	.003	.12
	Apr-15	1545	0	26	3.7	.07	25	6.7	19	1.8	58	58	40	31	.2	.05	.034	.05
	May-16	1000	0	27	5.2	.20	18	6.2	15	2.2	44	44	49	23	.3	.05	.009	.05
	Jun-10	1805	0	30	3.1	.09	21	4.3	13	2.2	30	34	32	22	.3	.02	.003	.09
	Sep-23	0945	4010	29	7.3	.40		5.0	11	1.4	26	28	45	18	.2	.2	.012	.23
	1970						25											
Indian Prairie Canal	Jan-16	0945	0	13.5	6.3	.24		5.7	11	2.3	22	20	61	20	.3	.1	.009	.54
	1969						19											
	Jan-15	1145	0	16	4.2	.24		5.5	11	3.6	-	26	44	20	.2	.2	.003	.11
	Feb-17	1545	0	18	4.3	.21	30	6.9	16	3.2	59	58	50	26	.2	.3	.009	.12
	Mar-25	1420	0	22	5.1	.21	4.7	1.0	15	2.8	22	16	139	23	.3	.05	.058	.76
	Apr-15	1420	0	25	3.7	.09	47	9.5	20	1.9	66	64	95	33	.3	.4	.030	.14
	May-16	1025	0	27	3.4	.10	14	4.0	8.8	6.5	20	21	32	14	.2	.00	.006	.05
	Jun-10	1825	0	30	4.7	.24	36	6.1	17	2.8	74	72	46	30	.4	.02	.009	.18
	1970																	
	Jan-16	1000	0	15.5	3.0	.28	21	4.2	15	2.9	30	29	36	26	.2	.07	.012	.20

Table 14
Chemical Analyses of Water in Tributaries to Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Station Name	Date	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Hardness CaCO ₃		Specific Conductance Micromhos at 25° C		pH value		Color (Units)	Dissolved Oxygen	
						Calculated	Residue at 180° C	Calcium Magnesium	Non Carbonate	Field	Laboratory	Field	Laboratory		Concentration	Percent Saturation
Fisheating Creek	Jan-15	1.7	1.8	0.10	0.12	94	146	36	16	203	191	-	6.5	120	10.0	100
	Feb-17	.92	1.4	.052	.075	119	172	53	20	227	235	7.0	6.8	120	10.0	105
	Mar-25	.74	.83	.052	.085	72	127	33	20	145	143	6.4	6.3	200	6.0	71
	Apr-15	2.1	2.3	.052	.098	78	140	39	17	154	158	6.9	6.3	240	7.0	85
	May-16	1.5	1.6	.029	.039	91	146	48	19	165	173	6.8	6.7	160	7.5	93
	Jun-10	1.2	1.3	.039	.059	84	131	48	14	135	157	7.1	6.7	160	5.9	79
	Jul-16	1.2	1.3	.050	.072	51	110	25	13	80	95	6.2	6.2	200	4.5	61
	Aug-27	1.3	1.8	.046	.052	60	92	29	13	90	107	6.6	6.6	180	3.3	43
	Sep-23	.23	.51	.059	.065	65	127	32	13	104	122	6.7	6.6	200	6.5	82
	Oct-27	1.0	1.0	.072	.088	53	102	28	14	100	100	6.5	6.3	160	5.0	60
	Nov-21	1.1	1.8	.023	.042	60	108	26	15	95	119	5.8	6.6	220	9.0	88
	Dec-09	1.0	1.3	.036	.055	70	117	30	15	140	135	7.0	6.5	200	7.0	74
	1970															
	Jan-14	.86	.95	.036	.050	54	103	21	13	115	110	5.2	6.3	120	-	-
Harney Pond Canal	1969															
	Jan-15	1.4	1.5	.042	.055	196	260	116	52	353	340	-	6.9	140	10.1	99
	Feb-17	.56	.76	.026	.050	207	241	128	44	360	379	7.5	7.3	100	10.0	105
	Mar-25	1.0	1.2	.036	.085	122	155	70	52	215	216	6.9	6.5	120	7.6	87
	Apr-15	2.1	2.2	.023	.050	158	201	93	45	295	285	7.6	7.7	100	7.5	92
	May-16	.81	.92	.072	.075	149	192	88	52	256	264	6.9	7.1	100	5.5	68
	Jun-10	.86	.98	.039	.055	112	146	63	35	132	192	6.5	6.7	80	5.5	72
	Sep-23	.22	.64	.072	.085	124	160	73	50	196	210	6.6	6.8	120	3.0	38
	1970															
	Jan-16	1.1	1.8	.10	.11	143	206	86	70	240	242	6.3	6.6	160	9.3	88
Indian Prairie Canal	1969															
	Jan-15	1.2	1.5	.039	.059	122	169	70	48	215	210	-	6.4	140	8.0	80
	Feb-17	.42	.88	.052	.052	167	202	104	56	270	282	7.3	7.1	100	10.0	105
	Mar-25	1.4	2.3	.006	.026	252	324	159	146	408	398	6.5	6.4	140	6.4	73
	Apr-15	1.6	2.2	.026	.050	244	296	157	104	418	405	7.5	6.6	100	6.8	81
	May-16	.84	.90	.052	.052	93	120	52	35	121	160	6.5	6.5	80	5.5	68
	Jun-10	.88	1.1	.14	.15	179	232	115	56	131	292	6.9	6.8	100	5.4	71
	1970															
	Jan-16	1.8	2.1	.16	.18	124	168	70	46	230	222	6.7	6.8	100	7.5	74

Table 14
Chemical Analyses of Water in Tributaries to Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Station Name	Date	Time	Discharge (cfs)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
											Field	Laboratory						
Kissimmee River	1969																	
	Jan-15	1125	1060	16	4.6	0.15	36	5.4	15	1.8	-	92	32	26	0.2	0.2	0.003	0.04
	Feb-17	1500	794	17	2.0	.17	28	5.2	17	2.6	84	80	24	29	.3	.1	.018	.10
	Mar-25	1320	3940	22	2.0	.13	26	2.5	8.0	1.4	66	64	15	13	.2	.02	.006	.08
	Apr-15	1445	2640	25	1.9	.11	26	2.8	8.8	1.0	80	54	21	16	.3	.05	.012	.03
	May-13	1515	1730	26	3.9	.14	26	2.9	9.3	1.1	72	72	14	16	.2	.1	.006	.03
	Jun-10	1845	1120	29	3.8	.08	24	3.4	11	1.2	66	66	15	18	.3	.02	.012	.02
	Jul-16	1430	116	32	4.5	.11	24	5.9	18	1.8	66	62	27	29	.4	.00	.015	.03
	Aug-26	1515	3060	32	4.1	.17	14	3.2	8.8	1.3	34	28	17	14	.2	.02	.009	.12
	Sep-23	1100	2480	29	6.7	.24	30	3.3	11	1.2	86	85	16	22	.3	.1	.006	.23
	Oct-27	1500	5920	25	4.3	.17	18	2.5	7.7	1.3	46	46	5.2	14	.2	.02	.012	.07
	Nov-21	1045	5040	18	3.0	.15	16	2.0	7.2	1.1	46	42	11	14	.3	.02	.006	.06
	Dec-09	1550	1300	18	3.2	.15	18	2.4	8.0	1.1	46	46	14	16	.3	.02	.021	.08
	1970																	
Taylor Creek	Jan-14	1015	8950	9.5	2.4	.17	14	2.1	7.7	1.4	36	36	8.0	13	.6	.02	.009	.08
	1969																	
	Jan-15	1045	14	14	6.5	.06	53	17	52	3.6	-	175	57	79	.4	.3	.006	.09
	Feb-17	1400	16	16	4.5	.16	74	22	111	7.5	167	165	86	212	.4	.5	.021	.35
	Mar-25	1245	43	23	4.8	.24	26	5.2	23	4.9	78	63	17	40	.4	.2	.030	.43
	Apr-15	1400	12	25	3.3	.15	39	7.4	28	3.7	119	108	26	47	.4	.2	.024	.19
	May-13	1700	121	29	7.5	.38	33	9.0	46	4.5	74	65	37	87	.4	.3	.058	.28
	Jun-10	1305	16	30	7.2	.10	49	13	66	5.0	124	120	48	121	.4	.09	.015	.26
	Jul-16	1330	15	34	6.6	.21	37	8.9	39	3.8	102	97	34	71	.5	.09	.015	.31
	Aug-26	1430	333	30	8.5	.34	26	6.9	38	3.1	66	55	24	76	.3	.2	.027	.36
	Sep-22	1300	40	30	8.1	.26	26	5.2	28	3.0	60	59	19	54	.3	.2	.018	.33
	Oct-27	1400	136	25	8.6	.30	16	3.6	15	3.9	38	37	7.0	32	.3	.1	.015	.16
	Nov-20	1400	97	19	4.8	.18	21	3.9	17	3.2	60	56	12	36	.4	.07	.015	.09
	Dec-09	1500	0	18	1.3	.18	37	8.0	39	4.1	96	92	28	79	.4	.3	.030	.26
	1970																	
	Jan-14	0945	47	11.5	5.6	.17	24	5.4	25	4.0	62	58	20	46	.2	.1	.015	.26

Table 14
Chemical Analyses of Water in Tributaries to Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Station Name	Date	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Hardness as CaCO ₃		Specific Conductance Micromhos at 25° C		pH value		Color (Units)	Dissolved Oxygen	
						Calculated	Residue at 180° C	Calcium Magnesium	Non Carbonate	Field	Laboratory	Field	Laboratory		Concentration	Percent Saturation
Kissimmee River	1969															
	Jan-15	0.67	0.97	0.050	0.059	167	203	112	36	288	288	-	7.2	120	8.5	85
	Feb-17	.56	.82	.072	.091	148	185	92	26	265	267	7.3	7.2	110	10.1	103
	Mar-25	.78	.89	.052	.078	100	116	76	23	149	180	7.9	7.0	120	7.4	84
	Apr-15	.65	.74	.062	.098	105	124	77	32	177	183	7.8	7.3	80	7.0	83
	May-13	.48	.66	.068	.11	109	144	77	18	179	200	7.9	7.4	80	7.0	85
	Jun-10	.65	.71	.039	.055	110	144	74	20	195	190	7.6	6.8	70	6.9	89
	Jul-16	.94	.99	.029	.042	142	180	85	34	266	245	7.7	6.9	70	7.2	97
	Aug-26	.87	1.0	.042	.052	77	119	48	25	150	150	6.8	7.0	80	4.9	66
	Sep-23	1.9	2.3	.088	.098	134	176	89	19	220	246	7.6	7.2	140	5.0	64
	Oct-27	1.3	1.4	.062	.072	77	115	56	18	145	142	7.3	7.3	90	6.4	76
	Nov-21	.63	.73	.075	.091	76	107	48	14	111	143	7.0	7.5	120	8.5	88
	Dec-09	.60	.72	.065	.078	86	113	55	18	170	158	8.0	7.1	120	7.5	79
	1970															
Taylor Creek	Jan-14	.83	.94	.065	.072	68	105	44	14	112	125	8.1	6.9	120	-	-
	1969															
	Jan-15	1.7	2.1	.17	.18	357	401	202	59	573	625	-	7.4	40	8.5	82
	Feb-17	.60	1.5	.98	.98	604	697	275	140	-	1750	7.6	7.4	60	9.0	90
	Mar-25	.49	1.1	.98	1.1	156	189	87	35	288	285	7.0	6.9	220	4.5	52
	Apr-15	.45	.88	.59	.59	211	243	128	40	388	386	7.6	7.4	100	6.0	71
	May-13	1.3	2.0	.95	1.1	261	355	120	66	497	485	7.3	7.0	120	6.2	80
	Jun-10	1.3	1.7	.072	.075	371	478	176	78	750	660	8.1	7.0	70	8.1	106
	Jul-16	1.3	1.7	.55	.55	251	317	129	50	462	438	7.7	7.1	100	5.5	76
	Aug-26	.98	1.6	.49	.52	213	286	94	48	405	400	6.8	7.0	100	4.4	58
	Sep-22	1.9	2.4	.055	.059	175	219	87	39	462	315	6.9	7.0	130	5.0	66
	Oct-27	1.0	1.3	.91	.91	108	155	55	25	204	190	6.0	6.7	140	4.0	48
	Nov-20	.72	.90	.55	.55	128	156	69	23	197	236	7.0	7.6	120	8.0	85
	Dec-09	1.1	1.7	.62	.68	245	293	126	51	490	453	7.4	7.6	130	7.4	78
	1970															
	Jan-14	.83	1.3	.59	.62	162	208	82	35	271	300	7.0	7.1	100	-	-

Table 14
Chemical Analyses of Water in Tributaries to Lake Okeechobee - Continued
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Time	Discharge (cfs)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
											Field	Laboratory						
Nubbin Slough	1969																	
	Feb-18	1140	-	17	4.7	0.15	40	11	37	3.9	130	128	39	65	0.4	0.05	0.012	0.07
	Mar-26	1530	-	20	7.1	.34	22	6.1	23	3.0	65	57	22	38	.4	.00	.009	.48
	Apr-16	1445	-	30	3.7	.10	38	8.8	30	2.8	114	120	34	47	.4	.00	.003	.12
	May-13	1625	-	28	9.3	.15	35	10	33	3.7	104	93	38	55	.3	.02	.015	.85
	Jun-10	1330	-	30	9.7	.20	25	6.4	25	5.0	78	63	21	42	.4	.02	.009	1.4
	Jul-17	1450	-	35	11	.20	29	8.3	28	6.3	101	75	30	49	.4	.00	.015	1.6
	Aug-26	1545	-	32	10	.35	17	4.2	16	2.7	48	41	20	27	.3	.3	.015	.49
	Sep-22	1330	-	31	10	.53	13	3.4	15	2.3	38	40	6.8	28	.3	.4	.009	.48
	Oct-28	1320	-	25	9.9	.40	14	4.2	17	3.4	42	37	10	33	.4	.00	.018	.63
	Nov-20	1430	-	19	5.6	.30	13	3.5	14	2.8	40	35	8.0	28	.4	.3	.009	.45

Table 14
Chemical Analyses of Water in Tributaries to Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Station Name	Date	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Hardness as Ca CO ₃		Specific Conductance Micromhos at 25 °C		pH value		Color (Units)	Dissolved Oxygen	
						Calculated	Residue at 180°C	Calcium Magnesium	Non Carbonate	Field	Laboratory	Field	Laboratory		Concentration	Percent Saturation
Nubbin Slough	1969															
	Feb-48	.98	1.1	0.29	0.30	265	306	145	40	458	465	7.5	7.4	90	6.0	62
	Mar-26	1.3	1.8	.36	.36	151	187	80	33	278	275	6.8	6.8	140	1.0	11
	Apr-16	.87	.99	.18	.20	224	254	131	33	398	398	7.9	7.3	80	9.4	124
	May-13	1.1	2.0	.42	.42	232	286	129	53	428	423	7.4	7.0	80	4.9	62
	Jun-10	1.8	3.3	.68	.68	168	233	89	38	312	290	6.9	6.8	120	1.1	15
	Jul-17	1.7	3.4	.85	.91	202	277	107	45	425	358	7.4	6.6	100	9.0	127
	Aug-26	1.3	2.1	.39	.43	120	158	60	26	188	195	6.6	6.7	160	2.8	38
	Sep-22	.21	1.1	.36	.36	102	169	47	14	165	180	6.6	6.8	240	3.5	47
	Oct-28	1.4	2.1	.65	.65	112	159	53	23	200	195	6.7	6.6	200	2.3	27
	Nov-20	1.3	2.0	.042	.046	95	138	47	18	152	178	6.5	6.8	160	7.5	80

Table 15
Chemical Analyses of Water in Drainage Canals of Lake Okeechobee - Continued
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Time	2/ Discharge (cfs)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
											Field	Laboratory						
St. Lucie Canal	1969																	
	Jan-15	1620	43	17	6.2	.06	55	17	51	3.5	-	182	55	77	4	0.2	0.003	0.06
	Feb-18	1050	43	17	6.4	.09	54	15	46	3.0	177	170	49	68	4	.4	.012	.12
	Mar-26	1440	6590	20	7.1	.05	52	15	48	3.2	196	174	51	69	6	.4	.003	.02
	Apr-16	1400	759	25	7.3	.00	52	14	45	2.8	161	166	50	69	5	.2	.006	.05
	May-14	1025	37	25	5.9	.08	42	12	34	2.9	148	142	40	54	3	.07	.003	.09
	Jun-10	1410	28	31	4.8	.01	46	11	36	2.6	146	148	39	56	4	.05	.003	.08
	Jul-17	1350	28	32	5.6	.02	43	11	34	2.6	128	136	34	53	5	.02	.000	.13
	Aug-29	1030	26	29	6.1	.02	43	12	40	2.9	124	144	40	60	3	.05	.009	.18
	Sep-22	1415	26	29	8.6	.11	50	8.1	34	2.9	152	149	34	52	3	.2	.052	.08
	Oct-28	1230	6090	25	11	.07	41	11	32	2.4	138	136	31	53	3	.07	.006	.01
	Nov-20	1530	6710	19	9.0	.10	40	9.7	27	2.7	140	123	30	46	4	.2	.006	.01
	1970																	
	Jan-15	1130	1640	13.5	7.1	.17	55	7.5	34	2.7	174	156	28	58	3	.1	.015	.16
	North New River Canal	1969																
Mar-26		1045	1580	21	5.8	.04	59	16	53	3.1	223	208	53	74	5	.09	.000	.05
Apr-16		0930	666	25	4.8	.04	56	16	52	3.0	192	188	54	74	5	.05	.000	.07
Jul-17		0945	512	31	18	.07	83	33	93	5.0	284	286	126	132	8	.02	.006	.11
Jul-29		1530	-2100	-	20	.08	100	41	122	5.8	-	340	163	170	8	.07	.003	-
Jul-31		1700	-2040	-	25	.07	114	49	110	5.7	-	400	179	154	9	.02	.006	-
Dec-10		1000	-2040	20	29	.09	113	50	239	8.5	556	495	107	332	1.3	.99	.070	.71
1970																		
Jan-15	1000	-1980	14	26	.06	91	38	138	7.5	385	367	122	182	8	.21	.043	.51	
West Palm Beach Canal	1969																	
	Mar-26	1350	1030	20	5.7	.04	51	14	47	3.0	183	168	49	67	5	.2	.003	.02
	Apr-16	1240	615	24	6.6	.14	51	14	47	3.1	167	176	50	67	4	.2	.003	.01
	Jul-17	1220	507	32	5.8	.02	47	12	38	2.7	150	152	41	58	4	.02	.000	.09
	Aug-29	0945	409	29	7.1	.02	47	14	45	3.1	124	152	49	68	3	.1	.015	.05
	Oct-28	1100	786	25	16	.05	48	15	43	3.4	158	152	43	66	3	.3	.009	.12
Miami Canal	1969																	
	Mar-26	0915	1640	22	5.1	.03	60	16	54	3.1	100	196	48	75	5	.1	.003	.06
	Apr-16	0830	927	24	5.4	.04	53	15	51	3.0	179	184	52	73	5	.07	.000	.03
	Jul-20	1000	-2040	-	19	.06	86	34	96	5.4	-	300	118	134	7	.2	.009	.10

Table 15
Chemical Analyses of Water in Drainage Canals of Lake Okeechobee - Continued
(Results in milligrams per liter except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Hardness as Ca CO ₃		Specific Conductance Microhmhos at 25° C		pH value		Color (units)	Dissolved Oxygen	
						Calculated	Residue at 180° C	Calcium Magnesium	Non-Carbonate	Field	Laboratory	Field	Laboratory		Concentration	Percent Saturation
St. Lucie Canal	Jan-15	1.8	2.1	0.029	0.033	356	393	207	58	680	620	7.5	7.5	45	8.5	98
	Feb-18	.17	.68	.033	.052	328	356	196	56	560	560	7.8	7.6	40	11.0	113
	Mar-26	.81	1.2	.036	.10	334	377	191	49	580	595	8.2	7.5	40	8.8	96
	Apr-16	1.4	1.6	.010	.023	323	359	187	51	575	580	8.5	7.3	40	9.5	113
	May-14	.91	1.1	.033	.036	280	380	155	38	475	472	8.0	7.6	20	6.0	71
	Jun-10	1.0	1.1	.029	.039	269	316	160	39	488	460	8.2	7.1	25	7.5	100
	Jul-17	1.1	1.3	.033	.042	251	316	153	41	490	431	8.6	7.3	30	7.3	99
	Aug-29	1.4	1.6	.036	.046	276	310	157	39	495	515	8.5	7.7	15	5.9	76
	Sep-22	.84	1.2	.14	.15	299	360	159	36	473	470	7.6	7.4	80	6.0	77
	Oct-28	1.0	1.1	.039	.042	249	280	148	36	445	440	8.0	8.0	40	6.7	80
	Nov-20	.00	.18	.055	.065	226	256	140	39	338	398	7.9	8.1	60	9.0	96
	1970															
	Jan-15	.88	1.2	.11	.11	271	323	168	41	475	488	7.8	7.7	50	9.0	86
	1969															
West Palm Beach Canal	Mar-26	1.0	1.2	.006	.026	321	368	185	47	570	584	8.2	7.5	30	8.8	96
	Apr-16	.88	1.1	.000	.013	327	360	185	41	578	584	8.4	7.9	30	7.5	89
	Jul-17	1.3	1.4	.026	.036	280	331	167	43	542	478	8.5	7.5	30	5.5	74
	Aug-29	1.4	1.6	.042	.046	309	338	175	51	532	570	8.5	7.6	20	6.7	86
	Oct-28	.69	1.1	.050	.050	311	342	182	57	535	540	7.9	8.0	30	6.5	77
North New River Canal	1969															
	Mar-26	1.0	1.1	.006	.023	367	412	213	43	630	663	8.1	7.5	40	7.0	78
	Apr-16	.94	1.1	.006	.016	354	394	206	52	620	640	8.2	7.9	30	6.4	76
	Jul-17	2.1	2.2	.029	.039	632	755	343	108	1080	1000	8.4	7.7	90	5.5	73
	Jul-29	-	-	-	-	790	859	418	140	-	1350	-	8.2	100	-	-
	Jul-31	-	-	-	-	835	949	486	158	-	1400	-	8.0	140	-	-
	Dec-10	2.0	3.8	.17	.16	1160	1240	488	82	2010	1980	7.7	8.3	160	4.0	43
Miami Canal	1970															
	Jan-15	2.9	3.7	.19	.20	788	875	384	83	1260	1340	7.8	7.8	120	4.5	43
	1969															
	Mar-26	1.1	1.3	.006	.020	369	404	216	55	640	663	8.2	7.8	35	7.0	80
	Apr-16	.84	.94	.013	.023	344	389	194	43	602	620	8.4	8.0	30	7.0	82
	Jul-20	1.3	1.6	.029	.036	642	746	355	109	-	1100	-	8.0	80	-	-

Table 15
Chemical Analyses of Water in Drainage Canals of Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Station Name	Date	Time	Discharge (cfs)	Temperature (°C)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate Nitrogen (NO ₃ -N)	Nitrite Nitrogen (NO ₂ -N)	Ammonia Nitrogen (NH ₄ -N)
											Field	Laboratory						
Caloosahatchee Canal	1969																	
	Mar-25	1535	4060	23	3.3	.01	49	12	39	3.7	142	142	46	62	0.5	0.05	0.006	0.09
	Apr-15	1715	1600	24	2.5	.03	47	12	40	2.7	152	148	41	59	.5	.02	.000	.05
	May-16	0900	2420	26	2.7	.05	45	12	35	2.4	140	138	45	54	.3	.00	.003	.09
	Aug-27	1430	5450	30	7.4	.08	36	15	46	5.8	124	124	53	65	.3	.00	.003	.08
	Oct-27	1700	4680	25	8.8	.17	32	10	30	2.6	106	110	27	48	.3	.00	.006	.12
	Nov-21	0900	5490	18	6.1	.07	36	11	31	2.3	114	118	34	48	.4	.07	.000	.05
	1970																	
	Jan-14	1150	-	12	3.7	.08	29	6.8	22	1.9	84	82	24	35	.3	.00	.003	.09

Table 15
Chemical Analyses of Water in Drainage Canals of Lake Okeechobee - Continued
 (Results in milligrams per liter except as noted)
 Analysis made by U. S. Geological Survey

Station Name	Date	Organic Nitrogen (N)	Total Nitrogen (N)	Orthophosphate (PO ₄ -P)	Total Phosphorus (P)	Dissolved Solids		Hardness as CaCO ₃		Specific Conductance Micromhos at 25 °C		pH value		Color (Units)	Dissolved Oxygen	
						Calculated	Residue at 180 °C	Calcium Magnesium	Non-Carbonate	Field	Laboratory	Field	Laboratory		Concentration	Percent Saturation
Caloosahatchee Canal	1969															
	Mar-25	1.0	1.2	0.039	0.055	286	336	172	56	518	520	7.6	7.2	70	5.4	62
	Apr-15	.93	1.0	.010	.010	278	310	167	46	508	505	7.8	7.5	50	6.1	72
	May-16	1.1	1.2	.050	.052	265	300	162	49	463	482	7.8	7.4	20	7.5	93
	Aug-27	1.4	1.5	.029	.033	290	325	152	50	520	525	7.7	8.1	60	5.2	68
	Oct-27	.98	1.1	.023	.033	213	258	121	31	380	380	7.0	7.5	60	4.8	57
	Nov-21	.83	.95	.020	.029	227	255	135	39	318	401	7.2	7.9	60	8.5	90
	1970															
	Jan-14	.85	.94	.050	.059	163	204	101	34	298	298	7.5	7.4	80	-	-

2/ Negative sign indicates reverse flow.

Table 16
Phytoplankton in Lake Okeechobee
CONCENTRATION IN CELLS PER MILLIMETER

Site	JAN 1969	MAY 1969	AUG 1969	JAN 1970	APR 1970	JUL 1970	OCT 1970	JAN 1971	APR 1971
1	<50	800	<40	<40	-	-	-	-	-
2	<50	320	<40	<40	<20	60	2,100	2,400	80
3	<50	100	<40	<40	-	-	-	-	-
4	<50	1,200	<40	<40	-	-	-	-	-
5	<50	4,600	<40	<40	<20	105,800	108,500e	473,700e	220
6	<50	3,600	<40	<40	-	-	-	-	-
7	<50	1,450	<40	<40	-	-	-	-	-
8	<50	340	<40	<40	1,130	5,850	3,200e	218,900e	37,400e
9	<50	170	<40	80	560	66,600	20,100e	200,600e	15,900e
10	<50	860	<40	<40	-	-	-	-	-
11	<50	1,350	<40	<40	-	-	-	-	-
12	<50	240	<40	<40	7,500	12,500	3,200e	960e	2,300
13	<50	100	<40	<40	-	-	-	-	-
14	<50	270	<40	<40	-	-	-	-	-
15	<50	2,900	<40	<40	100	1,730	15,400e	1,220e	6,400

e-Estimated

Table 17
Chemical and Biological Analyses of Water and Bottom Sediments in Lake Okeechobee, Kissimmee River and Taylor Creek,
October 1970-May 1972
(Results in milligrams per liter, except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Time	Discharge (cfs)	Lake Stage (ft)	Temperature (°C)	Silica (SiO ₂)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Carbonate (CO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃ -N)	Nitrite (NO ₂ -N)	Ammonia (NH ₄ -N)
											Field	Laboratory	Field	Laboratory						
Lake Okeechobee																				
Point No. 2	10-14-70	1045	14.2	27.0	9.1	40	12	33	2.6	-	140	-	0	38	49	0.4	0.002	0.003	0.013	
Point No. 5	10-14-70	1305	14.2	29.0	8.4	41	9.6	30	2.4	-	132	-	0	35	44	.3	.00	.003	.013	
Point No. 8	10-14-70	0915	14.2	26.0	11	46	11	31	2.4	-	148	-	0	37	47	.3	.00	.018	.006	
Point No. 9	10-14-70	0845	14.2	26.0	7.8	43	11	31	2.5	-	142	-	0	37	46	.3	.00	.003	.010	
Point No. 12	10-14-70	0935	14.2	26.0	11	45	12	37	2.7	-	154	-	0	43	52	.4	.09	.009	.016	
Point No. 15	10-14-70	1020	14.2	26.5	7.8	44	9.6	33	2.5	-	142	-	0	38	48	.3	.00	.006	.013	
Kissimmee River	1-12-71	1235	125	22.0	7.2	50	8.8	30	2.4	-	128	-	0	49	52	.2	.2	.006	.010	
Taylor Creek	1-12-71	1400	17	24.0	5.2	72	20	110	7.0	-	173	-	0	80	200	.2	.2	.030	.17	
Lake Okeechobee																				
Point No. 2	1-12-71	1045	12.9	22.0	12	47	12	36	2.7	-	156	-	0	40	54	.3	.1	.009	.000	
Point No. 5	1-12-71	1145	12.9	23.0	7.8	48	13	35	2.6	-	148	-	8	41	54	.2	.00	.006	.006	
Point No. 8	1-12-71	0925	12.9	21.0	8.1	49	11	35	2.6	-	144	-	8	41	52	.3	.00	.006	.003	
Point No. 9	1-12-71	0900	12.9	21.0	8.1	50	11	35	2.6	-	144	-	8	41	52	.3	.00	.006	.006	
Point No. 12	1-12-71	1000	12.9	22.0	12	48	12	37	2.8	-	160	-	0	44	58	.3	.1	.009	.013	
Point No. 15	1-12-71	1110	12.9	22.0	12	48	12	36	2.8	-	148	-	4	43	54	.2	.1	.012	.006	
Kissimmee River	4-27-71	1430	0	28.0	2.7	36	7.7	27	2.4	-	96	-	0	38	44	.3	.02	.018	.10	
Taylor Creek	4-27-71	0815	3.3	26.0	5.0	56	15	53	3.8	-	176	-	0	55	84	.5	.00	.012	.21	
Lake Okeechobee																				
Point No. 2	4-27-71	1100	11.1	27.5	10.0	52	13	38	2.9	-	166	-	0	47	58	.4	.3	.015	.075	
Point No. 5	4-27-71	1230	11.1	29.5	10.0	54	14	40	3.0	-	168	-	6	50	60	.4	.3	.009	.072	
Point No. 8	4-27-71	0900	11.1	26.0	9.6	54	15	40	3.0	-	168	-	4	51	60	.4	.2	.009	.072	
Point No. 9	4-27-71	0845	11.1	25.0	8.4	54	14	41	3.1	-	168	-	4	49	62	.5	.00	.012	.078	
Point No. 12	4-27-71	0945	11.1	26.5	6.2	54	13	39	2.9	-	166	-	0	48	63	.4	.2	.018	.078	
Point No. 15	4-27-71	1130	11.1	27.5	11	53	12	38	2.9	-	168	-	0	47	58	.4	.3	.021	.095	
Kissimmee River	8-19-71	1215	3030	30.0	5.8	23	4.7	15	1.5	52	57	0	0	26	26	.2	.3	.015	.026	
Taylor Creek	8-19-71	1330	462	28.0	4.2	23	4.6	21	3.6	54	52	0	0	20	40	.3	.3	.088	.18	

Table 17
Chemical and Biological Analyses of Water and Bottom Sediments in Lake Okeechobee, Kissimmee River and Taylor Creek,
October 1970-May 1972 - Continued
(Results in milligrams per liter, except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Organic Nitrogen (N)	Total Nitrogen (N)	Ortho Phosphate (PO ₄ -P)	Total Phosphorus (P)	Total organic carbon (TOC)	Dissolved Solids		Hardness as CaCO ₃		Specific Conductance Microhmhos at 25° C		pH value		Color (Units)	Turbidity (J T U)	Biochemical Oxygen demand (BOD)	Dissolved Oxygen		Phytoplankton (cells/milliliter)
							Calculated	Residue at 180° C	Calcium Magnesium	Non-carbonate	Field	Laboratory	Field	Laboratory				Concentration	Percent of saturation	
Lake Okeechobee																				
Point No. 2	10-14-70	.61	.67	.020	.050	-	254	282	151	36	445	450	8.3	8.1	20	15	-	7.6	94	2,100e
Point No. 5	10-14-70	.63	.67	.013	.036	-	236	271	143	35	420	420	8.3	7.9	20	6	-	7.9	101	108,500e
Point No. 8	10-14-70	.54	.58	.029	.052	-	260	274	161	40	445	450	8.2	8.0	20	4	-	7.8	95	3,200e
Point No. 9	10-14-70	.59	.61	.013	.046	-	249	283	154	37	435	440	8.2	8.0	20	7	-	7.8	95	20,100e
Point No. 12	10-14-70	.57	.71	.026	.052	-	280	311	163	37	500	495	8.0	8.1	30	9	-	6.7	82	3,200e
Point No. 15	10-14-70	.67	.71	.016	.046	-	254	284	151	34	450	450	8.4	8.0	15	13	-	7.4	91	15,400e
Kissimmee River	1-12-71	.5	.76	.039	.050	-	260	313	160	56	475	464	8.1	8.1	80	6	1.2	8.5	97	-
Taylor Creek	1-12-71	1.0	1.6	.62	.78	-	580	696	260	120	1160	1080	7.7	8.0	60	12	2.2	6.8	80	-
Lake Okeechobee																				
Point No. 2	1-12-71	.52	.64	.026	.026	-	280	313	170	39	485	497	8.5	8.1	30	6	.0	8.7	99	2,400
Point No. 5	1-12-71	.68	.71	.016	.016	-	283	310	170	39	478	497	8.8	8.4	30	10	1.4	9.3	107	473,700e
Point No. 8	1-12-71	.62	.64	.016	.026	-	280	322	170	36	470	486	8.6	8.4	25	12	1.1	9.0	100	218,900e
Point No. 9	1-12-71	.61	.64	.013	.029	-	280	314	170	39	460	486	8.6	8.4	30	13	1.1	9.0	100	200,600e
Point No. 12	1-12-71	.57	.72	.033	.050	-	290	326	170	39	495	508	8.5	8.2	30	14	.9	8.7	99	960e
Point No. 15	1-12-71	.58	.75	.033	.039	-	290	319	170	42	490	497	8.5	8.3	30	20	1.1	8.6	98	1,220e
Kissimmee River	4-27-71	.85	1.1	.023	.050	13	205	247	120	43	-	380	8.2	8.0	15	9	-	8.3	105	650
Taylor Creek	4-27-71	2.1	2.6	.17	.20	115	359	421	200	57	605	670	8.0	8.0	20	25	8.7	4.6	56	6,400
Lake Okeechobee																				
Point No. 2	4-27-71	2.2	2.7	.050	.065	19	305	363	180	47	535	550	8.1	8.2	15	45	1.8	7.8	98	80
Point No. 5	4-27-71	1.8	2.3	.026	.039	40	322	362	190	55	565	560	8.4	8.4	15	30	1.4	8.9	116	220
Point No. 8	4-27-71	2.3	2.6	.026	.039	18	321	337	200	52	545	570	8.5	8.4	10	35	2.5	7.7	94	37,400e
Point No. 9	4-27-71	.75	.95	.029	.046	22	319	357	190	48	550	570	8.6	8.3	15	40	1.3	7.3	87	15,900e
Point No. 12	4-27-71	.82	1.2	.042	.059	72	309	333	190	52	530	550	8.3	8.2	20	80	2.6	7.2	87	2,300
Point No. 15	4-27-71	2.3	2.9	.055	.075	22	307	345	180	44	545	550	8.4	8.2	20	60	1.6	8.2	102	1,000
Kissimmee River	8-19-71	1.2	1.6	.14	.18	23	132	227	77	31	225	235	7.1	7.0	140	3	1.1	3.9	51	0
Taylor Creek	8-19-71	1.5	2.3	.85	.88	31	146	162	77	34	311	270	6.7	7.7	200	10	3.0	5.0	63	1,100

e/ estimated

Table 17
Chemical and Biological Analyses of Water and Bottom Sediments in Lake Okeechobee, Kissimmee River and Taylor Creek,
October 1970-May 1972 - Continued
(Results in milligrams per liter, except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Time	Discharge (cfs) Lake stage (ft)	Temperature (°C)	Silica (SiO ₂)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Carbonate (CO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃ -N)	Nitrite (NO ₂ -N)	Ammonia (NH ₄ -N)
										Field	Laboratory	Field	Laboratory						
Lake Okeechobee																			
Point No. 2	8-19-71	1040	12.0	28.0	1.6	50	14	45	3.1	164	176	38	0	50	66	0.4	0.00	0.006	0.07
Point No. 5	8-19-71	0920	12.0	28.5	7.9	42	17	52	4.5	120	146	16	0	66	77	.5	.00	.006	.04
Point No. 8	8-19-71	0815	12.0	28.0	4.8	48	17	50	3.2	164	176	8	0	55	74	.4	.00	.006	.05
Point No. 9	8-19-71	1300	12.0	28.0	4.8	38	11	36	2.9	112	114	0	0	44	57	.3	.02	.009	.02
Point No. 12	8-19-71	1130	12.0	30.0	6.4	52	9.0	38	3.0	164	162	0	0	34	58	.4	.09	.018	.12
Point No. 15	8-19-71	1010	12.0	28.0	.6	52	14	44	3.0	160	166	12	8	50	64	.4	.00	.006	.08
Kissimmee River	11-10-71	0940	349	24.5	4.0	15	4.4	11	1.7	24	30	0	0	29	20	.2	.2	.012	.06
Taylor Creek	11-10-71	1515	52	23.5	7.0	27	6.6	29	5.1	74	72	0	0	24	54	.3	.3	.058	.27
Lake Okeechobee																			
Point No. 2	11-11-71	1200	14.4	21.5	6.3	60	18	53	3.8	232	216	12	0	66	80	.4	.1	.006	.04
Point No. 5	11-10-71	1130	14.4	23.0	3.7	42	12	36	3.1	132	140	8	0	46	56	.3	.00	.000	.02
Point No. 8	11-10-71	0845	14.4	23.5	4.4	46	14	42	3.3	160	160	0	0	48	65	.3	.00	.000	.02
Point No. 9	11-10-71	0800	14.4	23.5	3.9	42	12	37	3.2	144	148	0	0	42	59	.3	.00	.003	.04
Point No. 12	11-11-71	1330	14.4	23.0	6.6	47	8.0	28	4.2	144	152	0	0	34	46	.3	.3	.021	.10
Point No. 15	11-11-71	1030	14.4	21.5	3.4	49	16	46	3.5	184	176	8	0	50	70	.3	.00	.009	.06
Kissimmee River	2-02-72	1130	0	22.0	4.6	42	12	39	2.7	-	120	-	0	53	62	.3	.1	.009	.05
Taylor Creek	2-02-72	1345	21	23.0	4.1	56	17	68	4.8	-	168	-	0	64	110	.4	.09	.018	.12
Lake Okeechobee																			
Point No. 2	2-02-72	1015	13.7	22.0	7.4	56	17	50	3.3	-	192	-	0	59	72	.4	.2	.012	.04
Point No. 5	2-02-72	1445	13.7	23.0	7.0	56	18	54	3.4	-	176	-	12	61	76	.4	.00	.006	.02
Point No. 8	2-02-72	0830	13.7	22.0	4.6	56	16	48	3.3	-	176	-	8	53	70	.4	.00	.012	.02
Point No. 9	2-02-72	0745	13.7	21.5	5.8	54	17	48	3.3	-	180	-	4	54	72	.4	.00	.015	.05
Point No. 12	2-02-72	0915	13.7	22.0	8.4	56	17	48	3.3	-	192	-	0	57	70	.4	.2	.018	.08
Point No. 15	2-02-72	1045	13.7	22.0	6.0	54	16	46	3.3	-	180	-	0	56	66	.3	.1	.018	.09

Table 17
Chemical and Biological Analyses of Water and Bottom Sediments in Lake Okeechobee, Kissimmee River and Taylor Creek,
October 1970-May 1972 - Continued
(Results in milligrams per liter, except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Organic Nitrogen (N)	Total Nitrogen (N)	Ortho Phosphate (PO ₄ -P)	Total Phosphorus (P)	Total organic carbon (TOC)	Dissolved Solids		Hardness CaCO ₃		Specific Conductance Micromhos at 25° C		pH value		Color (units)	Turbidity (JTU)	Biochemical oxygen demand (BOD)	Dissolved Oxygen		Phytoplankton (cells/milliliter)
							Calculated	Residue at 180°C	Calcium	Magnesium	Non-carbonate	Field	Laboratory	Field	Laboratory			Cocentration	Percent of saturation	
Lake Okeechobee																				
Point No. 2	8-19-71	1.5	1.6	0.010	0.036	13	317	300	180	39	560	580	8.5	8.3	20	20	1.0	6.8	86	950
Point No. 5	8-19-71	1.9	2.0	.010	.029	25	339	426	175	56	583	610	8.7	8.3	50	62	1.1	7.0	89	3,000
Point No. 8	8-19-71	1.9	2.0	.010	.033	18	339	365	190	46	680	630	8.6	8.3	30	20	1.1	6.8	86	670
Point No. 9	8-19-71	2.5	2.6	.042	.078	18	250	305	140	47	450	450	8.2	8.0	55	15	2.6	7.3	92	54,600e
Point No. 12	8-19-71	1.3	1.5	.10	.13	14	282	338	170	34	512	500	7.8	7.5	80	10	1.4	5.0	66	6,000
Point No. 15	8-19-71	1.4	1.4	.010	.036	12	318	381	190	28	562	580	8.6	8.4	20	15	1.3	7.2	91	1,600
Kissimmee River	11-10-71	.85	1.1	.046	.052	14	101	139	56	31	145	182	6.9	5.7	120	3	.8	6.5	77	200
Taylor Creek	11-10-71	1.6	2.2	.65	.65	24	191	251	95	36	330	353	7.0	6.0	320	10	1.8	3.5	41	1,600
Lake Okeechobee																				
Point No. 2	11-11-71	2.2	2.4	.036	.039	16	394	449	224	108	660	704	8.5	6.5	50	45	.8	8.7	98	14,500
Point No. 5	11-10-71	1.8	1.8	.016	.026	15	268	316	155	40	485	486	8.5	6.2	100	7	1.6	8.7	100	47,200
Point No. 8	11-10-71	1.8	1.8	.016	.026	13	302	338	173	42	480	551	8.0	6.3	60	15	1.5	8.4	98	79,600
Point No. 9	11-10-71	1.6	1.6	.016	.033	13	272	311	155	33	450	490	8.2	6.6	60	10	1.8	8.5	99	29,200
Point No. 12	11-11-71	1.5	1.9	.19	.20	22	251	299	151	26	--	441	7.5	6.1	240	10	.9	6.2	71	3,900
Point No. 15	11-11-71	1.9	2.0	.046	.046	12	325	367	189	45	750	592	8.5	7.4	50	45	2.3	8.5	96	56,000
Kissimmee River	2-02-72	1.1	1.3	.033	.052	14	275	284	150	56	500	480	7.6	7.9	70	5	1.1	9.3	106	2,450
Taylor Creek	2-02-72	1.1	1.3	.23	.27	16	409	422	210	72	830	740	7.4	7.9	60	8	2.1	9.3	107	950
lake Okeechobee																				
Point No. 2	2-02-72	2.3	2.6	.050	.050	17	361	374	210	52	615	600	8.3	8.3	45	35	1.6	9.3	106	150
Point No. 5	2-02-72	2.7	2.7	.016	.026	24	375	382	220	52	690	640	8.6	8.7	45	8	1.4	9.5	109	15,700
Point No. 8	2-02-72	3.0	3.0	.026	.039	20	338	350	210	48	595	570	8.5	8.5	45	25	2.3	9.3	106	21,100
Point No. 9	2-02-72	3.0	3.1	.042	.055	19	344	362	200	51	625	600	8.5	8.4	45	35	1.7	9.6	108	11,900
Point No. 12	2-02-72	3.0	3.3	.052	.062	22	356	362	210	52	615	590	8.2	8.3	50	50	2.1	9.2	104	250
Point No. 15	2-02-72	3.0	3.2	.059	.062	24	337	348	200	53	580	560	8.3	8.3	70	50	1.5	9.3	106	1,250

e/ estimated

Table 17
Chemical and Biological Analyses of Water and Bottom Sediments in Lake Okeechobee, Kissimmee River and Taylor Creek,
October 1970-May 1972 - Continued
(Results in milligrams per liter, except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Time	Discharge (cfs) Lake stage (ft)	Temperature (°C)	Silica (SiO ₂)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)		Carbonate (CO ₃)		Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃ -N)	Nitrite (NO ₂ -N)	Ammonia (NH ₄ -N)
										Field	Laboratory	Field	Laboratory						
Kissimmee River	5-31-72	1750	875	28.0	2.0	14	4.4	13	1.9	29	30	0	0	26	21	0.3	0.00	0.003	0.03
Taylor Creek	5-13-72	1745	41	29.0	2.5	60	19	90	5.1	160	156	0	0	72	160	.5	.02	.009	.04
Lake Okeechobee																			
Point No. 2	5-31-72	1155	13.1	27.5	6.9	55	18	53	3.9	204	178	0	7	62	78	.5	.1	.003	.02
Point No. 5	5-31-72	1300	13.1	27.5	7.2	54	18	54	4.0	184	162	6	11	62	84	.5	.00	.003	.03
Point No. 8	5-31-72	0800	13.1	26.5	4.2	54	16	51	3.8	198	172	2	5	58	76	.5	.00	.006	.04
Point No. 9	5-31-72	0715	13.1	26.5	2.7	52	15	47	3.6	148	158	12	7	56	74	.5	.00	.003	.02
Point No. 12	5-31-72	1000	13.1	28.0	3.7	59	15	49	3.9	196	180	0	2	57	76	.5	.05	.006	.04
Point No. 15	5-31-72	0900	13.1	26.5	7.2	56	17	53	3.9	204	174	2	7	62	78	.5	.00	.006	.02

Table 17
Chemical and Biological Analyses of Water and Bottom Sediments in Lake Okeechobee, Kissimmee River and Taylor Creek,
October 1970-May 1972 - Continued
(Results in milligrams per liter, except as noted)
Analyses made by U. S. Geological Survey

Station Name	Date	Organic Nitrogen (N)	Total Nitrogen (N)	Ortho Phosphate (PO ₄ P)	Total Phosphorus (P)	Total organic carbon (TOC)	Dissolved Solids		Hardness CaCO ₃		Specific Conductance Micromhos at 25° C		pH Value		Color (units)	Turbidity (ITU)	Biochemical Oxygen demand (BOD)	Dissolved Oxygen		Phytoplankton (cells/milliliter)
							Calculated	Residue at 180° C	Calcium Magnesium	Non-carbonate	Field	Laboratory	Field	Laboratory				Concentration	Percent of saturation	
Kissimmee River	5-31-72	0.72	0.75	0.020	0.029	12	98	124	54	29	180	181	7.4	7.2	90	2	0.9	7.2	91	450
Taylor Creek	5-31-72	1.3	1.4	.42	.46	14	490	515	230	100	825	910	8.3	8.2	90	5	3.1	7.3	94	4,800
Lake Okeechobee																				
Point No. 2	5-31-72	1.3	1.5	.020	.020	16	380	400	210	55	620	660	8.3	8.6	60	10	1.0	7.6	95	1,150
Point No. 5	5-31-72	1.3	1.3	.016	.029	16	380	398	210	59	632	644	8.5	8.7	50	7	1.8	7.3	91	86,500
Point No. 8	5-31-72	1.4	1.4	.020	.026	22	360	387	200	53	560	624	8.4	8.6	70	20	.8	7.5	91	13,500
Point No. 9	5-31-72	1.3	1.3	.016	.020	18	340	376	190	52	600	594	8.6	8.6	60	10	1.1	7.0	85	20,600
Point No. 12	5-31-72	1.4	1.5	.026	.036	18	360	375	210	59	575	624	8.2	8.4	60	10	1.1	5.8	73	2,800
Point No. 15	5-31-72	1.5	1.6	.016	.026	20	370	400	210	57	580	650	8.4	8.6	80	20	1.1	7.7	94	23,900

Table 17
Chemical and Biological Analyses of Water and Bottom Sediments in Lake Okeechobee, Kissimmee River and Taylor Creek,
October 1970-May 1972 - Continued
(Results in milligrams per liter, except as noted)
Analysis made by U. S. Geological Survey

Station Name	Date	Aluminum (Al)	Arsenic (As)	Cadmium (Cd)	Chromium (Cr) hexavalent	Copper (Cr)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mercury (Hg)	Zinc (Zn)	Bottom Sediments (Percent Dry Weight)					Bottom Fauna (Number per Sq Meter) ^{1/}
												Biochemical Oxygen demand (BOD) (Mg/kg)	Organic carbon (C)	Nitrogen (N)	Phosphorus (P)	Iron (Fe)	
Lake Okeechobee																	
Point No. 2	11-11-71	-	-	-	-	-	-	-	-	-	-	93	2.21	0.25	0.017	0.70	129
Point no. 5	11-10-71	-	-	-	-	-	-	-	-	-	-	150	.08	.01	.006	.31	1419
Point No. 8	11-10-71	-	-	-	-	-	-	-	-	-	-	69	.12	.01	.008	.14	258
Point No. 9	11-10-71	-	-	-	-	-	-	-	-	-	-	52	16.87	1.15	.021	1.8	301
Point No. 12	11-11-71	-	-	-	-	-	-	-	-	-	-	140	8.37	.63	.019	2.6	4257
Point No. 15	11-11-71	0	-	1	0	0	20	2	0	0	60	50	15.57	1.19	.017	4.0	1892
Lake Okeechobee																	
Point No. 2	5-31-72	-	-	-	-	-	-	-	-	-	-	-	.37	.03	.018	.17	130
Point No. 5	5-31-72	-	-	-	-	-	-	-	-	-	-	-	.16	.03	.060	.91	1592
Point No. 8	5-31-72	-	-	-	-	-	-	-	-	-	-	-	.46	.06	.014	.53	1292
Point No. 9	5-31-72	-	-	-	-	-	-	-	-	-	-	-	9.85	.07	.018	.21	1483
Point No. 12	5-31-72	-	-	-	-	-	-	-	-	-	-	-	8.17	.07	.022	.25	12837
Point No. 15	5-31-72	0	10	0	1	10	0	0	0	0	10	-	16.16	1.24	.021	.15	2579

^{1/} Counts made by Florida Department of Pollution Control

Table 18
Phytoplankton observed in Lake Okeechobee, Kissimmee River and Taylor Creek
August 1971 - May 1972

A abundant, P present, - not present
 Position indicates date: August, November 1971, February, May 1972

Algae Species	Kissimmee R	Taylor Cr	Point					
			2	5	8	9	12	15
* <i>Anabaena circinalis</i>	—	—	—	P—	—	PP—	—	—
* <i>Anabaena flos-aquae</i>	—PP	A—	—	—	—	P-AA	—	—
* <i>Aphanizomenon holsaticum</i>	—P-	—A	-A-A	-AAA	AAAA	AAAA	AA-A	AAAA
<i>Ceratium hirundinella</i>	—	—	—	—	—	-P-	—	-P-
<i>Desmid</i> (unidentified)	—	—	-P-	-P-	-P-	—	-P-	-P-
<i>Fragilaria</i> Sp.	—	—	—	-P-	-PP-	-P-	-P-	—
<i>Gyrosigma</i> Sp.	—	—	—	-P-	—	—	—	—
<i>Melosira</i> Sp.	—	—P	P—	-PP-	—	-PP-	—	—
* <i>Merismopedia elegans</i>	—P-	-A-	-P-	AAPA	-PP-	P—	—	—
* <i>Microcystis aeruginosa</i>	-P-P	-P	-P-	PPP-	-PP-	PPP-	-P-	-P-
<i>Navicula</i> Sp.	—	—	—	—	—	—	—	-P-
<i>Pediastrum duplex</i>	—	—	—	—	-P	—	—	—
<i>Pediastrum simplex</i>	—	-P-	-P-	-PP-	-P-	—	—	-P-
<i>Scenedesmus quadricauda</i>	—	—	-P-	-P-	—	—	—	-P-
* <i>Spirulina</i> Sp.	—	-P-	APP-	-P-P	PPPP	PPPP	PPP-	PPPP
* <i>Stephanodiscus niagarae</i>	—	—PP	P-PP	P-P-	P-PP	P-PP	—PP	PPPP
<i>Synedra</i> Sp.	—	—	PPP-	-P-P	PPPP	PP-P	P-P	PA-P
Average total	775	2,100	4,200	38,100	28,700	29,100	3,240	20,700

* Blue-green algae

Table 19
Average number of bottom organisms per square meter in Lake Okeechobee
November 1971-May 1972
(Determinations made by Florida Department of Pollution Control)

Species	Point					
	2	5	8	9	12	15
Annelida	-	-	-	-	301	-
<i>Brachiura sowerbyi</i>	-	-	-	-	1828	-
<i>Oligochaete</i> (unidentified)	43	-	43	86	946	129
	-	1226	1140	752	5891	430
Arthropoda	-	-	-	-	43	43
<i>Taphromysis louisianae</i>	-	-	-	-	43	-
<i>Gammarus</i> Sp.	-	-	-	-	258	-
	-	-	22	-	108	15
<i>Cyathura polita</i>	-	43	86	-	86	-
	-	150	108	22	22	22
<i>Coelotanypus</i> Sp.	86	-	43	172	-	688
	43	-	-	408	236	301
<i>Chironomus crassicaudatus</i>	-	-	43	-	-	-
	-	-	-	-	22	-
<i>Chironomus</i> Sp.	-	1376	43	-	-	-
	-	22	-	-	-	-
<i>Chaoborus punctipennis</i>	-	-	-	-	-	-
	-	22	-	129	-	64
Mollusca	-	-	-	43	301	-
<i>Corbicula manilensis</i>	43	-	22	-	-	-
<i>Hyalopyrgus aegicostatus</i>	-	-	-	-	-	103
	-	172	-	64	-	154
<i>Hyalopyrgus</i> Sp.	-	-	-	-	43	-
	-	-	-	-	-	-
<i>Melanoides</i> Sp.	-	-	-	-	2279	-
	22	-	-	108	4687	64
<i>Physa</i> Sp.	-	-	-	-	-	-
	22	-	-	-	-	-
Totals	129	1419	258	301	4257	1892
	130	1592	1292	1483	12837	2579

**DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY**

This public document was promulgated at a total cost of \$2,777.50 or a per copy cost of \$2.78 for the purpose of disseminating hydrologic data.