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PROGRESS REPORT
UPPER KISSIMMEE CHAIN OF LAKES
WATER QUALITY AND BENTHIC INVERTEBRATE SAMPLING

By

James F. Milleson

Resources Planning Department

Central and Southern Florida
Flood Control District
West Palm Beach, Florida

INTRODUCTION

Water quality parameters were monitored by District personnel throughout the Upper Kissimmee Chain of Lakes from July 1973 to June 1974. Major emphasis was placed on monitoring lakes Tohopekaliga (Toho), Cypress, Hatchineha, and Kissimmee. Selected stations in East Lake Tohopekaliga (East Toho) were later added to the sampling schedule. In addition, one sample station was included in Shingle Creek, upstream from Lake Tohopekaliga. Samples of the benthic fauna were obtained from several locations in each lake twice during the year.

MATERIAL AND METHODS

Sampling locations were chosen in order to represent the water quality throughout the system of lakes while also reflecting the quality of selected surface water inflows. Actual sample sites were located in the field by their relation to shoreline configurations and conspicuous landmarks. The approximate locations of sampling stations are indicated in Figure 1.

Water quality data were taken on six different occasions during the study (Table 1). Stations 1-19 were sampled July 23-25, 1973; October 29-31, 1973; January 22-30, 1974; April 18-20, 1974; and June 18-20, 1974. Only Stations 1, 3, 4, 5, 9, 11, 13, 14, 16, 18, and 19 were sampled on October 3, 1973. Stations 21-25 were sampled in January, April, and June 1974.

At each station pH, dissolved oxygen, specific conductivity, and temperature were measured using a HYDROLAB$^{T.M.}$ Surveyor Model 6D. Measurements were obtained at the surface and at one meter intervals to the bottom. Samples of water

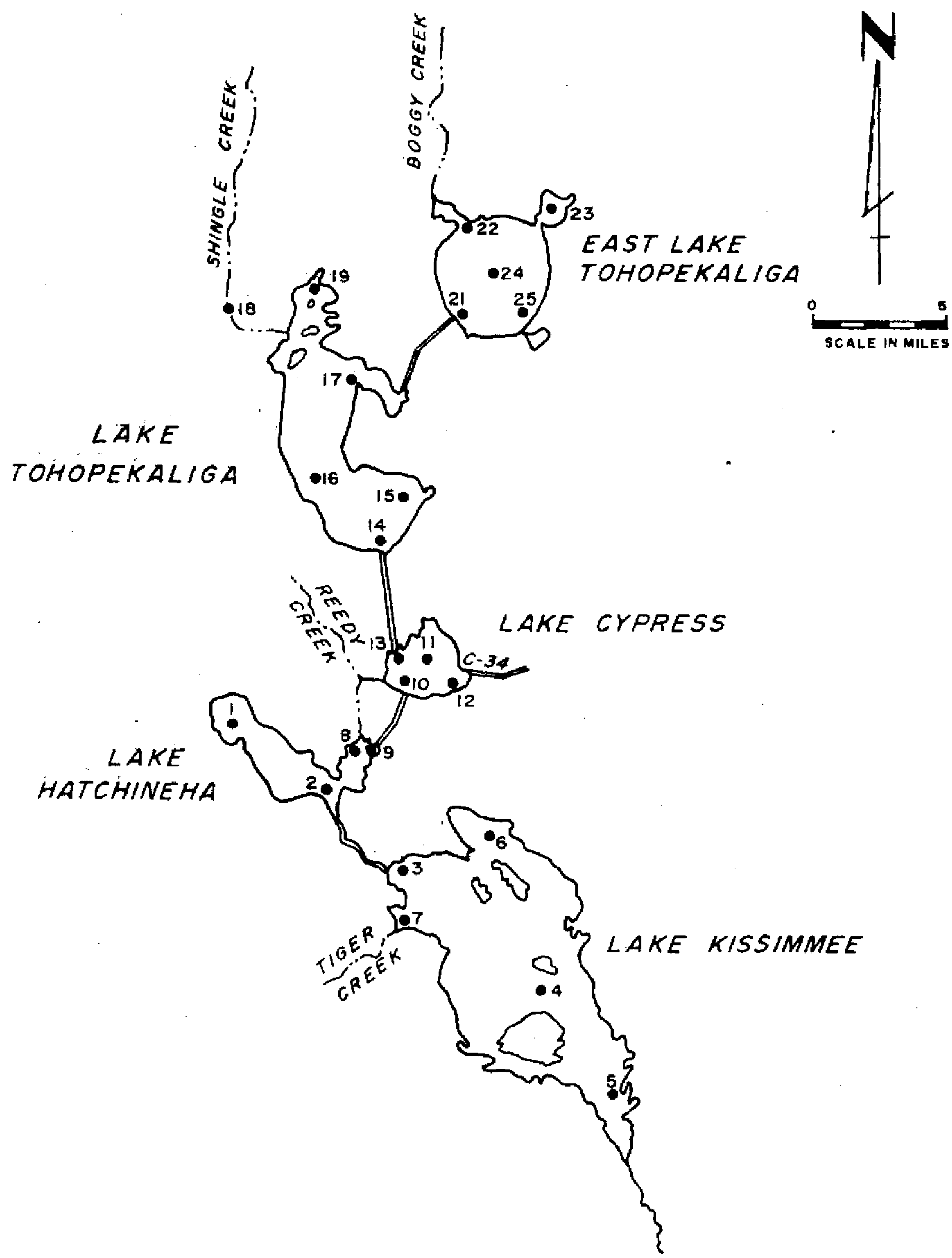

FIGURE I LOCATION OF SAMPLING SITES IN THE UPPER KISSIMMEE BASIN

TABLE 1 Sampling schedule for Kissimmee Chain of Lakes, July 1973 - June 1974

Station	July 23-25 1973	Oct 2-4 1973	Oct 29-31 1973	Jan 22-30 1974	Apr 18-20 1974	June 18-20 1974
1	W	W,E	W	W,B	W	W,E
2	W		W	W,B	W	W
3	W	W,E	W	W,B	W	W,E
4	W	W,E	W	W,B	W	W,E
5	W	W,E	W	W,B	W	W,E
6	W		W	W,B	W	W
7	W		W	W,B	W	W
8	W		W	W,B	W	W
9	W	W,E	W	W,B	W	W,E
10	W		W	W,B	W	W
11	W	W,E	W	W,B	W	W,E
12	W		W	W,B	W	W
13	W	W,E	W	W,B	W	W,E
14	W	W,E	W	W,B	W	W,E
15	W		W	W,B	W	W
16	W	W,E	W	W,B	W	W,E
17	W		W	W,B	W	W
18	W	W,E	W	W,B	W	W,E
19	W	W,E	W	W,B	W	W,E
21				W,B	W	W
22				W,B	W	W
23				W,B	W	W,E
24				W,B	W	W,E
25				W,B	W	W
26					W	W

W = surface water sample

B = bottom water sample

E = Ekman benthic sample

from the lake surface were collected in the field, stored in polyethylene plastic bottles, refrigerated, and returned to West Palm Beach for laboratory analyses. Total Kjeldahl nitrogen (TKN) and total phosphate (PO_4) concentrations were determined on unfiltered lake water. Samples for determination of NO_2, NO_3, NH_3, ortho-PO_4, total dissolved PO_4, Cl, SiO_2, Ca, Mg, Na, and K were filtered in the field through a 0.45 micron filter. During the January 1974 sampling trip, additional water samples were obtained from within 0.5 meter of the bottom using a Niskin water sampler.

In October 1973 and June 1974, samples of the benthic fauna were obtained from approximately one-half of the stations with a 6 x 6 inch Ekman dredge. The contents of the dredge were washed through a 20-mesh seive (850 micron openings) with lake water. The remaining organisms and detritus were then placed into quart jars, labeled, and preserved with a 10% formalin solution. After return to West Palm Beach these samples were again washed through a 20-mesh seive and floated in a sugar-water solution to facilitate separation of organisms from detritus. All organisms were identified and counted. In October 1973, two Ekman grabs were secured at each station sampled. The combined results were doubled to yield the number of organisms per square foot of bottom. During June 1974, four grabs totalling 1 square foot were obtained at each location.

RESULTS

WATER QUALITY

Values for the various water quality parameters have been presented as concentrations of the principle element. For instance NO_2, NO_3, NH_3, and TKN are expressed as ppm N while ortho-PO_4, total PO_4 and total dissolved PO_4 are expressed as ppm P.

In the text of this report the data for lakes East Toho, Cypress, Hatchineha, and Kissimmee are presented as the average of the four or five stations sampled in each lake. Concentrations of the various parameters measured throughout Lake Tohopekaliga varied considerably so data from selected stations have been reported.

Complete water quality data are presented in Appendix I and selected summarized data appear in Table 2 in this section.

pH

Hydrogen-ion concentrations throughout this chain of lakes were generally between pH 6.0 and 8.0. Values of pH in excess of 8.0 and as high as 9.2 were occasionally reported, usually accompanying phytoplankton blooms. The higher pH values were reported during April, June, and July, while lower values occurred in October and January. The pH values from the Shingle Creek station were consistently lower than those from Lake Tohopekaliga, ranging from 5.6 on October 3, 1973 to 7.2 in June 1974. East Lake Toho exhibited a pH value between 6.0 and 7.0 during the months of January, April, and June.

Specific Conductivity

Conductivity measurements (Table 2a) throughout the system of lakes were generally between 75 and 200 micromhos/cm. Values in excess of 200 were reported from Shingle Creek in June, July, January, and April. Average conductivities for lakes Cypress, Hatchineha, and Kissimmee were within a range of 25 units for each sampling date except July 1973. Conductivity in these lakes was lower in October and January (88-135 micromhos/cm) and higher in April, June, and July (121-171 micromhos/cm).

Nitrogen Parameters

Nitrite concentrations in the Kissimmee lakes were generally below the limits of detection (.004 parts per million or 4 ppb) but were occasionally between 5 and 7 ppb. Concentrations in excess of 10 ppb occurred mainly in Shingle Creek and the north end of Lake Toho. Only in two samples from Lake Hatchineha and one each from East Toho and Kissimmee did NO_2 values exceed 10 ppb.

Nitrate (NO_3) values from the Kissimmee lakes showed no definite patterns, either throughout the system on a given sampling date or on a seasonal basis. At times several stations or lake averages had concentrations of NO_3 that were at or near the level of detection of 4 ppb, while other lakes and stations had concentrations of 40-80 ppb. Usually, NO_3 concentrations were low in areas where field observation indicated high phytoplankton activity. In East Toho however, NO_3 concentrations were always low (4-6 ppb) and there were no observable plankton blooms. Nitrate concentrations in Shingle Creek and at the north end of Lake Toho were often considerably higher than concentrations throughout the remainder of the system and ranged as high as 198 ppb.

Ammonia concentrations in the surface water of the Kissimmee Lakes exhibited no discernible trends and ranged from below the limit of laboratory detection (10 ppb) to 80 ppb.

Total Kjeldahl nitrogen (TKN) is a measure of nitrogen combined in organic forms such as proteins and amino acids, and includes decomposition products and ammonia. TKN values (Table 2b) were generally lower in lakes Cypress, Hatchineha, and Kissimmee than they were in Lake Toho. TKN values were also lower in Shingle Creek than in Lake Toho, probably because the creek was usually flowing and less likely to have large plankton populations. East Toho exhibited lower TKN values than the other lakes during January, April, and June 1974. On a yearly basis the general trend for the four lower lakes was low TKN concentrations in October, with higher values during the warmer months. Values recorded in April from lakes Hatchineha and Kissimmee did not follow this trend.

Phosphorus Parameters

Water from the upper Kissimmee Lakes was analyzed for total phosphate, total dissolved phosphate, and ortho-phosphate. From these values, the dissolved organic and particulate phosphate fractions can be determined.

Ortho-phosphate concentrations in the waters of lakes East Toho, Cypress, Hatchineha, and Kissimmee were often near or below the limits of detection (.002 ppm or 2 ppb). Only during early October 1973, in lakes Cypress and Hatchineha, and during June 1974 in Hatchineha, were ortho-phosphate levels in excess of 10 ppb encountered. In contrast, ortho-phosphate levels in Lake Tohopekaliga were encountered below 10 ppb only at Station 15 in January 1974 and Stations 15 and 14 in June 1974. Shingle Creek was one major source of ortho-phosphate input. Concentrations recorded in Shingle Creek ranged from 140 to over 3000 ppb. The northernmost station in Lake Tohopekaliga likewise had high ortho-phosphate values, ranging from 320-760 ppb. On each date sampled ortho-phosphate concentrations decreased from north to south in Lake Tohopekaliga. This trend was continued throughout the remainder of the chain of lakes.

The same basic trend noted for ortho-phosphate concentrations was apparent for the total phosphate values also. Beginning with Shingle Creek and the north end of Lake Tohopekaliga, total phosphate values consistently decreased southward through lakes Cypress, Hatchineha, and Kissimmee. Total phosphate concentrations in Shingle Creek ranged from 428-3310 ppb, and from 600-880 ppb at the north Lake Toho station (19). Throughout the lower three lakes, total phosphate ranged from 14-127 ppb. On the dates sampled, total phosphate values for East Lake Toho were within the ranges of the lower three lakes.

On an annual basis, lakes Kissimmee, Hatchineha, Cypress, and the south end of Lake Tohopekaliga had high total phosphate concentrations in the summer and fall, and low concentrations during the winter and spring months.

Chloride and Silica

Chloride concentrations (Table 2c) throughout the system averaged about 20 ppm and ranged from 13.7 to 26.4 ppm. Chlorides in Shingle Creek ranged as high as 30.8 ppm. Seasonally, concentrations throughout the system were highest during spring and summer, and lowest in autumn and winter.

Shingle Creek was a major source of silica input into the system with concentrations ranging from 6.86 to 10.95 ppm. Silica concentrations in the remainder of the system ranged from below detection (0.40 ppm) to 4.57 ppm (Table 2d). Silica concentrations were generally highest throughout the lakes in June and July.

Major Cations

Calcium, magnesium, sodium, and potassium concentrations (Table 2e) were determined from water samples collected during each of the sampling periods. On any given date, concentrations of these cations in lakes Kissimmee, Hatchineha, Cypress, and the south end of Lake Toho were usually within a narrow range. Sodium and potassium concentrations decreased slightly through the chain of lakes from north to south.

Shingle Creek generally exhibited the highest concentrations of the cations. Calcium and sodium concentrations were often twice those of the lower lakes.

During the first year of sampling, the cation concentrations were higher in the spring and summer months and lower in the autumn and winter.

Surface and Bottom Measurements

Data from the surface and bottom sampling during January 1974 indicated that the lake waters were well mixed vertically (Appendix I). Concentrations of the various parameters in the bottom waters were not greatly different from the surface measurements.

Table 2. Summary of Selected Water Quality Data from Kissimmee River Chain of Lakes, July 1973 - June 1974

Lake [1]	July 1973	Oct. 3, 1973	Oct. 30, 1973	Jan. 1974	Apr. 1974	June 1974
	(a) Specific Conductivity - micromhos/cm					
E. Toho				102	109	129
Shingle Creek	205	120	170	215	290	310
Toho South [2]	200	140	135	99	160	210
Cypress	171	135	100	88	140	166
Hatchineha	140	110	91	90	141	146
Kissimmee	121	120	110	102	147	148
	(b) Total Kjeldahl Nitrogen TKN - ppm					
E. Toho				1.19	.65	.97
Shingle Creek	1.02	1.08	.95	1.36	.82	1.46
Toho South	1.74	1.29	1.14	1.86	2.22	2.69
Cypress	1.45	.91	.84	1.54	1.69	2.58
Hatchineha	1.46	.98	.99	1.70	.91	2.30
Kissimmee	1.09	1.06	1.07	1.44	.98	1.91
	(c) Chloride - ppm					
E. Toho				16.1	19.8	20.5
Shingle Creek	20.9	14.0	20.4	22.9	27.9	30.8
Toho South	26.4	21.1	19.4	17.6	21.4	22.1
Cypress	22.9	21.4	17.9	17.9	21.3	23.0
Hatchineha	17.4	18.4	13.7	15.5	18.4	20.0
Kissimmee	16.4	20.3	16.0	18.6	18.7	19.4
	(d) Silica - ppm					
E. Toho				.52	.65	.96
Shingle Creek	8.57	6.86	10.67	8.05	7.39	10.95
Toho South	1.68	1.19	<.40	<.40	.84	1.78
Cypress	4.57	1.02	.59	.54	.97	4.04
Hatchineha	4.30	2.46	2.96	2.55	.94	3.06
Kissimmee	2.96	3.12	2.92	2.30	1.62	2.53

(e) Major Cations - Range in Concentrations - ppm

	Ca	Mg	Na	K
E. Toho	2.9-5.4	2.7-3.1	11.4-13.0	1.6-1.8
Shingle Creek	10.2-20.0	3.5-5.4	8.3-39.0	2.1-4.0
Toho South	5.3-9.5	3.3-4.4	13.1-20.0	2.0-2.4
Cypress	3.9-8.0	3.0-4.2	11.6-17.3	1.4-2.5
Hatchineha	6.3-8.6	3.3-4.2	8.8-12.7	0.75-1.6
Kissimmee	5.3-8.0	3.1-3.8	10.8-13.4	0.9-1.4

[1] Values for lakes East Toho, Cypress, Hatchineha, and Kissimmee are the average of all stations sampled in each lake.

[2] Toho South values are for Station No. 14 only.

Water temperatures usually differed from less than 1 to 3^{o} C between surface and bottom waters. Temperature differences were least in the early morning, then increased as the sun warmed the surface waters later in the day. Dissolved oxygen concentrations usually differed less than 1 ppm between the surface and bottom waters. Measurements of pH were usually 0.3 to 0.4 units higher at the surface than at the bottom.

Conductivities varied only slightly through the water column from top to bottom. At 15 of 24 stations the conductivity remained constant or varied only one unit between the surface and the bottom. At the remaining stations conductivity increased toward the bottom. The maximum difference between surface and bottom conductivities was 15 micromhos/cm, recorded at Station 19.

Values for nitrogen and phosphorus constituents were often identical on the surface and at the bottom of the water column, or differed only slightly. Occasionally TKN or total PO_4 concentrations were higher at the bottom of the water column than at the top.

Similarities in the data for the major ions also support the contention the lake waters were well mixed.

BENTHIC INVERTEBRATE FAUNA

Lake Configurations and Bottom Types

A brief description of the various lake contours is provided to familiarize the reader with the general benthic habitats in the Kissimmee Basin. Maps and contours were obtained from the U.S. Army Corps of Engineers.

East Lake Tohopekaliga has a uniform basin shape which slopes from about 58 feet at the shoreline to a minimum elevation of about 40 feet msl.

One sample obtained from near the center of the lake (Station 24) (Figure 1) revealed the bottom sediments composed of at least 8 inches of fine silt. In

Fells Cove (Station 23), the bottom consisted of one inch of loose silt over a more compacted silt-like substance.

Lake Tohopekaliga has a far more irregularly contoured bottom than East Tohopekaliga and consists of three basins aligned in a north to south direction. The lake depth averages from about 7 to 8 feet, but during high water stage, the deepest portion is about 12 feet deep. Benthic samples were secured in October 1973 and June 1974 at Stations 19, 16, and 14. The bottom sediments at Stations 19 and 14 consisted of mud and silt, while Station 16 consisted of mud and detritus mixed with sand.

Lake Cypress is a simple saucer-shaped basin which slopes very gradually toward the center. The deepest portion of the lake lies at 42 feet msl and is about 10.5 feet deep during high lake stages. Sediment from Station 11 near the center of the lake contained mud, silt, and sand. The bottom at Station 13, near the mouth of C-35, was mainly composed of sand and some silt.

Lake Hatchineha has an elongated trough-like basin and is oriented in a northwest to southeast direction. The basin slopes from a shoreline elevation of 52.5 feet msl to 41 feet msl at the bottom. The eastern extension of the lake is generally more shallow with most of the bottom lying at elevation 45 feet msl or above. Station 1 on the western side of the lake had a bottom composed of mud, silt, sand, and detritus. Bottom sediments from Station 9 in the shallow east portion of the lake were composed of sand and silt.

Bottom contours in Lake Kissimmee are extremely irregular. There are four islands in the lake, surrounded by varying expanses of shallow water, and two deeper portions where water depth may reach 19 feet during the high stage. At Stations 3 and 5 the bottom sediments were composed mainly of sand. At Station 4, the bottom was composed primarily of mud and silt.

Benthic Invertebrate Species Composition and Density

Eighteen species of invertebrates were recovered from the benthic sampling in the Upper Kissimmee Chain of Lakes during October 1973 and June 1974. Members from the phylum Annelida were only identified to class (i.e. Oligochaeta, Hirudinea) whereas all other organisms from the phylum Mollusca and Arthropoda were identified to genus, and in many cases, to species.

Tables 3 - 7 present the number of each organisms recovered per square foot of benthic substrate at each station. Table 8 summarizes the species composition of lakes Toho, Cypress, Hatchineha, and Kissimmee based on two samplings. The species composition of the four lakes was similar. Eleven of the eighteen species recovered were present in all of the lakes.

Table 3. Benthic Composition of Lake Tohopekaliga (# organisms/ft^2)

Species	Station / Date	19: 10-73	19: 6-74	16: 10-73	16: 6-74	14: 10-73	14: 6-74
ANNELIDA							
Oligochaeta		20	8	170	21	20	12
Hirudinea		6	3	14	54		1
AMPHIPODA							
Hyalellidae							
Amphitoe aztecus					7		1
PELECYPODA							
Corbiculidae							
Corbicula leana		2	5	4	1		
Unionidae							
Elliptio sp.				8	3	2	2
GASTROPODA							
Viviparidae							
Viviparus sp.		4	2		3		
DIPTERA							
Chironomidae							
Glyptotendipes paripes			128	332	2217		3
Pentaneurini sp.		8	7	38	34	20	12
Procladius sp.			3	6	28		
Culicidae							
Chaoborus punctipennis			1				2
Ceratopogonidae							
Culicoides sp.				4	2		
HEMIPTERA							
Corixidae							
Trichocorixa sp.				2			

Table 4. Benthic composition of Lake Cypress (# organisms/ft^2)

Species	Station	13		11	
	Date	10-73	6-74	10-73	6-74
ANNELIDA					
Oligochaeta		168	22	74	19
Hirudinea		4	18	28	2
AMPHIPODA					
Hyalellidae					
Amphitoe aztecus			1		
PELECYPODA					
Corbiculidae					
Corbicula leana		2	11		2
Unionidae					
Elliptio sp.		4	1		1
GASTROPODA					
Viviparidae					
Viviparus sp.		8			6
DIPTERA					
Chironomidae					
Glyptotendipes paripes		28	19	88	
Chironomus (Cryptochironomus) sp.		2	2		
Pentaneurini sp.		2		36	2
Procladius sp.		2	1		
Culicidae					
Chaoborus punctipennis			1		
Ceratopogonidae					
Culicoides sp.			2		
EPHEMEROPTERA					
Ephemeridae					
Hexagenia limnophila			3		

Table 5. Benthic composition of Lake Hatchineha (# organisms/ft^2)

Species	Station 9 Date 10-73	9 6-74	1 10-73	1 6-74
ANNELIDA				
Oligochaeta		30	12	5
Hirudinea	2	43	2	1
AMPHIPODA				
Hyalellidae				
Amphitoe aztecus	8	45		11
PELECYPODA				
Corbiculidae				
Corbicula leana			2	
Unionidae				
Elliptio sp.	2			
GASTROPODA				
Viviparidae				
Viviparus sp.	2	2		2
DIPTERA				
Chironomidae				
Glyptotendipes paripes	6	5		15
Pentaneurini sp.		12	6	2
Procladius sp.	4			
Culicidae				
Chaoborus punctipennis	2	1		10
Ceratopogonidae				
Culicoides sp.		13		5
EPHEMEROPTERA				
Ephemeridae				
Hexagenia limnophila		61		18
Caenidae				
Caenis diminuta		1	2	

Table 6. Benthic composition of Lake Kissimmee (# organisms/ft^2)

Species	Station	3		4		5	
	Date	10-73	6-74	10-73	6-74	10-73	6-74
ANNELIDA							
Oligochaeta		6	69	10	4	40	167
Hirudinea		8	13	4	5		5
AMPHIPODA							
Hyalellidae							
Amphitoe aztecus			16			2	
PELECYPODA							
Corbiculidae							
Corbicula leana		12	34				
Unionidae							
Elliptio sp.			3				2
GASTROPODA							
Viviparidae							
Viviparus sp.			3			2	
COLEOPTERA							
Dytiscidae							
Hydrovatus striatus							2
DIPTERA							
Chironomidae							
Glyptotendipes paripes		18	28				2
Pentaneurini sp.		8	1	14	14	14	
Procladius sp.		4					
Tanytarsus sp.			3				
Culicidae							
Chaoborus punctipennis		2	10	22	14	12	12
Ceratopogonidae							
Culicoides sp.			1				
EPHEMEROPTERA							
Ephemeridae							
Hexagenia limnophila		6	6				
Caenidae							
Caenis diminuta			1				
TRICOPTERA							
Psychomyiidae							
Lype sp.			1				

Table 7. Benthic composition of East Lake Tohopekaliga (# organisms/ft^2)

	Station 24	23
Species	Date 6-74	6-74
ANNELIDA		
Oligochaeta		
Hirudinea	2	3
PELECYPODA		
Corbiculidae		
Corbicula leana	11	6
DIPTERA		
Chironomidae		
Glyptotendipes paripes	1	
Culicidae		
Chaoborus punctipennis		3
Ceratopogonidae		
Culicoides sp.		1
EPHEMEROPTERA		
Ephemeridae		
Hexagenia limnophila		13

Table 8. Presence of species in each lake during October 1973 and/or June 1974 sampling

Species	Lake Tohopekaliga	Lake Cypress	Lake Hatchineha	Lake Kissimmee
ANNELIDA				
Oligochaeta	X	X	X	X
Hirudinea	X	X	X	X
AMPHIPODA				
Hyalellidae				
Amphitoe aztecus	X	X	X	X
PELECYPODA				
Corbiculidae				
Corbicula leana	X	X	X	X
Unionidae				
Elliptio sp.	X	X	X	X
GASTROPODA				
Viviparidae				
Viviparus sp.	X	X	X	X
COLEOPTERA				
Dytiscidae				
Hydrovatus striatus				X
DIPTERA				
Chironomidae				
Glyptotendipes paripes	X	X	X	X
Chironomus (Cryptochironomus) sp.		X		
Pentaneurini sp.	X	X	X	X
Procladius sp.	X	X	X	X
Tanytarsus sp.				X
Culicidae				
Chaoborus punctipennis	X	X	X	X
Ceratopogonidae				
Culicoides sp.	X	X	X	X
EPHEMEROPTERA				
Ephemeridae				
Hexagenia limnophila		X	X	X
Caenidae				
Caenis diminuta			X	X
HEMIPTERA				
Corixidae				
Trichocorixa sp.	X			
TRICOPTERA				
Psychomyiidae				
Lype sp.				X

DISCUSSION

Visual observations and Hydrolab$^{T.M.}$ measurements made throughout the sampling period characterize the physical nature of the surface waters throughout the chain of lakes. Most of the lakes were noted as having darkly colored waters. Occasionally Secchi disc measurements were low, often less than 50 cm. Wegener and Holcomb (1972) reported an increase in turbidity measurements in Lake Tohopekaliga due to windy conditions and influxes of tannic substances following peak rainfall.

Hydrogen ion concentrations were generally below pH 7.0 in October and January throughout the basin, and in Shingle Creek throughout the year. The acidic character of the water was lost during the warmer months of the year. This could have been due to an increase in photosynthesis by phytoplankton which removed CO_2 from the water.

Hydrolab profiles of dissolved oxygen and temperature showed very little variation through the water column at any time of the year (except during isolated plankton blooms). This indicated that lake waters were holomictic (well mixed and not subject to stratification).

Water quality data indicated that two areas contributed high concentrations of nitrogen and phosphorus compounds as well as some cations and other substances to the surface waters of the basin. Shingle Creek, which drains the area southwest of Orlando, contained high concentrations of several nitrogen and phosphorus compounds. Nitrate values were observed as high as 198 ppb. Ortho-phosphate and total phosphate concentrations were observed in excess of 3300 ppb. Water flowing into the north end of Lake Tohopekaliga is also a likely source of nutrient loading. In some instances throughout the study, concentrations of nitrate, nitrite, ortho-phosphate, and total phosphate were higher in the north end of the lake than in Shingle Creek. Wegener and Holcomb (1972) isolated three sources of nutrient laden water entering Lake Tohopekaliga north of Shingle Creek. In addition, concentrations of Ca, Mg, Na, K, and SiO_2 in Shingle Creek and the north end of Lake Toho generally exceeded all other values obtained throughout the system of lakes on a given date. In contrast, water quality from the stations adjacent to Canoe Creek (C-34) in Lake Cypress, Reedy Creek (Dead River) in Lake Hatchineha, and Tiger Creek in Lake Kissimmee did not indicate that these were major sources of enrichment to their receiving bodies.

Some of the chemical parameters indicated distinct spatial trends throughout the chain of lakes on a given date. Seasonal or annual trends were likewise apparent.

Phosphorus is an essential element in the growth of plants and animals and is found in water almost exclusively in the fully oxidized states, as various forms of phosphate. The concentrations of both ortho-phosphate and total phosphate declined from north to south through the chain of lakes from Shingle Creek through lakes Tohopekaliga, Cypress, Hatchineha, and Kissimmee (Figures 2 and 3). For each date sampled, there was a rapid initial decline in concentrations from north to south within Lake Toho and a more gradual decline through the remaining lakes. This phosphorus may be utilized by phytoplankton and/or macrophytic plants in Lake Toho at a very rapid rate. Concentrations of phosphorus can be related to actual quantities once a detailed water budget has been prepared. These results, when coupled with further chemical and biological studies would aid in determining more exactly the pathways of phosphorus throughout Lake Toho and the remainder of the Kissimmee Basin. On a seasonal basis total phosphate concentrations were highest in the wet season months and lowest in the dry season. The relationship between phosphate concentrations and rainfall becomes apparent when the values from October 3, 1973 are compared with those from October 30, 1973 (Figure 2 and Table 9). In the 14 days preceding the October 3 sample, the town of Kissimmee recorded 5.6 inches of rainfall. In contrast only 0.34

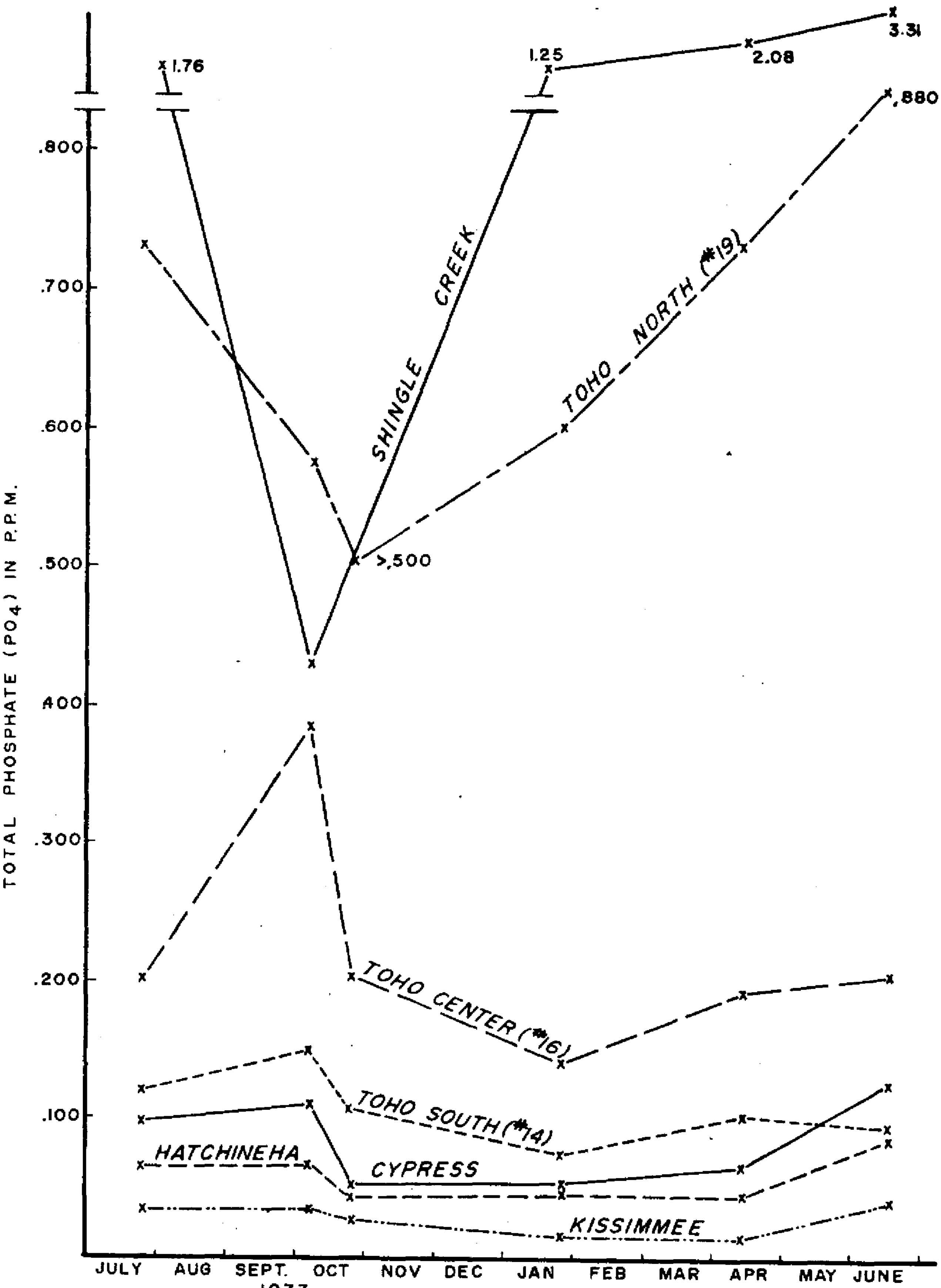

FIGURE 2 TOTAL PHOSPHATE CONCENTRATIONS THROUGH OUT THE KISSIMMEE LAKES

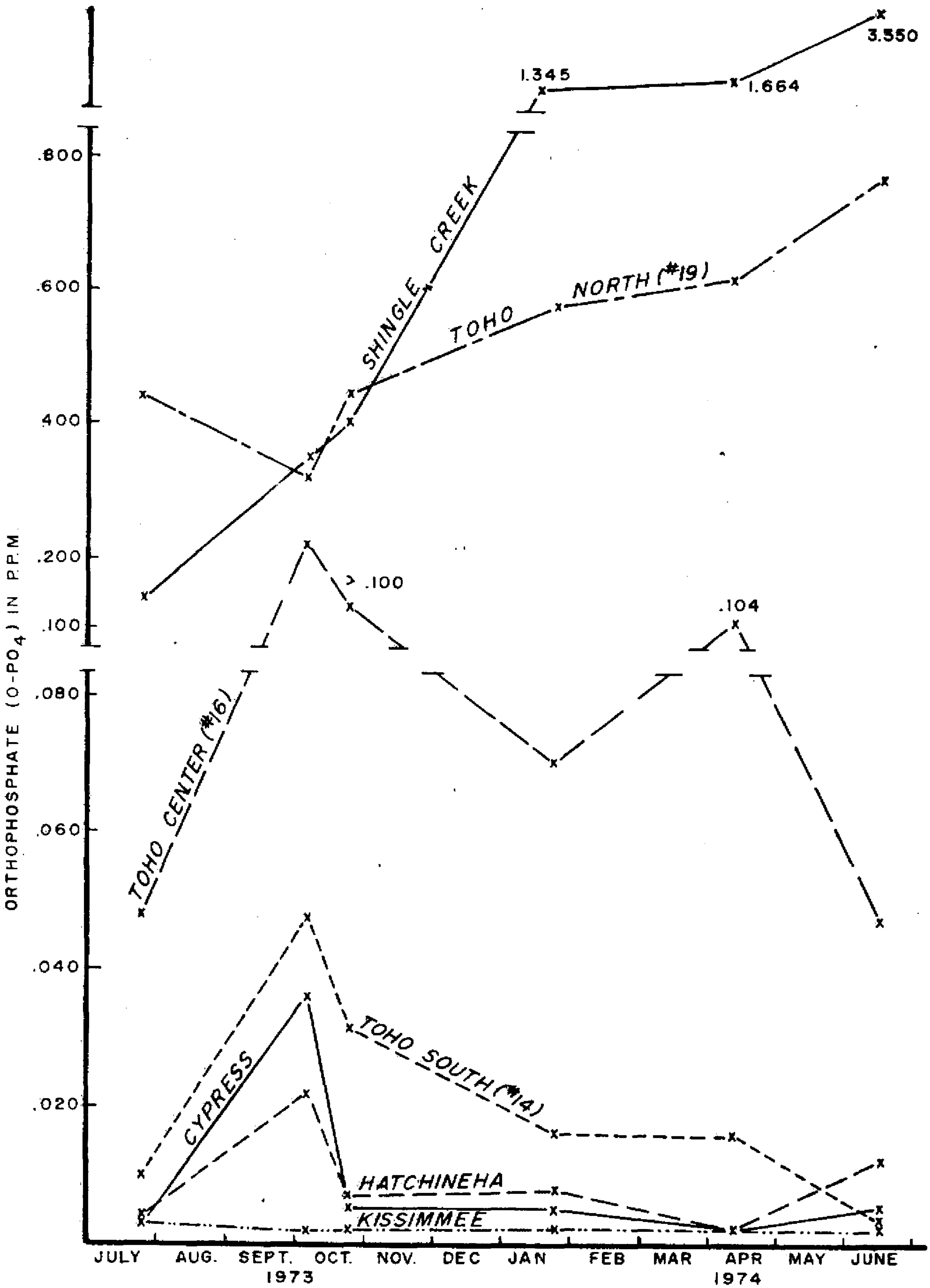

FIGURE 3 ORTHOPHOSPHATE CONCENTRATIONS THROUGH OUT THE KISSIMMEE LAKES

Table 9. Total Phosphate Concentrations in ppm Throughout the Kissimmee Basin Lakes, October 2-3, 1973 and October 29-31, 1973.

Lake	October 2 - 3, 1973	October 29 - 31, 1973
Toho North (19)	0.572	>0.500
Toho Center (16)	0.381	0.202
Toho South (14)	0.140	0.107
Cypress (Average)	0.110	0.050
Hatchineha (Average)	0.067	0.040
Kissimmee (Average)	0.036	0.027

inches of rainfall were recorded for the 14 days prior to the October 30 sample. Total phosphate concentrations in the lake waters of the basin were considerably higher in the beginning of October than at the end of the month. This could have been due to surface runoff or increased groundwater movement into the basin carrying higher amounts of phosphorus from the surrounding land.

Trends for the various nitrogen compounds were less consistent than for phosphorus compounds. Nitrates and nitrites were usually greater in Shingle Creek and the north end of Toho than in the rest of the lake. No other trends were apparent throughout the remainder of the basin. Nitrate, nitrite, and ammonia are all component forms of the nitrogen cycle and are therefore dependent on complex biological relationships. For example, high NO_3 concentrations in the water may be the result of surface runoff, sewage treatment plant discharge, or biological decomposition. Low NO_3 concentrations are often evidence that all available nitrate has been utilized by biological activity. To be fully meaningful, nitrate and other forms of nitrogen concentrations in lake water must be considered with reference to phytoplankton population dynamics and other biological processes.

Two of the cations, Na and K generally decreased in concentration in the lake waters from north to south. This response indicated that the major loading occurred in Shingle Creek and the north end of Lake Toho. As the water flowed southward through the chain of lakes, concentrations decreased as these elements were either utilized biologically or chemically, or diluted.

Water quality data were obtained from Lake Okeechobee from June 1973 to May 1974 (Davis and Marshall, 1975) and for Lake Istokpoga in Highlands County from August 1973 to September 1974 (Milleson, 1975). Lake average values from these lakes were compared with data from the Kissimmee Basin lakes during a comparable time period. In Table 10, lakes Cypress, Hatchineha, and Kissimmee

Table 10: Water Quality Data from Selected Florida Lakes - Range of Concentrations in ppm

	NO2	NO_3	TKN	o-PO_4	T-PO_4
Kissimmee Basin[1]	<.004-.010	<.004-.068	.84-2.58	.002-.036	.014-.127
Toho North	<.004-.019	<.004-.139	.91-2.50	.320-.760	.572-.880
Toho South[1]	<.004-.006	<.004-.076	1.14-2.69	.003-.049	.074-.140
Lake Okeechobee[2]	.004-.010	.008-.152	1.23-2.23	.002-.008	.027-.397
Lake Istokpoga[3]	<.004-.005	<.004-.051	.70-1.28	<.002-.029	.036-.056

	Ca	Mg	Na	K	Cl
Kissimmee Basin	3.9-8.6	3.0-4.2	8.8-17.3	0.7-2.5	13.7-23.0
Toho North	11.2-15.6	3.2-4.4	9.0-20.0	2.5-3.7	13.6-26.4
Toho South	5.3-9.5	3.3-4.4	13.1-20.0	2.0-2.4	17.6-26.4
Lake Okeechobee	37.9-56.9	13.8-19.3	51.5-60.6	3.8-5.9	73.6-98.3
Lake Istokpoga	3.2-6.8	2.2-4.0	6.2-10.2	1.2-1.8	10.5-16.2

1. Values from July 1973 - June 1974
2. Values from June 1973 - May 1974
3. Values from August 1973 - September 1974

have been grouped together under the heading Kissimmee Basin. East Lake Tohopekaliga was not considered because a full year's data was not available. The variations in chemical concentrations which have been observed in Lake Tohopekaliga have necessitated a separate listing of some individual stations. Chemical concentrations were generally highest in the north end of Lake Toho (Station 19) and lowest in the south end (Station 14).

Concentrations of nitrate and total phosphate in the Kissimmee Basin generally exceeded those of Lake Istokpoga, but were lower than concentrations found in Lake Okeechobee. Nitrite concentrations in all of the lakes were similar. Lake Okeechobee had the lowest ortho-phosphate concentrations, whereas the Kissimmee Basin lakes contained the highest levels. Major cation and anion (Ca, Mg, Na, K, and Cl) concentrations were lowest in Lake Istokpoga. Lake Okeechobee had considerably higher levels of Ca, Mg, Na and Cl than the Kissimmee lakes.

Lake Tohopekaliga has been treated under two separate listings because of the extreme differences in concentrations found between the north and south ends of the lake. Concentrations of nitrate, ortho-phosphate, total phosphate, major cations, and chloride in the southern portion of Lake Toho were only slightly in excess of values throughout the remainder of the Kissimmee Basin. Of the major cations only calcium had considerably higher concentrations in the north Toho station than the rest of the basin. The highest concentrations of nitrate in north Toho were nearly double those in the remainder of the Kissimmee basin, and was nearly as high as in Lake Okeechobee. Ortho-phosphate and total phosphate concentrations in the north end of Lake Toho were the highest of all lakes considered.

The cursory sampling schedule for the invertebrate fauna of the lake bottoms obviously did not represent all of the different benthic habitats (water depths, sediment types). Complete representation of the entire benthic fauna is unlikely, and changes in species types or numbers due to seasonal variation were not well represented. Despite this, it generally appeared that the species composition of the benthic fauna of lakes Tohopekaliga, Cypress, Hatchineha, and Kissimmee was similar.

For comparison, benthic invertebrate data were obtained from Lake Tohopekaliga (Wegner and Holcomb, 1972). A total of 131 samples of the benthic fauna were obtained from the limnetic portion of the lake between 1969 and 1971. The species list provided by Wegener and Holcomb included several additional species not found in our samples. This was probably due to the large number of samples taken and the variety of substrate types sampled. These additional species were primarily members of the Orders Ephemeroptera, Odonata, Tricoptera and Coleoptera.

The major difference noted between the Wegener and Holcomb benthic samples and those reported in this paper for Lake Tohopekaliga was the presence of the Asiatic clam, *Corbicula leana*. No *Corbioula leana* were reported as of 1972 whereas 12 individuals were collected from six samples in October 1973 and June 1974. A later publication (Wegener and Williams, 1974) reported the collection of Corbiculidae individuals from limnetic Ekman samples in December 1974.

CONCLUSIONS

1. Water from the five major Kissimmee Basin Lakes was well mixed during all sampling periods and was not subject to any prolonged stratification.
2. Shingle Creek, which drains the area southwest of Orlando, Florida, and the station in the north end of Lake Tohopekaliga, consistently had the highest concentrations of nitrogen and phosphorus compounds, some major cations, chloride, and silica. Nitrate concentrations ranged as high as 198 ppb as N, and total phosphate concentrations were recorded in excess of 3300 ppb as P. Based on these sampling results, Shingle Creek and tributaries

flowing into the north end of Lake Tohopekaliga were the major sources of nutrient enrichment in the chain of lakes.

3. Concentrations of ortho-phosphate and total phosphate in the north end of Lake Tohopekaliga and Shingle Creek were usually ten or more times greater than concentrations in the south end of Lake Tohopekaliga on the same date. A more gradual decline in phosphate concentrations from north to south throughout the remainder of the lakes was evidenced from the sampling results.
4. On an annual basis, phosphate concentrations in the surface waters of the system were higher in the wet season months (July 1973, early October 1973, and June 1974) and lower in the dry season (late October 1973, January 1974, and March 1974).
5. Concentrations of nitrate and nitrite were usually higher in Shingle Creek and north Lake Toho than in the remainder of the lake. No other trends for nitrogen compounds throughout the basin were apparent.
6. Sodium and potassium concentrations in the surface water decreased from north to south in the lower four lakes of the chain. Concentrations of calcium, magnesium, chloride, and silica were more variable throughout the basin.
7. The overall water quality in East Lake Tohopekaliga was similar to that of lakes Cypress, Hatchineha, and Kissimmee. Nutrient concentrations in the Kissimmee Basin lakes were generally higher than levels in Lake Istokpoga (Highlands County) and lower than concentrations in Lake Okeechobee. Major cation (Ca, Mg, Na, K) and chloride concentrations were likewise lower in Lake Istokpoga and higher in Lake Okeechobee when compared to the Kissimmee lakes.
8. Further analysis of the changes in chemical composition of surface water in the Kissimmee Lakes will require investigation of additional factors such as

rainfall, dilutions, tributary stream flows, water flow patterns, and comprehensive phytoplankton population studies to determine actual loadings and nutrient cycles in detail.

9. The benthic invertebrate composition in the limnetic portions of lakes Tohopekaliga, Cypress, Hatchineha, and Kissimmee was similar. From a total of eighteen different species collected from these lakes, eleven were common to all lakes.

10. A comparison of the benthic invertebrate data with samples collected from 1969 to 1971 in Lake Tohopekaliga indicates that the Asiatic clam, *Corbicula leana*, has recently become established in the benthic community.

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APPENDIX I

Kissimmee Basin Lakes Water Quality Data

July 1973 - June 1974

All results in mg/l except when noted and
specific conductivity (Cond.Field) which is mhos/cm

0 indicates data missing

- indicates results less than
quoted limit of sensitivity

* KISSIMMEE LAKE BASIN - P32 *

RETRIEVAL DATE 06/19/75

JULY 24-25 1973 SURFACE

STATION NUMBER	TEMP DG-C	D.O. MG/L	PH FIELD	COND FIELD	SECCHI CM	NO2-N MG/L	NO3-N MG/L	NH3-N MG/L	TKN MG/L
L- 18	27.50	5.3	6.30	205.	0	-0.004	.038	.030	1.02
L- 19	29.50	5.8	6.90	185.	0	-0.004	-0.004	-0.010	1.55
L- 17	32.00	7.8	7.40	160.	0	.006	-0.002	-0.010	1.22
L- 16	31.00	10.6	8.70	180.	0	-0.004	.009	-0.010	1.83
L- 15	31.00	12.8	9.00	190.	0	-0.004	.005	-0.010	1.89
L- 14	32.50	14.6	9.20	200.	0	-0.004	-0.004	-0.010	1.74
L- 13	32.00	9.4	8.00	200.	0	-0.004	-0.004	-0.010	1.37
L- 12	31.50	9.5	8.00	160.	0	-0.004	-0.004	-0.010	1.48
L- 11	31.50	8.7	8.10	160.	0	-0.004	-0.004	-0.010	1.55
L- 10	31.50	10.3	8.60	165.	0	-0.004	-0.004	-0.010	1.40
L- 8	31.80	7.1	6.10	140.	0	-0.004	-0.004	.040	1.70
L- 9	30.50	8.3	7.60	140.	0	-0.004	-0.004	.030	1.46
L- 1	30.00	8.3	7.30	140.	0	-0.004	-0.004	-0.010	1.54
L- 2	30.00	7.3	6.50	140.	0	-0.004	-0.004	-0.010	1.14
L- 3	30.50	8.7	8.50	130.	0	-0.004	-0.004	.030	.25
L- 6	30.00	8.7	8.25	130.	0	-0.004	-0.004	.030	1.53
L- 7	30.00	6.3	5.30	65.	0	-0.004	-0.004	.030	.83
L- 4	29.00	8.6	7.90	140.	0	-0.004	-0.004	.020	1.48
L- 5	29.20	8.6	7.70	140.	0	-0.004	-0.004	-0.010	1.36

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* KISSIMMEE LAKE BASIN - P32 *
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RETRIEVAL DATE 06/19/75

JULY 24-25 1973 SURFACE

STATION NUMBER	OR-P MG/L	T-P MG/L	TD-P MG/L	CA TIT	MG H-CA	NA A.A.	K MG/L	CL MG/L	SIO2 MG/L
L- 18	.140	1.760	0	16.7	4.3	20.4	3.30	20.9	8.6
L- 19	.440	.730	0	14.6	4.4	0	2.46	20.0	4.1
L- 17	.124	.300	0	9.0	3.8	17.4	1.82	22.8	1.2
L- 16	.048	.200	0	10.1	4.3	19.1	2.27	25.4	1.7
L- 15	.012	.155	0	9.5	4.4	19.9	2.41	26.1	1.5
L- 14	.019	.120	0	9.5	4.4	20.0	2.37	26.4	1.7
L- 13	.002	.100	0	11.6	5.1	19.8	2.61	24.5	2.6
L- 12	.005	.100	0	6.7	3.9	17.6	2.07	22.6	5.2
L- 11	.003	.100	0	6.7	3.9	17.9	3.17	22.4	4.8
L- 10	.004	.090	0	7.0	3.9	14.0	2.15	22.1	5.7
L- 8	-0.002	.050	0	9.2	3.7	12.8	.95	17.6	5.2
L- 9	.002	.090	0	7.0	4.0	13.0	1.54	19.3	3.6
L- 1	.019	.050	0	10.3	4.7	12.0	1.33	15.6	4.8
L- 2	.002	.070	0	7.7	4.3	13.0	1.48	17.0	3.6
L- 3	-0.002	.050	0	6.8	3.5	13.3	1.22	17.0	2.5
L- 6	.007	.030	0	8.1	3.7	14.0	1.24	17.2	3.5
L- 7	.003	.030	0	4.2	3.0	10.0	.75	12.3	2.3
L- 4	-0.002	.040	0	7.9	3.8	14.5	1.40	17.6	3.3
L- 5	-0.002	.030	0	8.4	3.8	15.0	1.49	17.9	3.1

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* KISSIMMEE LAKE BASIN - P32 *
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RETRIEVAL DATE 06/30/75

OCTOBER 2-3 1973 SURFACE

STATION NUMBER	TEMP DG-C	D.O. MG/L	PH FIELD	COND FIELD	SECCHI CM	NO2-N MG/L	NO3-N MG/L	NH3-N MG/L	TKN MG/L
********	********	********	********	********	********	********	********	********	********
L- 18	24.80	2.5	5.60	120.	0	.011	.021	.044	1.08
L- 19	27.00	5.1	6.00	135.	0	.012	.068	.073	1.00
L- 16	28.00	6.1	6.15	110.	0	.005	.039	.021	1.05
L- 14	27.50	7.3	6.50	140.	0	-0.004	.017	-0.010	1.29
L- 13	27.50	6.9	6.40	140.	0	-0.004	.018	-0.010	1.04
L- 11	27.90	7.7	6.50	130.	0	-0.004	.017	-0.010	.78
L- 9	27.70	7.5	6.40	140.	0	-0.004	.018	-0.010	.96
L- 1	27.80	6.1	5.90	81.	53.	.007	.046	.055	1.01
L- 3	30.00	8.0	6.90	120.	0	-0.004	.021	-0.010	1.10
L- 4	28.00	8.4	7.70	125.	0	.005	0	.015	1.10
L- 5	27.50	7.3	6.60	115.	0	.005	0	-0.010	.97

STATION NUMBER	OR-P MG/L	T-P MG/L	TD-P MG/L	CA TIT	MG H-CA	NA A.A.	K MG/L	CL MG/L	SIO2 MG/L
********	********	********	********	********	********	********	********	********	********
L- 18	.344	.428	0	10.2	3.5	8.3	2.10	14.0	6.9
L- 19	.320	.572	0	11.2	3.2	9.0	2.55	13.6	2.0
L- 16	.220	.381	0	6.6	3.5	11.7	2.04	19.1	3.3
L- 14	.049	.140	0	5.3	4.0	13.7	2.02	21.1	1.2
L- 13	.057	.121	0	4.8	3.8	14.2	2.12	21.7	1.1
L- 11	.014	.099	0	3.9	3.5	13.3	1.75	21.1	.9
L- 9	.040	.093	0	6.4	4.0	13.1	1.87	21.1	1.0
L- 1	.004	.041	0	6.6	3.8	7.3	.95	15.8	3.9
L- 3	-0.002	.057	0	5.0	38.0	11.5	1.46	20.1	2.3
L- 4	-0.002	.025	0	5.1	3.5	11.5	1.20	20.7	3.5
L- 5	-0.002	.026	0	5.7	3.8	11.1	1.17	20.1	3.5

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* KISSIMMEE LAKE BASIN - P32 *
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RETRIEVAL DATE 06/19/75

OCTOBER 29-31 1973 SURFACE

STATION NUMBER	TEMP DG-C	D.O. MG/L	PH FIELD	COND FIELD	SECCHI CM	NO2-N MG/L	NO3-N MG/L	NH3-N MG/L	TKN MG/L
L- 18	20.40	6.6	6.15	170.	0	.010	.019	-0.015	.95
L- 19	21.70	7.6	6.50	150.	0	.019	.139	.025	.91
L- 17	21.50	7.9	6.50	140.	0	.008	.071	-0.010	1.01
L- 16	21.50	8.6	6.75	135.	0	.004	-0.004	-0.010	.62
L- 15	21.00	8.4	6.70	135.	0	-0.004	-0.004	-0.010	.94
L- 14	21.40	8.4	6.60	135.	0	-0.004	.057	-0.010	1.14
L- 13	22.00	8.6	6.55	110.	0	.004	.012	-0.010	.75
L- 12	21.50	9.1	6.40	89.	0	.004	.004	-0.010	.88
L- 11	21.70	9.2	7.10	110.	0	.005	.028	-0.010	.88
L- 10	22.00	8.3	6.00	91.	0	.006	.013	.045	.85
L- 8	20.50	6.7	6.00	87.	0	.011	.052	.026	.92
L- 9	21.00	7.4	6.20	92.	0	.014	.089	.016	.87
L- 1	20.80	7.8	6.55	86.	0	.007	.074	-0.010	.89
L- 2	22.00	6.4	5.95	98.	0	.006	.046	.021	1.30
L- 3	23.70	7.9	6.35	110.	0	.005	.011	-0.010	.72
L- 6	23.00	8.7	6.80	80.	0	-0.004	-0.004	-0.010	1.55
L- 7	23.50	8.1	6.60	115.	0	.004	-0.004	-0.010	1.17
L- 4	23.30	8.6	7.30	120.	0	-0.004	-0.004	-0.010	1.04
L- 5	23.50	8.3	6.65	125.	0	-0.004	-0.004	-0.010	.85

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* KISSIMMEE LAKE BASIN - P32 *
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RETRIEVAL DATE 06/19/75

OCTOBER 29-31 1973 SURFACE

STATION NUMBER	OR-P MG/L	T-P MG/L	TD-P MG/L	CA TIT	MG H-CA	NA A.A.	K MG/L	CL MG/L	SIO2 MG/L
L- 18	.400	>0.500	>0.500	12.6	3.7	14.1	2.74	20.4	10.7
L- 19	.440	>0.500	>0.500	11.4	3.2	11.0	2.99	16.8	6.5
L- 17	.256	.360	.342	8.5	3.1	11.5	2.52	17.4	3.1
L- 16	>0.100	.202	.199	6.6	3.0	11.5	2.33	18.0	.7
L- 15	.031	.077	.060	5.7	3.5	13.4	2.35	19.4	-0.4
L- 14	.031	.107	.056	5.7	3.3	13.1	2.36	19.4	-0.4
L- 13	.003	.044	.022	4.1	3.0	11.7	1.77	18.4	.4
L- 12	.003	.047	.023	3.7	2.8	11.6	1.68	18.4	.4
L- 11	.005	.051	.032	4.1	3.1	11.8	1.74	18.0	.3
L- 10	.009	.057	.031	4.0	3.1	11.1	1.60	16.8	1.2
L- 8	.010	.040	.027	6.9	2.9	8.8	.80	14.4	4.4
L- 9	.009	.059	.028	7.3	3.4	9.0	1.13	14.0	2.9
L- 1	.006	.036	.029	7.3	3.5	7.5	1.14	11.9	2.5
L- 2	.004	.028	.020	5.8	3.4	9.9	1.37	14.4	2.1
L- 3	.002	.037	.012	5.4	3.4	10.7	1.48	15.4	2.0
L- 6	-0.002	.019	.003	6.5	3.0	10.9	1.32	16.4	3.6
L- 7	-0.002	.020	.014	5.1	3.0	10.3	1.37	15.4	2.3
L- 4	-0.002	.036	.007	6.0	3.0	11.1	1.42	16.4	3.1
L- 5	-0.002	.023	.005	6.7	3.1	11.1	1.34	16.4	3.6

* KISSIMMEE LAKE BASIN - P32 *

RETRIEVAL DATE 06/29/75

JANUARY 22-23 1974 TOP AND BOTTOM

STATION NUMBER	TEMP DG-C	D.O. MG/L	PH FIELD	COND FIELD	SECCHI CM	NO2-N MG/L	NO3-N MG/L	NH3-N MG/L	TKN MG/L
L- 22	22.50	7.5	6.50	94.	147.	-0.004	-0.004	.030	.97
L- 22	[illegible]	6.3	6.30	[illegible]	0	-0.004	-0.004	-0.010	1.23
L- 23	23.00	7.6	6.10	94.	56.	.011	.014	-0.010	1.62
L- 23	21.20	7.0	5.90	95.	0	.011	.014	.030	3.26
L- 24	25.10	8.6	7.20	97.	170.	.005	-0.004	-0.010	1.18
L- 24	21.00	7.5	6.40	97.	0	.009	-0.004	-0.010	1.80
L- 25	24.50	8.7	6.80	96.	157.	.007	-0.004	.020	.93
L- 25	22.00	7.4	6.40	96.	0	.008	-0.004	.030	1.01
L- 21	22.20	7.8	6.70	130.	142.	-0.004	-0.004	.010	1.27
L- 21	21.40	7.3	6.40	130.	0	-0.004	-0.004	-0.010	1.28
L- 18	20.60	6.1	6.80	215.	74.	.006	.198	.060	1.36
L- 18	20.50	6.1	6.70	215.	0	.007	.190	.060	1.40
L- 19	22.00	7.5	7.00	145.	81.	.013	.090	.060	1.82
L- 19	21.20	5.7	6.75	160.	0	.008	.117	.080	2.81
L- 17	22.00	7.4	6.90	91.	94.	.005	.008	.060	1.63
L- 17	21.20	6.7	6.70	98.	0	.004	.011	.080	2.84
L- 16	22.30	8.1	7.40	91.	74.	-0.004	-0.004	.030	1.80
L- 16	21.80	6.7	7.20	91.	0	.005	.005	-0.010	2.18
L- 15	23.00	9.2	8.40	95.	81.	.004	-0.004	.040	2.03
L- 15	22.40	7.2	7.40	97.	0	.005	.004	-0.010	1.97
L- 14	22.50	8.2	7.70	99.	86.	.006	-0.004	-0.010	1.86
L- 14	21.50	5.6	6.90	100.	0	-0.004	-0.004	-0.010	1.97
L- 13	23.10	6.7	6.50	88.	117.	-0.004	.010	-0.010	1.35
L- 13	22.90	6.4	6.40	88.	0	-0.004	.016	.040	1.69
L- 12	24.50	7.4	7.10	90.	102.	-0.004	-0.004	-0.010	2.03
L- 12	22.00	5.7	6.80	90.	0	-0.004	-0.004	.020	1.58
L- 11	23.00	8.1	7.40	87.	99.	-0.004	-0.004	-0.010	1.31
L- 11	21.70	6.1	6.90	87.	0	-0.004	.007	.020	1.80
L- 10	23.30	7.3	7.00	87.	86.	-0.004	-0.004	.030	1.49
L- 10	22.00	5.9	6.60	87.	0	-0.004	-0.004	.040	1.52

*** KISSIMMEE LAKE BASIN - P32 ***

RETRIEVAL DATE 06/29/75

JANUARY 22-23 1974 TOP AND BOTTOM

STATION NUMBER	OR-P MG/L	T-P MG/L	TD-P MG/L	CA TIT	MG H-CA	NA A.A.	K MG/L	CL MG/L	SIO2 MG/L
L- 22	.010	.027	.020	2.8	2.8	12.0	2.00	14.9	-0.4
L- 22	.024	.092	.034	3.1	2.8	12.0	2.00	16.7	-0.4
L- 23	.002	.028	.014	3.7	2.5	10.0	.80	15.1	1.0
L- 23	.004	.120	.014	3.8	2.6	9.0	.70	15.5	1.0
L- 24	-0.002	.019	.005	2.6	2.8	11.0	1.80	16.9	-0.4
L- 24	.003	.018	.008	2.5	3.1	12.0	1.90	17.4	.4
L- 25	.004	.015	.010	2.5	2.9	12.0	2.00	17.1	-0.4
L- 25	-0.002	.013	.005	2.4	3.1	12.0	2.10	16.9	-0.4
L- 21	-0.002	.018	.006	2.8	2.7	12.0	2.00	16.5	-0.4
L- 21	-0.002	.042	.005	2.5	2.7	12.0	2.00	16.5	-0.4
L- 18	1.345	1.250	1.270	15.4	4.4	20.0	3.40	22.9	8.1
L- 18	1.331	1.360	1.160	15.4	4.5	20.0	3.50	23.3	8.1
L- 19	.575	.600	.580	14.0	4.0	14.0	3.00	18.4	3.0
L- 19	.636	.650	.640	12.6	4.0	16.0	3.00	18.6	3.5
L- 17	.301	.340	.320	11.2	3.8	14.0	2.30	18.4	1.3
L- 17	.294	.370	.310	9.8	3.4	13.0	2.20	18.4	1.4
L- 16	.070	.140	.088	6.8	3.4	13.0	2.00	17.3	-0.4
L- 16	.069	.280	.085	6.8	3.3	14.0	2.20	17.3	-0.4
L- 15	.009	.097	.023	5.4	3.2	14.0	2.00	17.6	-0.4
L- 15	.009	.088	.021	6.8	3.5	15.0	2.10	17.8	-0.4
L- 14	.016	.074	.029	6.8	3.6	15.0	2.10	17.6	-0.4
L- 14	.020	.120	.035	5.4	3.5	14.0	1.90	18.2	-0.4
L- 13	.009	.057	.025	5.4	3.3	13.0	1.50	17.6	.6
L- 13	.014	.087	.030	5.4	3.3	13.0	1.40	19.4	.6
L- 12	.003	.052	.021	4.0	3.0	13.0	1.30	18.0	.5
L- 12	.004	.048	.020	4.0	3.2	13.0	1.40	18.4	.5
L- 11	.004	.051	.014	2.4	3.2	12.0	1.40	18.0	.6
L- 11	.004	.083	.022	4.0	3.3	14.0	1.50	18.4	.6
L- 10	.003	.047	.021	4.0	3.1	14.0	1.40	18.0	.5
L- 10	.005	.053	.020	4.0	3.1	13.0	1.40	18.4	.5

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* KISSIMMEE LAKE BASIN - P32 *
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RETRIEVAL DATE 06/29/75

JANUARY 30-31 1974 SURFACE AND BOTTOM

STATION NUMBER	TEMP DG-C	D.O. MG/L	PH FIELD	COND FIELD	SECCHI CM	NO2-N MG/L	NO3-N MG/L	NH3-N MG/L	TKN MG/L
********	********	********	********	********	********	********	********	********	********
L- 8	22.90	7.3	6.80	120.	70.	-0.004	.055	.020	1.70
L- 8	22.60	7.3	6.70	120.	0	-0.004	.055	.030	1.80
L- 9	22.90	7.0	7.20	55.	71.	-0.004	.067	.070	1.80
L- 9	22.60	7.1	6.70	65.	0	-0.004	.060	.050	1.70
L- 1	23.20	8.2	7.80	90.	96.	-0.004	.090	.020	1.50
L- 1	22.50	7.5	7.80	96.	0	-0.004	.078	.020	2.40
L- 2	23.00	7.6	7.00	96.	101.	-0.004	.063	.040	1.30
L- 2	22.80	7.0	6.60	98.	0	-0.004	.062	.040	1.60
L- 3	22.60	8.4	7.20	125.	97.	.011	.012	.020	1.30
L- 3	22.40	7.7	6.90	125.	0	-0.004	-0.004	-0.010	2.10
L- 6	22.80	8.1	7.10	53.	110.	.006	.034	.080	1.50
L- 6	22.40	7.6	6.80	64.	0	-0.004	.010	.100	1.50
L- 7	22.40	8.5	7.20	125.	116.	-0.004	-0.004	-0.010	1.50
L- 7	22.20	7.2	6.80	125.	0	-0.004	-0.004	-0.010	1.60
L- 4	23.00	9.0	7.60	130.	104.	-0.004	-0.004	.020	1.50
L- 4	21.70	6.9	6.70	130.	0	-0.004	-0.004	.020	1.40
L- 5	23.50	7.9	6.45	77.	102.	-0.004	-0.004	.030	1.40
L- 5	22.00	5.9	6.30	83.	0	-0.004	.018	-0.010	1.40

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* KISSIMMEE LAKE BASIN - P32 *
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RETRIEVAL DATE 06/29/75

JANUARY 30-31 1974 SURFACE AND BOTTOM

STATION NUMBER ********	OR-P MG/L ********	T-P MG/L ********	TO-P MG/L ********	CA TIT ********	MG H-CA ********	NA A.A. ********	K MG/L ********	CL MG/L ********	SIO2 MG/L ********
L- 8	.011	.059	.036	7.3	3.5	11.0	.70	15.1	3.3
L- 8	.012	.089	.037	8.0	3.6	11.0	.70	15.1	1.9
L- 9	.006	.049	.038	8.0	3.5	12.0	.70	18.6	2.1
L- 9	.013	.059	.036	7.7	3.6	10.0	.60	15.7	1.9
L- 1	.006	.034	.024	8.7	3.9	10.0	.80	13.7	2.5
L- 1	.004	.110	.024	9.0	3.6	8.0	.70	13.7	.6
L- 2	.011	.041	.034	8.0	3.8	9.0	.80	14.7	2.3
L- 2	.012	.060	.033	7.8	3.8	10.0	.80	14.3	2.0
L- 3	-0.002	.016	.008	7.0	3.3	13.0	1.00	18.6	2.0
L- 3	-0.002	.040	.005	7.0	3.4	12.0	.90	18.2	2.3
L- 6	-0.002	.016	.010	7.3	3.3	13.0	.90	19.0	3.2
L- 6	-0.002	.021	.008	7.0	3.4	13.0	.90	19.2	2.2
L- 7	-0.002	.018	.009	6.7	3.5	12.0	1.00	17.6	2.0
L- 7	-0.002	.032	.008	7.0	3.2	13.0	1.00	18.0	2.0
L- 4	-0.002	.011	.006	7.0	3.3	14.0	.90	18.6	2.1
L- 4	-0.002	.019	.003	7.0	3.4	13.0	.70	18.8	2.1
L- 5	-0.002	.011	.008	7.0	3.5	14.0	.80	19.6	2.1
L- 5	-0.002	.011	.007	7.7	3.4	14.0	.70	19.6	2.5

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* KISSIMMEE LAKE BASIN - P32 *
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RETRIEVAL DATE 06/18/75

APRIL 17-19 1974 SURFACE

STATION NUMBER	TEMP DG-C	D.O. MG/L	PH FIELD	COND FIELD	SECCHI CM	NO2-N MG/L	NO3-N MG/L	NH3-N MG/L	TKN MG/L
L- 22	24.40	7.5	6.30	120.	145.	-0.004	-0.004	.040	.54
L- 23	25.00	7.8	6.10	120.	82.	.004	-0.004	.050	.98
L- 24	24.00	8.2	6.50	94.	160.	-0.004	-0.004	.040	.59
L- 25	24.50	8.5	6.70	91.	195.	-0.004	-0.004	.040	.50
L- 21	24.00	7.8	7.00	120.	189.	-0.004	-0.004	-0.010	.62
L- 18	24.00	7.0	7.05	290.	77.	.006	.190	.020	.82
L- 19	27.00	12.0	8.60	210.	45.	-0.004	.110	.080	1.13
L- 17	25.00	10.6	8.30	180.	66.	-0.004	-0.004	.020	1.44
L- 16	24.00	10.8	8.80	180.	44.	-0.004	-0.004	.030	1.87
L- 15	23.50	9.7	8.70	160.	60.	-0.004	-0.004	.030	1.61
L- 14	23.50	9.0	8.70	160.	49.	-0.004	.076	.010	2.22
L- 13	23.20	8.6	7.10	150.	46.	-0.004	.231	.010	1.07
L- 12	23.50	8.0	6.90	140.	46.	-0.004	.114	-0.010	1.70
L- 11	23.00	8.5	7.30	120.	62.	-0.004	.008	.050	2.52
L- 10	22.50	8.4	7.10	150.	60.	-0.004	-0.004	.040	1.47
L- 8	22.50	5.4	6.20	150.	55.	-0.004	.009	.020	.81
L- 9	24.20	7.6	6.60	150.	47.	-0.004	-0.004	.040	1.19
L- 1	23.50	8.4	7.20	130.	103.	-0.004	-0.004	.020	.69
L- 2	23.10	8.3	7.20	135.	71.	-0.004	-0.004	.030	.95
L- 3	25.40	8.1	7.00	140.	102.	-0.004	.082	.010	.80
L- 6	25.00	8.9	8.10	150.	95.	-0.004	.007	.020	.86
L- 7	25.00	9.1	8.20	150.	98.	-0.004	-0.004	.010	.81
L- 4	25.60	8.9	8.20	145.	98.	-0.004	.132	-0.010	1.04
L- 5	25.50	9.4	8.25	150.	73.	-0.004	-0.004	.010	1.38

*** KISSIMMEE LAKE BASIN - P32 ***

RETRIEVAL DATE 06/18/75

APRIL 17-19 1974 SURFACE

STATION NUMBER	OR-P MG/L	T-P MG/L	TD-P MG/L	CA A.A.	MG A.A.	NA A.A.	K MG/L	CL MG/L	SIO2 MG/L
L- 22	-0.002	.021	.013	3.2	2.6	12.0	1.80	19.8	1.0
L- 23	-0.002	.028	.015	4.2	2.6	12.0	1.20	19.0	.5
L- 24	-0.002	.017	.009	3.2	3.0	13.0	2.00	20.0	.6
L- 25	-0.002	.016	.008	2.4	3.0	13.0	1.90	20.2	-0.4
L- 21	-0.002	.016	.008	2.4	3.0	15.0	2.20	19.8	.7
L- 18	1.664	2.080	1.760	20.0	5.4	39.0	2.60	27.9	7.4
L- 19	.608	.730	.690	15.6	4.4	20.0	3.70	24.2	2.8
L- 17	.172	.268	.184	8.6	4.0	19.0	1.80	22.6	1.0
L- 16	.104	.192	.132	8.6	4.4	17.0	2.50	22.2	1.3
L- 15	.021	.102	.038	7.6	4.4	16.0	2.30	21.8	.9
L- 14	.016	.101	.034	7.6	4.4	16.0	2.20	21.4	.8
L- 13	-0.002	.053	.019	6.0	4.0	15.0	1.90	21.2	1.1
L- 12	-0.002	.054	.022	5.0	3.6	15.0	1.60	21.4	1.1
L- 11	-0.002	.095	.018	6.0	3.8	12.0	1.50	21.0	1.0
L- 10	-0.002	.054	.021	6.0	3.6	16.0	1.80	21.6	.6
L- 8	-0.002	.044	.020	6.0	3.4	13.0	1.90	21.0	.9
L- 9	-0.002	.060	.023	5.0	3.8	15.0	1.90	21.0	1.1
L- 1	-0.002	.030	.019	7.6	4.4	11.0	1.20	14.1	.8
L- 2	-0.002	.043	.025	6.8	4.2	11.0	1.40	17.7	.9
L- 3	-0.002	.020	.010	6.8	3.8	11.0	1.20	17.7	1.4
L- 6	-0.002	.011	.003	7.6	3.6	11.0	1.20	18.7	1.3
L- 7	-0.002	.014	.004	7.6	4.0	14.0	1.40	18.3	1.9
L- 4	-0.002	.012	.003	7.6	3.8	12.0	1.40	19.0	1.9
L- 5	-0.002	.012	.002	7.6	4.0	13.0	1.40	19.8	1.5

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* KISSIMMEE LAKE BASIN - P32 *
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RETRIEVAL DATE 06/18/75

JUNE 18-20 1974 SURFACE

STATION NUMBER ********	TEMP DG-C ********	D.O. MG/L ********	PH FIELD ********	COND FIELD ********	SECCHI CM ********	NO2-N MG/L ********	NO3-N MG/L ********	NH3-N MG/L ********	TKN MG/L ********
L- 22	30.00	7.3	6.70	130.	122.	-0.004	.004	.011	.90
L- 23	32.20	6.8	6.70	125.	108.	-0.004	.013	.042	1.17
L- 24	33.00	7.0	7.00	130.	169.	-0.004	-0.004	-0.010	.95
L- 25	32.50	7.6	7.05	130.	188.	-0.004	-0.004	.027	1.27
L- 21	30.50	7.5	7.10	130.	186.	-0.004	-0.004	.077	.58
L- 18	30.00	6.3	7.20	310.	56.	.006	.056	.037	1.46
L- 19	30.00	9.9	8.70	225.	41.	-0.004	-0.004	.016	2.50
L- 17	30.00	8.6	8.70	190.	52.	-0.004	-0.004	.010	1.78
L- 16	30.70	12.8	9.60	200.	46.	-0.004	.022	-0.010	2.72
L- 15	30.00	12.8	9.70	210.	56.	-0.004	-0.004	-0.010	2.47
L- 14	30.50	12.8	9.70	210.	55.	-0.004	-0.004	-0.010	2.69
L- 13	28.50	10.2	9.20	165.	35.	-0.004	-0.004	.015	2.28
L- 12	28.00	6.4	8.40	165.	35.	-0.004	-0.004	-0.010	2.67
L- 11	28.50	8.5	9.10	170.	35.	-0.004	-0.004	.013	2.82
L- 10	29.50	8.3	8.85	165.	38.	-0.004	.006	.011	2.54
L- 8	28.50	5.3	6.70	160.	50.	-0.004	-0.004	.029	1.87
L- 9	28.50	6.7	6.80	160.	32.	-0.004	.006	.019	2.95
L- 1	28.00	7.2	7.50	125.	50.	-0.004	.005	.046	1.91
L- 2	28.30	6.9	7.85	140.	60.	-0.004	-0.004	.061	2.46
L- 3	29.50	6.8	6.90	145.	50.	-0.004	-0.004	-0.010	1.54
L- 6	29.00	8.3	8.60	150.	91.	-0.004	-0.004	-0.010	1.89
L- 7	29.00	8.0	8.60	145.	74.	-0.004	-0.004	-0.010	1.55
L- 4	28.50	8.2	8.80	150.	87.	-0.004	-0.004	-0.010	2.39
L- 5	29.40	8.5	8.80	150.	69.	-0.004	-0.004	-0.010	2.20

KISSIMMEE LAKE BASIN - P32

RETRIEVAL DATE 06/18/75

JUNE 18-20 1974 SURFACE

STATION NUMBER	OR-P MG/L	T-P MG/L	TD-P MG/L	CA A.A.	MG A.A.	NA A.A.	K MG/L	CL MG/L	SIO2 MG/L
L- 22	-0.002	.018	.150	3.4	3.2	10.0	1.70	20.3	1.2
L- 23	.003	.033	.015	7.0	2.8	12.0	1.00	19.1	.8
L- 24	-0.002	.016	.006	5.2	3.1	13.0	1.90	21.1	.9
L- 25	-0.002	.026	.031	5.2	2.9	13.0	1.80	21.1	1.1
L- 21	.003	.026	.127	6.0	3.5	12.0	1.80	21.1	.8
L- 18	3.350	3.310	3.230	20.0	4.4	30.0	4.00	30.8	11.0
L- 19	.760	.880	.490	15.0	4.1	20.0	2.80	26.4	4.7
L- 17	.330	.516	.333	8.6	2.8	17.0	1.90	24.1	3.6
L- 16	.047	.207	.258	8.6	3.0	19.0	2.10	23.1	2.0
L- 15	.003	.095	.036	7.8	3.0	15.0	1.80	22.1	1.4
L- 14	.003	.097	.018	8.6	3.3	17.0	2.00	22.1	1.8
L- 13	.005	.157	.025	7.8	3.5	18.0	1.80	23.1	3.5
L- 12	.005	.107	.021	6.0	3.4	16.0	1.60	23.1	3.9
L- 11	.005	.149	.024	7.8	3.6	14.0	1.40	23.1	4.3
L- 10	.004	.095	.021	7.0	3.4	15.0	1.70	22.5	4.4
L- 8	.005	.089	.019	7.8	3.6	12.0	1.20	22.5	2.3
L- 9	.013	.122	.028	7.8	3.6	17.0	1.60	22.1	3.2
L- 1	.010	.065	.021	7.0	3.3	10.0	1.00	16.2	3.6
L- 2	.018	.071	.022	7.0	3.6	9.0	.80	19.3	3.2
L- 3	.003	.072	.016	7.0	3.2	12.0	1.10	18.9	2.3
L- 6	-0.002	.025	.002	7.8	3.3	10.0	.90	19.9	3.0
L- 7	.003	.037	.014	6.0	2.7	12.0	1.00	18.5	2.2
L- 4	-0.002	.038	.003	9.6	3.5	14.0	1.10	20.1	2.6
L- 5	-0.002	.029	.005	9.6	3.6	11.0	1.10	19.7	2.6