Technical Memorandum

LAKE WATCH REPORT - 1987
THE STATUS OF ALGAL BLOOMS ON LAKE OKEECHOBEE IN 1987

DRE - 273

by

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EXECUTIVE SUMMARY

In conjunction with the Lake Watch Program, algal bloom density and coverage were monitored on Lake Okeechobee between October and December 1986 and between April and November 1987. Thirty five Lake Watch maps describing algal blooms on the lake were issued to the media, other agencies, and the general public. Algal blooms ($\geq$ 40 mg/m^3 chlorophyll a) were present on some portion of the lake during the entire period. Greatest areal coverage occurred in late June-early July 1987 as 286 square miles (740 km^2) or 42% of the lake surface area exhibited bloom conditions. During this time, chlorophyll a concentrations ranged as high as 95 mg/m^3 and exceeded 40 mg/m^3 at 49% of the stations (N = 55). From mid-July to November 1987, algal bloom coverage declined (< 10% of the lake surface) and mean chlorophyll a values were less than 25 mg/m^3. Between May and November 1987, chlorophyll a concentrations were similar between the littoral and pelagic zones, averaging 25 and 24 mg/m^3, respectively. Chlorophyll a concentrations were apparently not related to phosphorus or nitrogen in the limnetic zone. In the littoral zone, however, chlorophyll a was positively correlated to phosphorus and nitrogen concentrations and both these nutrients explained 42% of the variation in algal biomass. Mid-day dissolved oxygen levels below 2.0 mg/L were recorded at 5% of the stations sampled in 1987. However, depressed oxygen levels were not associated with algal blooms. Oxygen concentrations were positively correlated to chlorophyll a levels. *Microcystis*, *Anabaena*, and *Lyngbya* were the dominant algae observed during this period. Two algal samples containing *Microcystis aeruginosa* collected in August 1987 demonstrated moderate hepatotoxicity when injected into laboratory mice. Although algal blooms were common and, at times, expansive during summer 1987, no short-term adverse environmental impacts or fish kills associated with these blooms were observed.

INTRODUCTION

Algal blooms are common in eutrophic lakes such as Lake Okeechobee, and result from the rapid growth and accumulation of microscopic phytoplankton that occur under suitable environmental conditions. High algal densities can 1) impart undesirable taste and odor in drinking water supplies, 2) produce toxins that may adversely affect human health, 3) alter aquatic macrophyte, invertebrate and fish communities, 4) kill invertebrates and fish, and 5) decrease the economic, recreational, and aesthetic value of water bodies.

The shallow depth and geographic location of Lake Okeechobee suggest that algal blooms likely have occurred in the past. Major blooms on the lake were recorded in the early 1970's (Joyner 1974; Marshall 1977), and a bloom of blue-green algae (Anabaena) covered over 300 km^2 of the lake in August 1986 (Jones 1987). During this latter event, algae concentrated at the edge of the littoral zone in the western region, and the subsequent death and decomposition of this algae depleted dissolved oxygen and elevated ammonia concentrations. Gill-breathing invertebrates in the immediate vicinity were killed, but there was no significant fish mortality. This event attracted both state and national attention and raised concern about the future well-being of the lake. In addition, the need to monitor and understand the processes which produce algal blooms in Lake Okeechobee was recognized.

Phosphorus and nitrogen have been identified as primary nutrients regulating algal production in lakes and reservoirs (Jones and Bachmann 1976; Baker et al. 1981; Canfield 1983). Over time, phosphorus concentrations in the water have increased in Lake Okeechobee. Between 1973 and 1979, average annual total phosphorus (TP) concentrations in the pelagic zone doubled from 49 to 97 mg/m^3 (Federico et al. 1981). Between 1979 and 1987, annual average TP concentrations have varied between 63 and 99 mg/m^3 (South Florida Water Management District 1988). Average annual total nitrogen (TN) concentrations were highest in 1980 (2,620 mg/m^3), but have declined to 1,490 - 1,840 mg/m3 between 1982 and 1987 (South Florida Water Management District 1988). Based on the empirical models developed by Baker et al. (1981), Smith (1982), and Canfield (1983), these relatively high TP and TN concentrations have the potential to cause dense algal blooms on Lake Okeechobee.

Annual phosphorus loading rates have varied between 154 and 526 mg TP/m^2 during the past fourteen years. A substantial percentage of this input is anthropogenic, primarily arising from agricultural practices in the watershed. Since 1979, the South Florida Water Management District (SFWMD) has embarked on a basin-wide program to reduce the amount of phosphorus and nitrogen entering the lake in an attempt to prevent adverse environmental impacts.

Besides monitoring nutrient concentrations and inputs, the District has an extensive research program underway to examine factors regulating algal bloom formation in Lake Okeechobee. As part of this effort and in response to public concern following the 1986 bloom, the District initiated the Lake Watch program in October 1986. The objectives of the program were to provide for timely detection and identification of algal blooms on Lake Okeechobee. The information collected would be issued to the media, other agencies, and the general public as a single-page map with corresponding text on the status of algal blooms on the lake. In addition, the compilation of these data in an annual report could be used to determine whether algal bloom coverage and intensity is varying over time. This report summarizes data collected during 1986 and 1987.

METHODS

Various methods were used to assess algal abundance on Lake Okeechobee including: 1) incorporation of the established, routine sampling program; 2) helicopter surveys; 3) additional collections made by boat, and 4) satellite imagery. As part of the routine sampling program, the Water Quality Division (SFWMD) collected sub-surface (0.5m) samples in the open-water or limnetic zone (Germain and Shaw 1988, Figure 1) and the littoral zone for chlorophyll a and water chemistry analysis from October to December 1986 to supplement information presented in Lake Watch maps. Limnetic zone data collected between May and August 1986 is presented to examine limnological conditions prior to and during the massive algal bloom that occurred during 1986. Littoral zone sampling was initiated in August 1986 and the program was completely established by December 1986. Therefore, this data is also presented.

In 1987, the Water Quality Division collected samples for chlorophyll a and water chemistry analysis once a month between May 1 and November 18 from the 8 limnetic stations. During 1986-87, the Water Quality Division measured oxygen levels at the surface using a HYDROLAB and water clarity was determined using a 20 cm secchi disk. Thirty five stations located around the deepwater fringes of the vegetative littoral zone were sampled between April 14 and November 24, 1987. Between June 8 and November 19, 1987, surface water samples were collected weekly by helicopter throughout the lake to verify satellite imagery of blooms (Figure 2; see Appendix 1). During 1987, satellite imagery was used only once to supplement data collected for a Lake Watch report. Results of satellite photography to detect algal blooms on the lake will be presented in another report (Worth, in preparation).

After collection, water samples for chlorophyll a analysis were transported to the laboratory, filtered onto Whatman GF/C glass fiber filters (1.2 um) and neutralized with a $MgCO_3$ solution. These filtered samples were not frozen for more than two days before being ground (tissue homogenization) for one to two minutes and extracted with 90% acetone. Chlorophyll extracts were centrifuged for 15 minutes and supernatants placed in 1 cm curvets for absorption measurements in a Perkin-Elmer spectrophotometer. Chlorophyll a was corrected for phaeophytin using the equations of Parson and Strickland (1963). Fresh algal samples were examined microscopically at 200 to 400x and dominant taxa recorded. Ortho-phosphorus (OP), total phosphorus (TP), total nitrogen (TN), and turbidity were determined by the methods outlined in Federico et al. (1981).

Algal densities exceeding 40 mg/m^3 of chlorophyll a were considered a "bloom". Blooms with chlorophyll a concentrations greater than 90 mg/m^3 were considered to have potential to cause adverse environmental impacts. Locations of algal samples were plotted on a geographical reference map (AUTOCAD). The extent of coverage was delineated by extrapolation of data points, and from personal observations obtained from over-flights. Because of inconsistent sampling techniques, estimates of algal bloom size were not computed in 1986. Bloom conditions were not always apparent from visual observations. Although somewhat subjective, areal coverage information served as a relatively reliable estimate of the magnitude and extent of blooms on the lake.

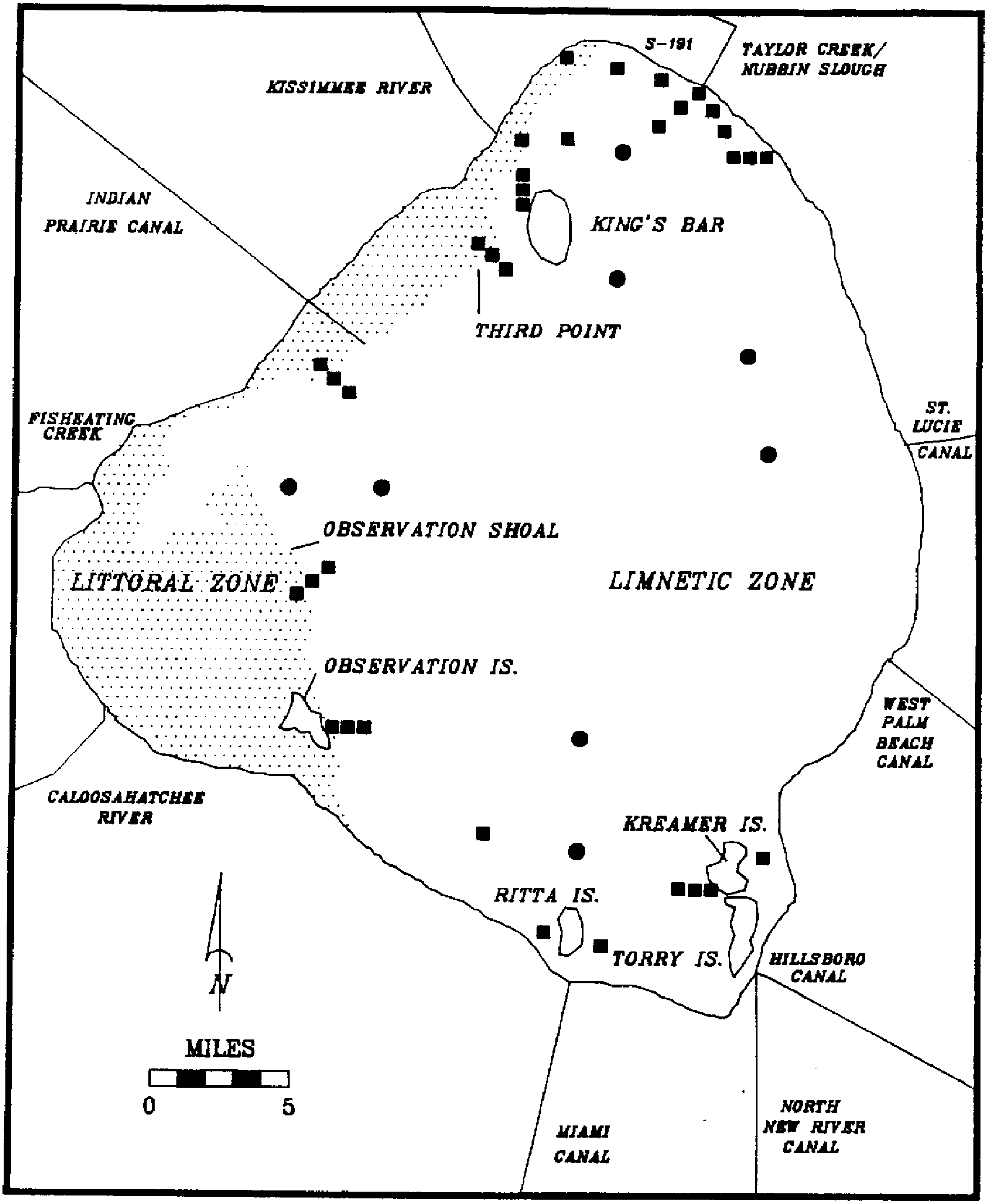

Figure 1. Routine water quality sampling stations in Lake Okeechobee. Circles represent limnetic stations and squares represent littoral stations.

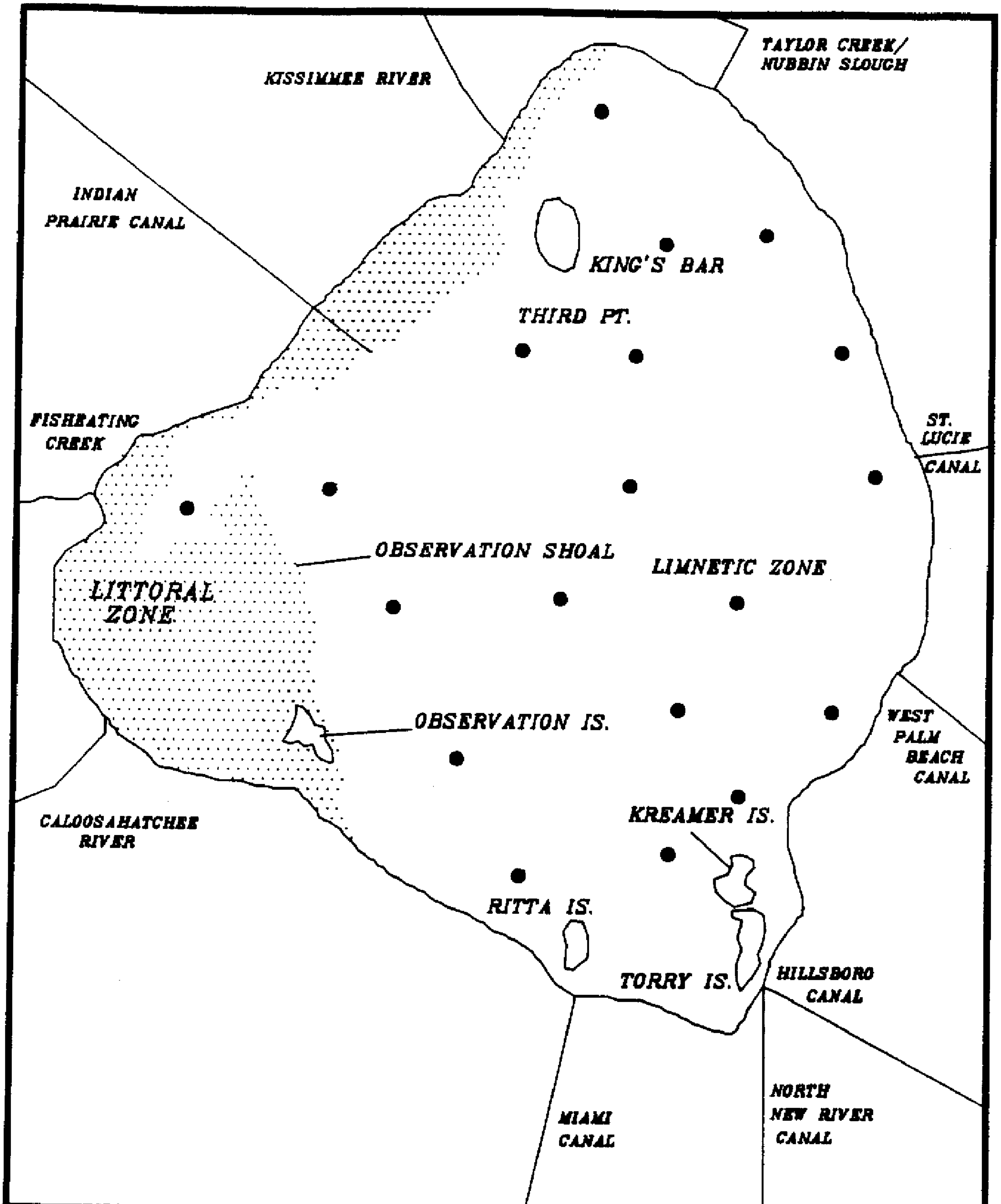

Figure 2. Location of helicopter survey sampling stations for chlorophyll a analysis.

Between August and November 1987, two water samples were sent to Dr. Wayne Carmichael at Wright State University in Dayton, Ohio to test for toxicity. Standard mouse bioassays were conducted using intraperitoneal injection followed by a pathologic examination (Theiss and Carmichael 1985).

Statistical analysis of data followed the procedures of SAS (SAS 1985). Pair-wise comparisons of mean values were made using Student's t-test with incorporation of the appropriate variance term. Homogeneity of variances were tested using the F-statistic. Pearson product-moment correlations were computed to describe relationships between parameters. Chlorophyll a-to-total phosphorus and chlorophyll a-to-total nitrogen plots indicated the variance increased with higher concentrations. Therefore, these data were transformed to $\log_{10}$ values and simple and multiple regression equations were computed to predict chlorophyll a levels. Unless, otherwise stated, statistical significance was defined at $P < 0.05$.

RESULTS

Between October 31 and December 11, 1986, 8 Lake Watch maps of algal blooms on Lake Okeechobee were issued (Appendix 2). Generally, areal coverage of blooms relative to lake size were small. Mean chlorophyll a concentrations in the limnetic zone ranged from 15 to 33 mg/m^3 for seven dates between May and December 1986 (Table 1). These concentrations were near historic levels. Mean chlorophyll a levels in the littoral zone were similar ranging from 15 to 37 mg/m^3 between August and December (Table 2). Although a massive algal bloom formed in mid-July in the southern limnetic region of the lake, routine sampling did not detect high nutrient or chlorophyll a concentrations. Mean monthly TP concentrations were less than the historic average, ranging from 49 to 60 mg/m^3 in May-July 1986 (Table 3). Secchi disk readings indicated relatively clear conditions during this time. In August 1986, the lowest monthly TN concentration on record in the limnetic zone was observed (Table 3). A rapid decline in TN was evident between July and August which could have favored nitrogen-fixing Anabaena circinalis, the dominant algae comprising the bloom. Thus, clear water conditions and low nitrogen concentrations were the only two unusual events that were evident in association with this algal bloom. Further research is necessary to determine mechanisms responsible for episodic algal blooms.

Between April 14 and November 23, 1987, 27 Lake Watch maps were issued (Appendix 2). Algal blooms were detected on each survey with the exception of July 9. Blooms ranged from 6 to 740 km^2 in size and encompassed from 1 to 42% of the lake's surface (Table 4). Greatest coverage occurred from June 24 to July 6 and thereafter, declined to less than 10% of the lake surface. Examination of wind speed data recorded by the National Oceanic and Atmospheric Administration at Moore Haven indicated calm conditions were prevalent on the lake from mid-June to mid-July, accounting for rapid expansion of algal bloom coverage, but not for its decline.

Peak algal densities, as measured by chlorophyll a concentrations, also occurred between mid-June and early July, 1987 (Tables 5 to 7). Chlorophyll a levels were highly variable ranging from 1 to 134 mg/m^3. For the three different sampling collection locations (1 = routine limnetic; 2 = routine littoral; 3 = helicopter) for individual sampling dates, mean chlorophyll a concentrations ranged from 17 to 41 mg/m^3. With the exception of this highest mean value (41 mg/m^3), these chlorophyll a concentrations were considered in the eutrophic range (Forsberg and Ryding 1980). Blue-green algae dominated the phytoplankton in 1987, with Microcystis, Anabaena, and Lyngbya the most common genera observed in the lake.

Table 1. Summary statistics for chlorophyll a concentrations (mg/m^3) collected from limnetic zone stations in Lake Okeechobee from May to December 1986.

Sample date (1986)	Number collected	Mean	Standard deviation	Range	Frequency (%) of stations $\geq$ 40 mg/m^3
May 1	8	25	11	6 - 39	0
June 23	8	23	16	10 - 57	13
July 2	5	15	11	4 - 33	0
August 7	7	24	16	13 - 57	14
September 25	7	26	28	8 - 78	29
October 23	8	33	25	8 - 86	25
December 10	8	29	15	7 - 52	25

Table 2. Summary statistics for chlorophyll a concentrations (mg/m^3) collected from littoral zone stations in Lake Okeechobee from August to December 1986.

Sample date (1987)	Number collected	Mean	Standard deviation	Range	Frequency (%) of stations $\geq$ 40 mg/m^3
August 7-15	15	37	27	5 - 74	40
September 3-4	19	22	11	4 - 47	5
October 3-4	8	26	11	14 - 44	13
November 6	16	20	8	7 - 39	0
November 17	12	15	12	3 - 37	0
December 4-12	35	27	16	6 - 56	31

Table 3. Mean total phosphorus (TP), ortho-phosphorus (OP), total nitrogen (TN), secchi (SECCHI) disk readings, and turbidity (TURB) in the limnetic zone of Lake Okeechobee, May to October 1986.

	Parameter				
Date sampled (1986)	TP (mg/m3)	OP (mg/m3)	TN (mg/m3)	SECCHI (cm)	TURB (JTU)
May 1	59	7	1,580	59	18.1
June 3	60	6	1,590	59	13.6
July 2	49	13	1,400	96	8.7
August 7	51	13	830	66	10.5
September 25	79	37	1,730	56	9.2
October 23	78	31	1,450	54	15.8

Table 4. Area and percent coverage of algal blooms (> 40 mg/m3 chlorophyll a) on Lake Okeechobee from April to November 1987.

Survey date (1987)	Area km2	(mi2)	Percent of lake surface area
April 23	100	(38)	5
April 24-26	390	(151)	21
May 13	155	(60)	9
May 19-20	304	(118)	17
June 2-4	155	(60)	9
June 8	145	(56)	8
June 15	186	(72)	10
June 16-22	173	(67)	10
June 24-25	359	(139)	20
June 29	471	(182)	27
June 30-July 6	740	(286)	42
July 9	0	(0)	0
July 13-16	48	(18)	3
July 20-23	27	(11)	2
July 27-29	25	(10)	1
August 3-6	5	(6)	1
August 8-10	19	(7)	1
August 14-17	6	(2)	<1
August 24-26	67	(26)	4
August 31	28	(11)	2
September 3-8	148	(57)	9
September 14-17	19	(7)	1
September 21-23	44	(17)	3
October 5-7	104	(40)	6
October 19	55	(21)	3
October 26	54	(21)	3
November 18-19	58	(23)	3

Table 5. Summary statistics for chlorophyll a concentrations (mg/m^3) collected from littoral zone stations in Lake Okeechobee from April to November 1987.

Sample date (1987)	Number collected	Mean	Standard deviation	Range	Frequency (%) of stations $\geq$ 40 mg/m^3
April 14, 21	35	26	17	1 - 63	20
May 5, 6	35	23	13	1 - 45	9
May 19, 20	35	22	16	2 - 58	20
June 2, 3	34	30	20	3 - 75	41
June 16, 17	35	29	20	3 - 65	31
June 30, July 1	35	34	22	4 - 95	40
July 13, 16	35	22	16	4 - 66	14
July 28, 29	35	23	18	3 - 67	17
August 11, 12	35	23	15	3 - 64	6
August 25, 26	35	23	15	2 - 49	14
September 8, 9	35	22	16	3 - 63	20
September 22, 23	35	20	14	2 - 55	9
October 6, 7	35	22	15	3 - 66	6
October 20, 21	34	24	15	4 - 68	14
November 23, 24	29	20	17	3 - 78	17

Table 6. Summary statistics for chlorophyll a concentrations (mg/m^3) collected from limnetic zone stations in Lake Okeechobee from May to November 1987.

Sample date (1987)	Number collected	Mean	Standard deviation	Range	Frequency (%) of stations $\geq$ 40 mg/m^3
May 1	8	22	12	10 - 44	13
June 4	8	25	10	11 - 38	0
June 24	8	41	12	28 - 67	25
July 21	8	23	9	12 - 38	0
August 18	8	23	8	10 - 36	0
September 14	8	17	8	9 - 35	0
November 18	8	24	13	13 - 51	13

Table 7. Summary statistics for chlorophyll a concentrations (mg/m^3) collected by helicopter from Lake Okeechobee from June to November 1987.

Sample Date (1987)	Number Collected	Mean	Standard Deviation	Range	Frequency (%) of Stations $\geq$ 40 mg/m^3
June 8	19	26	20	8 - 82	25
June 15	20	39	30	6 - 134	35
June 22	20	43	23	15 - 88	50
June 29	20	42	20	9 - 98	40
July 6	20	43	21	10 - 84	55
July 13	20	21	10	6 - 40	5
July 20	20	25	14	4 - 53	15
July 27	20	19	7	6 - 33	0
August 3	20	24	20	7 - 105	5
August 10	20	15	10	2 - 50	5
August 17	20	21	9	3 - 40	5
August 24	20	18	12	4 - 46	5
August 31	18	18	9	4 - 42	5
September 8	20	23	15	2 - 52	15
September 14	20	21	11	4 - 40	5
September 21	20	18	12	2 - 43	10
September 28	20	27	16	4 - 70	25
October 5	20	31	15	4 - 63	25
October 19	20	26	12	12 - 49	20
October 26	20	21	12	3 - 56	20
November 19	20	25	19	12-63	10

There were no significant differences in mean chlorophyll a levels between the littoral and limnetic zone during the 1987 survey period (Table 8). However, mean TP values were significantly lower in the littoral zone compared to the limnetic zone. Average TN levels were similar between zones. Non-algal turbidity was lower near the edge of the littoral-limnetic interface (approximate bottom elevation of 3.05 meters msl at the edge of the emergent vegetative zone) than in the open-water region of the lake (Table 8). Secchi disk readings were higher and turbidity values were lower in the littoral zone compared to the limnetic zone. Since chlorophyll a concentrations were similar between zones, differences in water clarity were likely due to suspended non-algal sediments. Flocculent, fine-particle sediments are found in the deeper, open-water regions of the lake. Wind resuspension of these sediments decreased light availability and could restrict algal production. In the littoral zone, higher light penetration was present for algal growth. In addition, reduced sedimentation of algal cells by flocculation was possible. Although TP concentrations were lower in the littoral zone, algal growth conditions were more favorable in this zone than in the limnetic zone.

Total nitrogen-to-total phosphorus (TN:TP) ratios (by weight) were also highly variable ranging from 3 to 160 in 1987 (Table 8). TN:TP ratios were higher in the littoral zone than in the limnetic zone. For both zones, average TN:TP ratios exceeded 17:1 suggesting that algal production was primarily regulated by phosphorus (Sakamoto 1966). In the littoral zone; the majority (89%) of sample TN:TP ratios were greater than 17:1.

No relationship could be demonstrated between chlorophyll a levels and phosphorus and nitrogen concentrations in the limnetic zone in 1987. However, in the littoral zone, chlorophyll a concentrations were positively correlated to TP and TN (Table 9). Phosphorus and nitrogen independently explained 39 and 10% of the variance in chlorophyll a concentrations, respectively. Combined in multiple regression analysis, these nutrients explained 42% of the variation in chlorophyll a. There was a weak, but significant correlation ($r = 0.21; P < 0.01$) between TP and TN.

Between May and December 1986, day-time oxygen concentrations below 2.0 mg/L (critical threshold for warmwater fish) were measured on four occasions. Three of these low dissolved oxygen levels were associated with the large algal bloom that caused invertebrate mortality in August 1986. Ammonia, which in high concentrations is toxic to many aquatic organisms, was 3.67 mg/L at one station. There was no relationship between chlorophyll a and oxygen concentrations in the littoral zone. However in the limnetic zone, increased oxygen levels were associated ($r=0.41, P<0.01$) with higher algal biomass.

Dissolved oxygen levels ranged from 0.2 to 13.5 mg/L between April and November 1987. Oxygen concentrations below 2.0 mg/L were recorded at 4.5% of the 552 stations. These low oxygen levels were found in the littoral zone and were mostly observed at "inner" stations, approximately 50 to 100 meters inward toward the levee from the pelagic:vegetative littoral interface. These lower oxygen levels were not associated with algal blooms as chlorophyll a values ranged from 3 to 20 mg/m^3 at these sites. Aquatic macrophyte decomposition/respiration or high oxygen demand from organic hydrosoils may have accounted for these depressed oxygen levels. Oxygen concentrations were significantly higher in the pelagic zone averaging 8.0 mg/L compared to 7.0 mg/L in the littoral zone. Oxygen levels were positively correlated to chlorophyll a concentrations in the pelagic and littoral zones ($r = 0.48$, $r = 0.43$, $P < 0.01$; respectively). These relationships were expected, because samples

Table 8. Mean[1] chlorophyll a, total phosphorus (TP), and total nitrogen (TN) concentrations, and TN:TP ratios from Lake Okeechobee collected between April 14 and November 23, 1987. Data are from the routine sampling program. Values in parenthesis are ranges.

Parameter	Zone: Littoral	Zone: Limnetic
chlorophyll a (mg/m^3)	24[a] (1 - 95)	25[a] (9 - 67)
TP (mg/m^3)	63[b] (10 - 557)	98[a] (23 - 198)
TN (mg/m^3)	1,690[a] (<500 - 3480)	1,690[a] (1,100 - 2,380)
TN:TP	37.8[a]	20.5[b]
Secchi (cm)	88[a] (18 - 295)	55[b] (13 - 210)
Turbidity (JTU)	6.3[b] (0.1 - 78.0)	24.7[a] (2.8 - 75.0)

[1] Mean values followed by the same letter are not significantly ($P < 0.05$) different.

Table 9. Regression equations predicting chlorophyll a concentrations (Chla) from total phosphorus (TP) and total nitrogen (TN) levels from littoral zone stations in Lake Okeechobee sampled between April 14 and November 30, 1987. All slope coefficients were significantly ($P < 0.01$) greater than zero. Ranges are given in Table 8 and $N = 517$.

Regression equations	r^2
$\log_{10}(Chla) = -0.266 + 0.884\log_{10}(TP)$	0.39
$\log_{10}(Chla) = -3.062 + 1.340\log_{10}(TN)$	0.10
$\log_{10}(Chla) = -2.869 + 0.825\log_{10}(TP) + 0.840\log_{10}(TN)$	0.42

were collected during daylight hours (9:30 - 15:30) when algae were photosynthetically active and generating oxygen. Minimum oxygen levels are usually observed at daylight, before photosynthesis begins. Large-scale algal decomposition, which can deplete oxygen, was not observed during 1987.

The two algal samples collected on August 13 and 18, 1987, near the Harney Pond Canal and in Eagle Bay demonstrated moderate hepatotoxicity (W. Carmichael, Wright State University; personal communication). Lethal dose incurring 50% mortality (LD50) on ICR Swiss male mice was 150 mg of concentrated algae per kg mouse. Biopsy procedures indicated liver weights were two-fold higher than normal. Microcystis aeruginosa, a common blue-green algae, was identified as the toxin-producing organism in these samples. Dr. Carmichael concluded these tests "indicated low toxicity in the water, but moderate toxicity for the algae present". Futhermore, "unless bioconcentration of the toxin or toxic cells was occurring, it is unlikely that the level of toxic cells represents a direct threat to animals".

CONCLUSIONS

Although algal blooms were common and at times expansive in size, no short-term adverse environmental impacts or fish kills associated with these blooms were observed on Lake Okeechobee, between April and November, 1987. Mericas and Malone (1984) reported a higher risk of fish kills occurred when chlorophyll a and TP concentrations exceeded 120 and 400 mg/m^3, respectively, in small ponds in Louisiana. Above this critical TP level, physical factors such as temperature, wind, and light regulate excessive growth that may cause fish kills due to oxygen depletion (Mericas and Malone 1984). During 1987 in Lake Okeechobee, algae were not highly concentrated along the edge of the littoral zone. Oxygen depletion, lysing, and subsequent release of ammonia from decomposing algae that was toxic to some aquatic invertebrates in summer 1986 was not observed in 1987. Long-term and perhaps subtle effects of these algae blooms on aquatic plant and fish communities in the lake are unknown. Future data and reports should be compared to these results to assess any long-term trends in the concentration and coverage of algal blooms on Lake Okeechobee.

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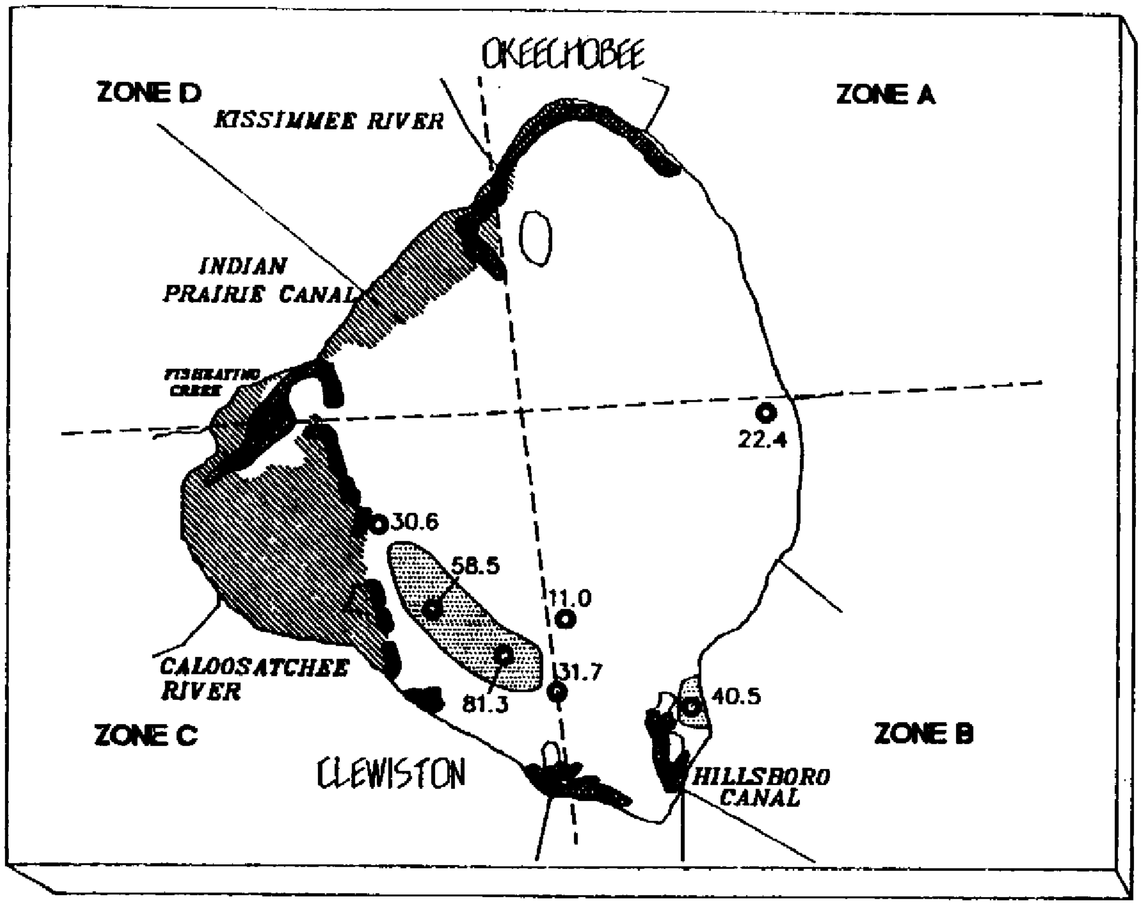
APPENDIX 1

Table A1. Latitude and longitude coordinates for stations sampled by helicopter from Lake Okeechobee between June and November, 1987, for chlorophyll a concentrations.

Station	Latitude		Longitude	
	degrees	minutes	degrees	minutes
1	26	51.3	80	40.7
2	26	51.3	80	46.1
3	26	48.4	80	43.8
4	26	46.6	80	46.4
5	26	45.9	80	51.5
6	26	49.0	80	53.7
7	26	54.6	80	55.7
8	26	54.7	80	50.5
9	26	54.6	80	43.9
10	26	54.5	80	38.9
11	26	58.6	80	38.9
12	26	58.5	80	47.3
13	26	58.6	80	57.9
14	26	57.9	81	2.9
15	27	2.6	80	51.2
16	27	2.4	80	47.4
17	27	2.3	80	40.1
18	27	6.2	80	42.6
19	27	6.3	80	46.2
20	27	10.4	80	48.2

APPENDIX 2

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 1



LAKE WATCH 10/31/86

District biologists found evidence this week of a continuing algal bloom in the vicinity of the Clewiston Water Treatment Plant Intake structure, and in the Pelican Bay area. Water Plant Officials say taste and odor problems have improved, but complaints continue. Highest chlorophyll-a reading was 81 milligrams per cubic meter. There are no Game & Fish Commission reports of fish kills or stress to the littoral zones.

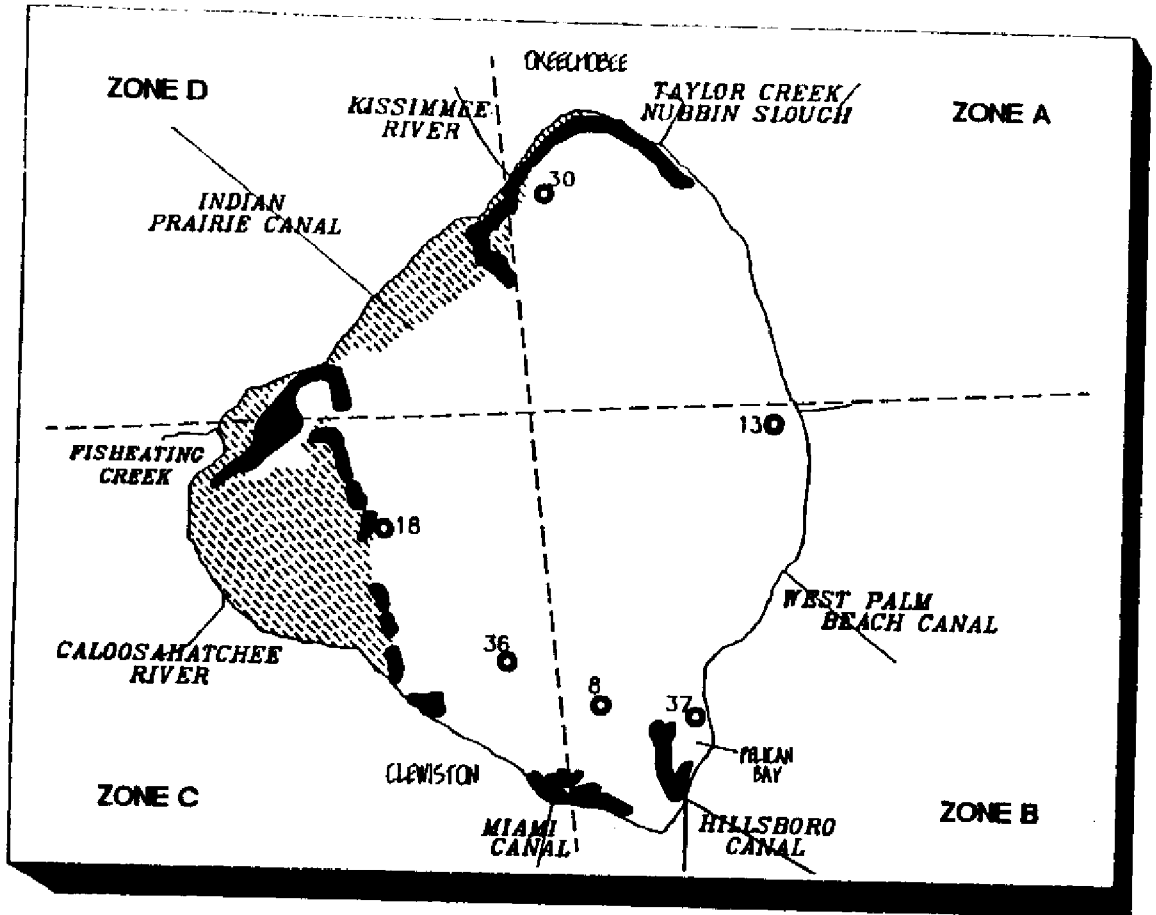
LEGEND

- SAMPLING SITE
- SPRAY AREA
- BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A
(milligrams per cubic meter)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.



LAKE WATCH 11/5/86

The bloom recorded during the past two to three weeks in the vicinity of the Clewiston Water Treatment Plant intake structure and in Pelican Bay has decreased in intensity and is no longer distinct bloom. Water Treatment Plant officials say taste and odor problems persist. Biologists identified Raphidiopsis as the dominant algae species in the bloom. Florida Game and Fresh Water Fish Commission officials have received no reports of fish kills or stress to the littoral zone.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 2

LEGEND

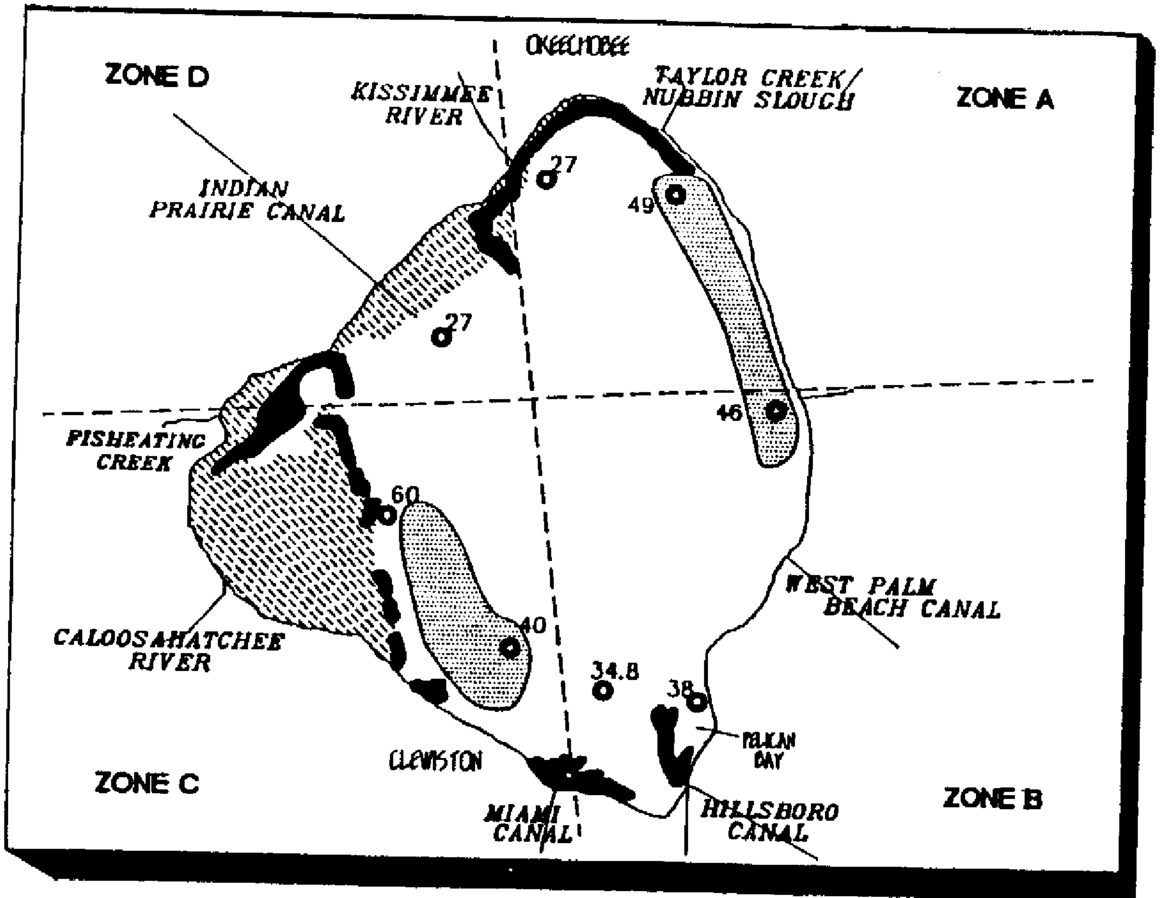
- SAMPLING SITE
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 3



LAKE WATCH 11/6/86

LEGEND

- SAMPLING SITE
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

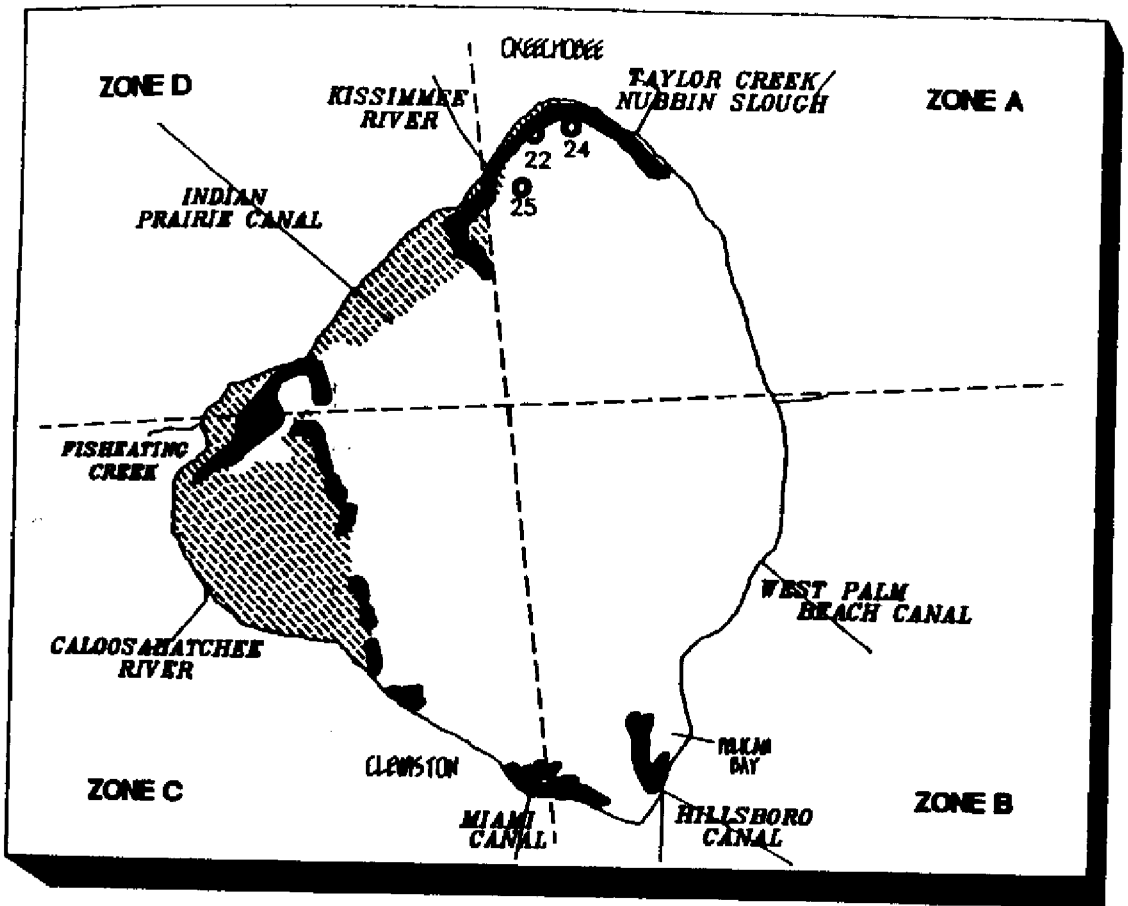
CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

The three week old algal bloom reported in the vicinity of the Clewiston Water Plant has decreased in intensity over the past several days. Water Plant officials report that taste and odor problems continue. Biologists identified <u>Raphidiopsis</u> as the dominant algae comprising the bloom.

Chlorophyll a concentrations in ZONE A show an increase above the 40 mg/m3 bloom threshold.

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.



LAKE WATCH 11/13/86

The algal bloom located in the vicinity of the Clewiston Water Plant has dissipated. Samples collected in Zone A last Friday indicated Chlorophyll–a concentrations above the 40 mg/m3 bloom threshold. However, follow–up monitoring on Monday and Wednesday of this week showed a drop in chlorophyll–a levels in that sector. Today's aerial inspection of the Lake indicated no apparent problem areas.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 4

LEGEND

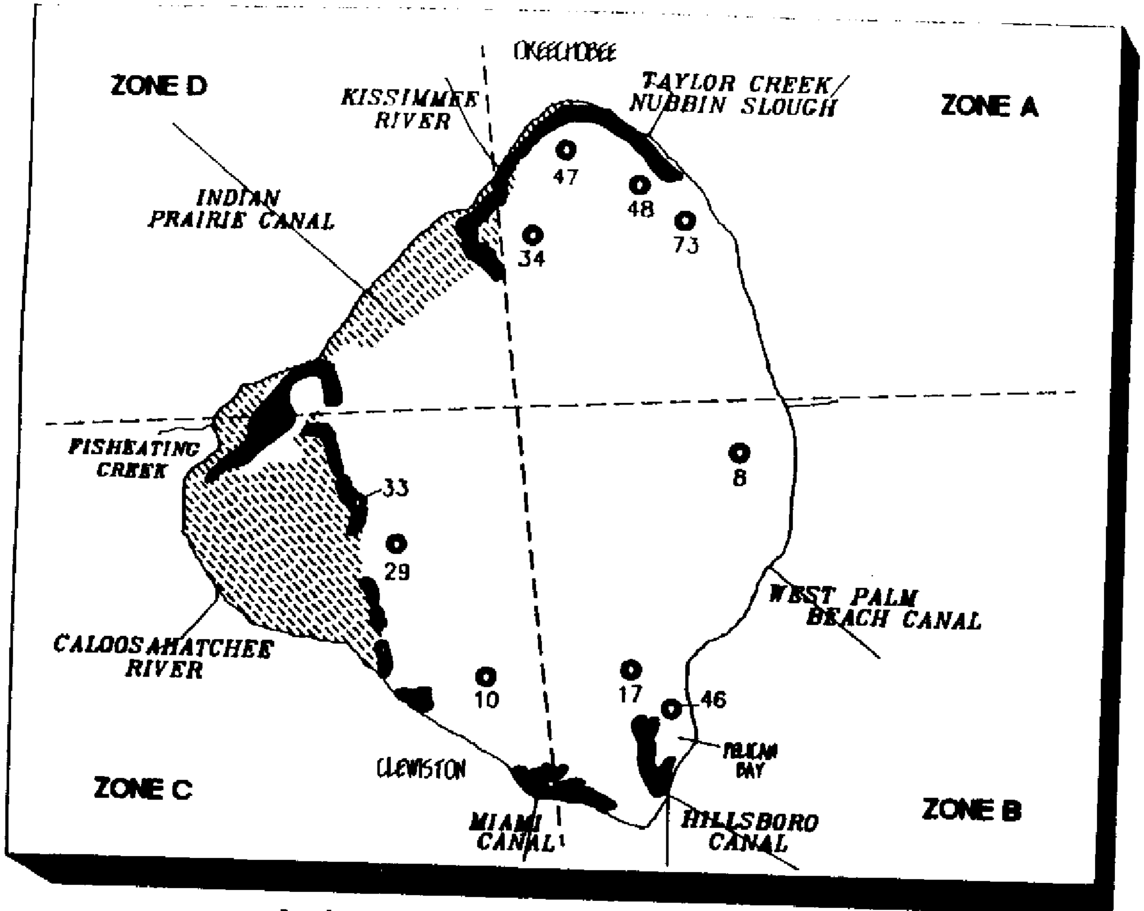
- SAMPLING SITE
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL–A
(milligrams per cubic meter)

(Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 – 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.



LAKE WATCH 11/17/86

A bloom composed of a variety of algae species including Anabaena circinalis was detected in samples taken near the northeast shore of the lake. No adverse impacts are reported at this time. Calm weather has allowed algae to float to the surface, imparting a green tint to the water. The highest chlorophyll-a reading found was 73 mg/m3 offshore of Henry Creek, with lower chl-a values reported five miles north and west of Henry Creek. A small bloom was also detected in the Pelican Bay area (46 mg/m3).

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 5

11/19/86

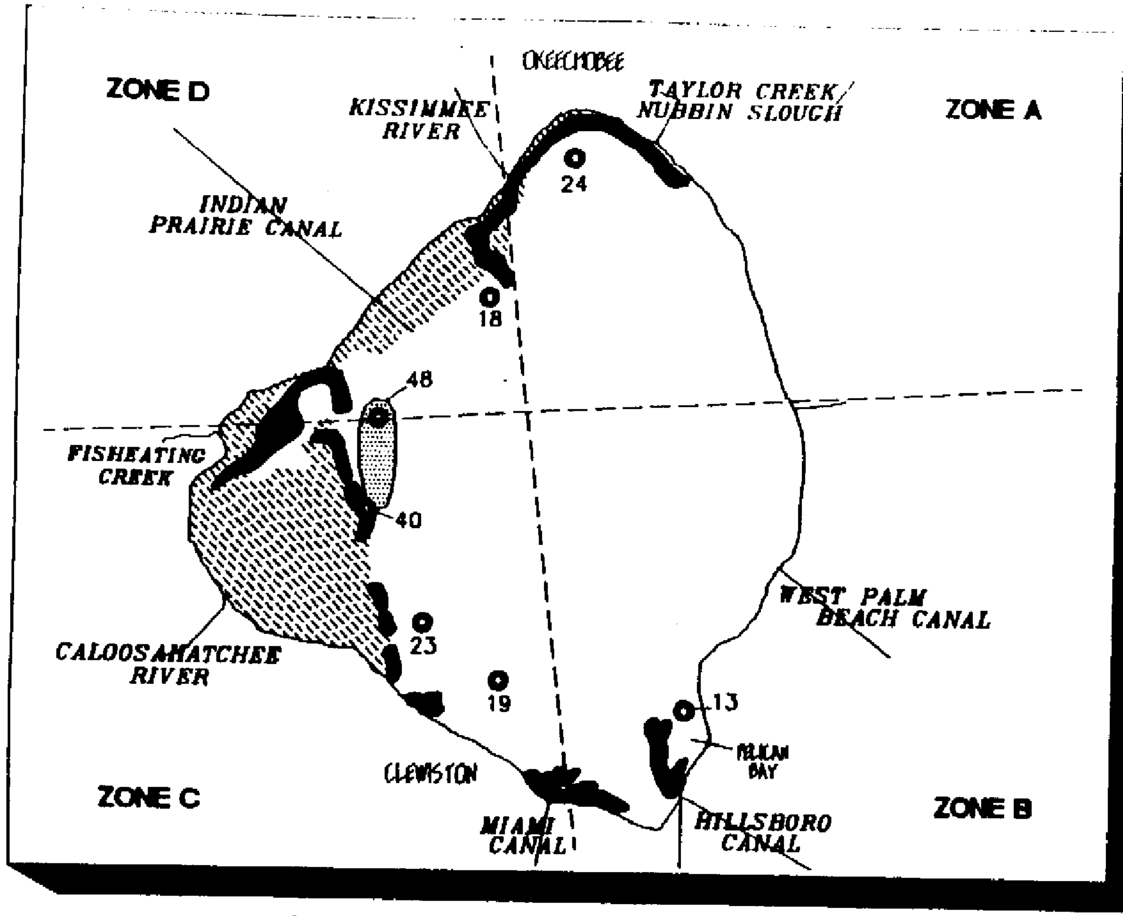
LEGEND

- SAMPLING SITE
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- ‹ 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.



LAKE WATCH 11/19/86

Monday's isolated blooms in the northeast quadrant and Pelican Bay areas of the lake have dissipated. Wednesday's helicopter survey showed an algal bloom in Fisheating Bay (48 mg/m3) stretching south to the Observation Shoal area (40 mg/m3). Chlorophyll–a increases in Fisheating Bay are thought to be the result of calm weather which allows algae to accumulate at the water's surface.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 6 (11/20/86)

LEGEND

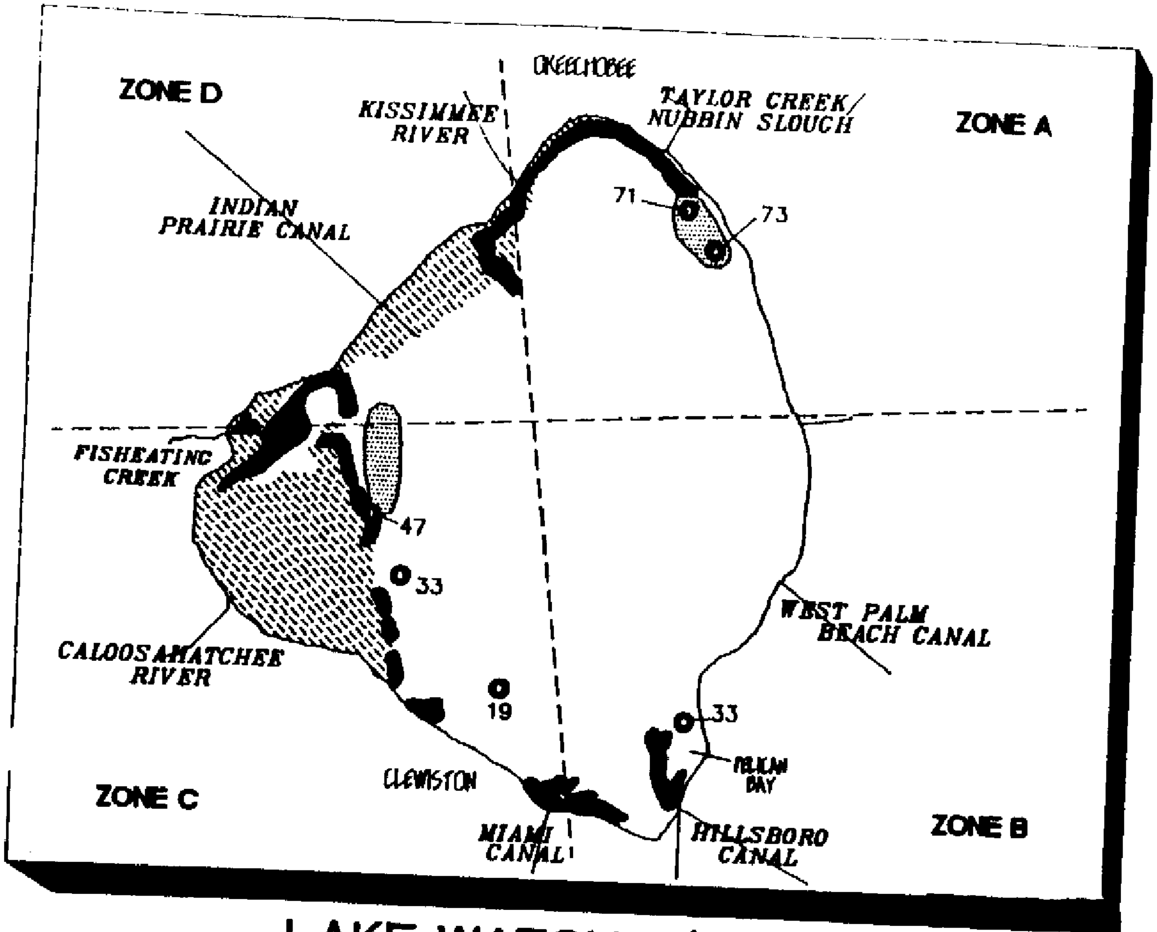
- SAMPLING SITE
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
LAKE OKEECHOBEE UPDATE # 7 (11/24/86)



LAKE WATCH 11/21/86

Low intensity isolated blooms in the northeast quadrant and near Observation Shoal were detected in samples taken on the above date. The highest Chlorophyll-a readings were found near the northeastern shoreline between Henry Creek and pump station S-135. These Chl-a values are believed to be the result of calm weather which allows the algae to accumulate near the water's surface.

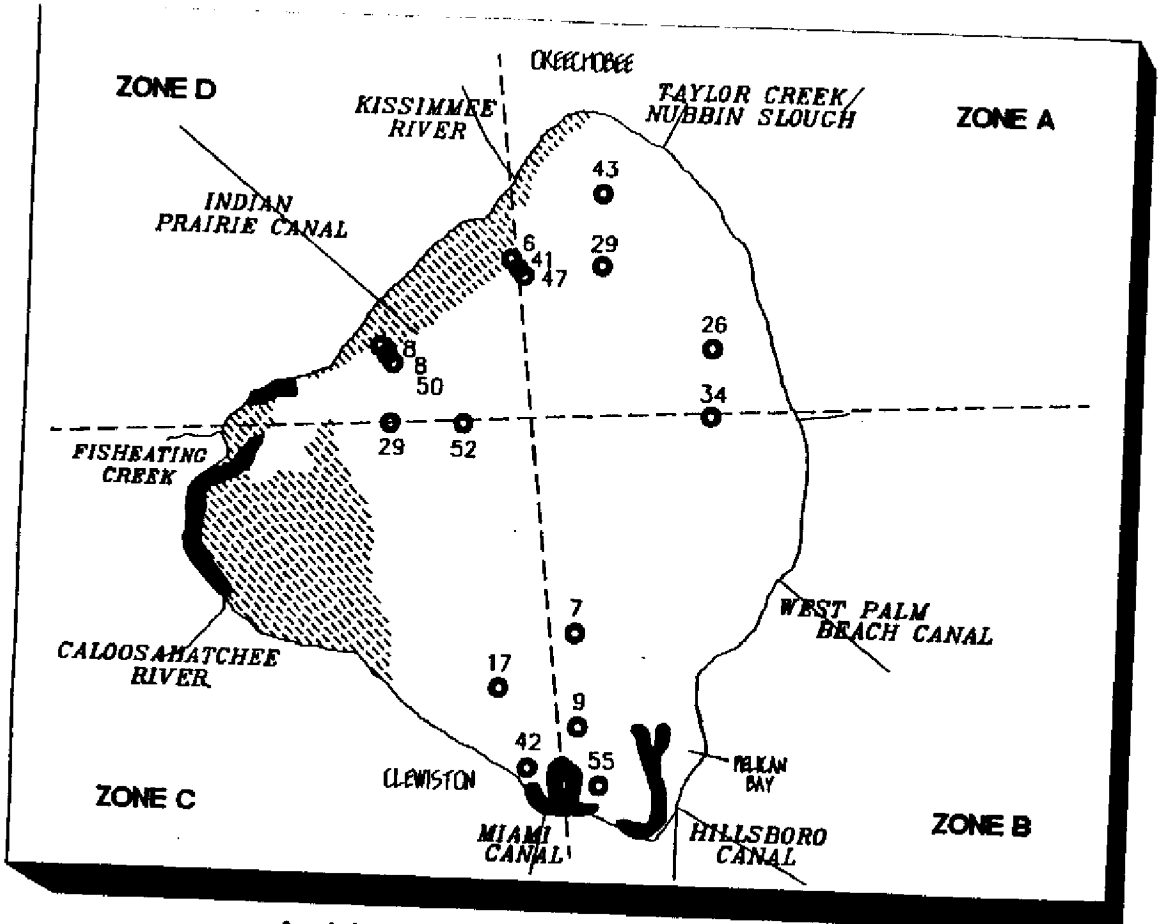
LEGEND

- SAMPLING SITE
- PHOSPHORUS REMOVAL SIT
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.



LAKE WATCH 12/11/86

Seventeen water samples were collected yesterday and today. Results of chlorophyll-a tests indicate the occurrence of low-intensity algal blooms in the northwest section and south end of the lake. These chlorophyll values are typical of late autumn levels recorded in the lake during the last thirteen years. The dominant species are a mixture of blue-green algae and diatoms which are normally found in the lake. There have been no reports of adverse impacts from the current algal levels.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 8 (12/11/86)

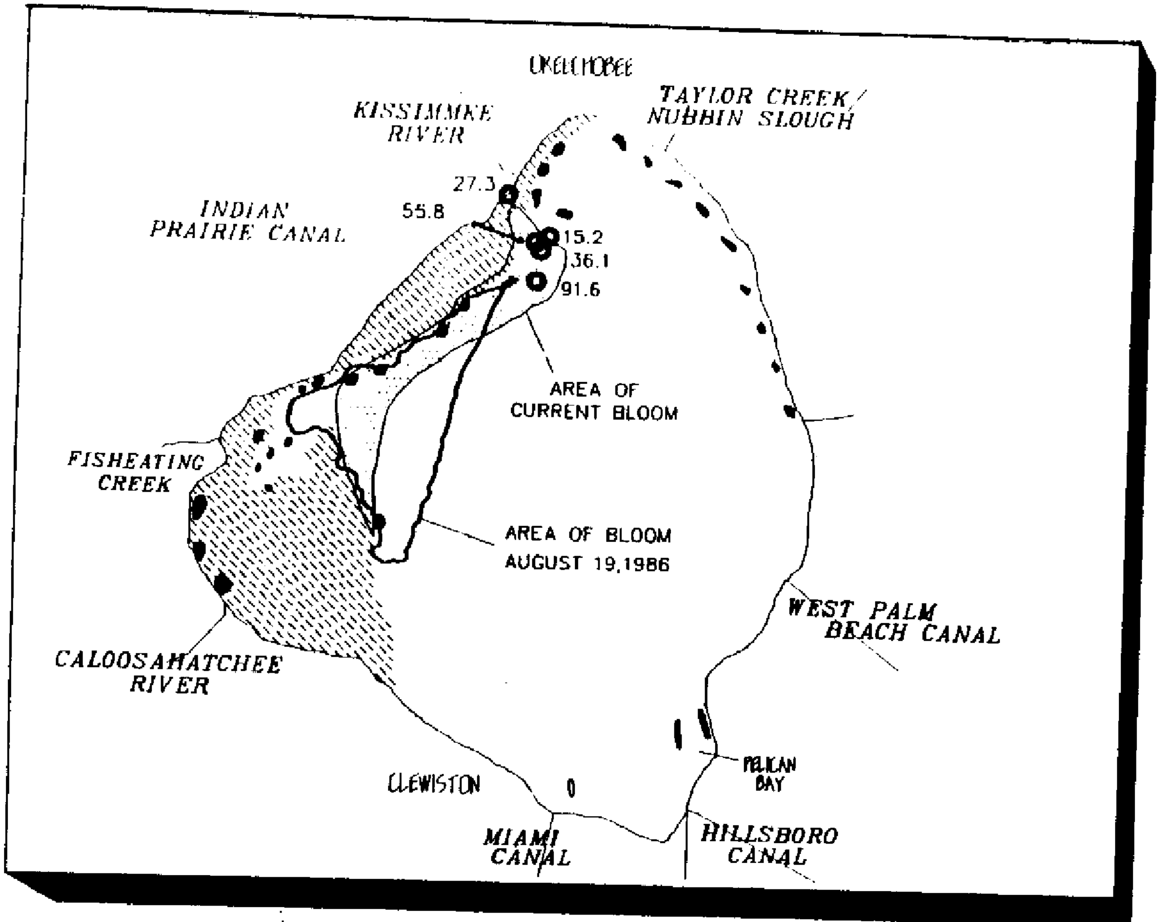
LEGEND

- SAMPLING SITE
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.



LAKE WATCH 04/24/87

Elevated levels of Anabaena circinalis have been detected in some areas offshore of marshes along the western side of Lake Okeechobee. Of five samples taken from the vicinity of King's Bar on Thursday afternoon (April 23), two contained Chlorophyll-a values indicative of a bloom. Three other samples showed Chlorophyll-a values considered normal. Public reports of a bloom extending South from King's Bar are under investigation. Calm conditions and warm temperatures may be encouraging Anabaena growth at the surface. There are no reports of adverse impacts to fish or wildlife.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 9 (04/24/87)

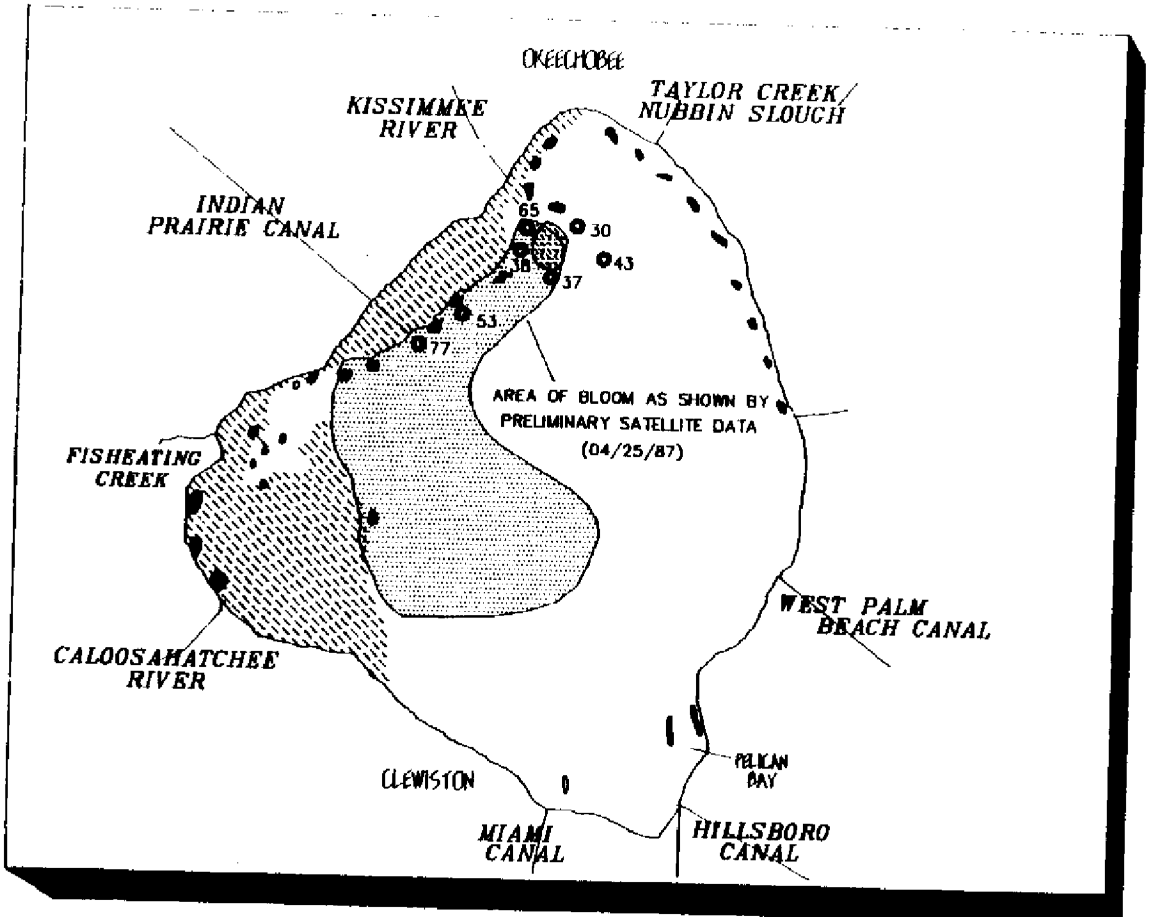
LEGEND

- SAMPLING SITE
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.



LAKE WATCH 04/28/87

Field investigations Friday (4/24) and Sunday (4/26) revealed that the algae bloom detected last week continues along the western shore of the lake, with the highest chlorophyll-a values offshore of Indian Prairie Canal and west of King's Bar. Preliminary satellite imagery taken Saturday showed the bloom to cover a wide area of the southwest portion of the lake. Sunday's reconnaisance of the western shoreline showed no adverse impacts to lake or marsh aquatic organisms.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 10 (04/26/87)

LEGEND

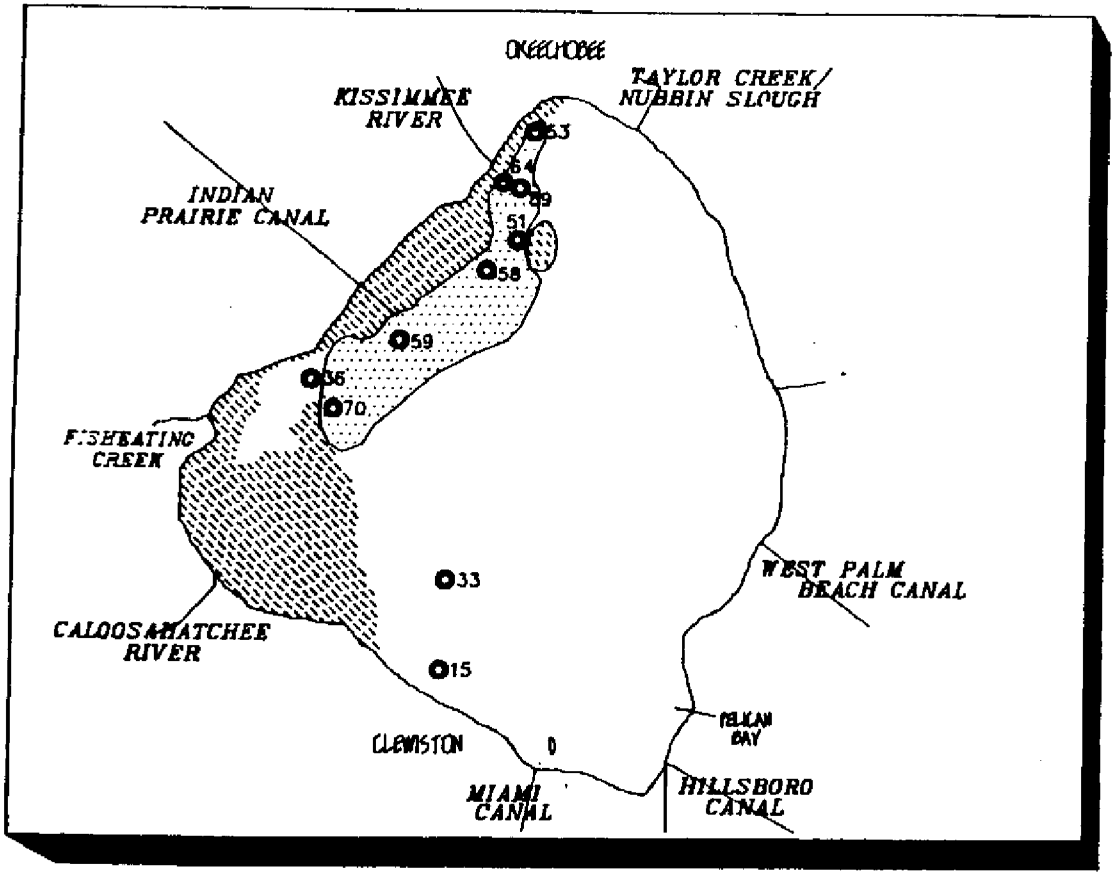
- SAMPLING SITE
- CHEMICAL SPRAY AREA
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

CALL
1-800-221-5533
TO REPORT ALGAL BLOOMS OR FISH KILLS.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 11 (05/14/87)



LAKE WATCH 05/14/87

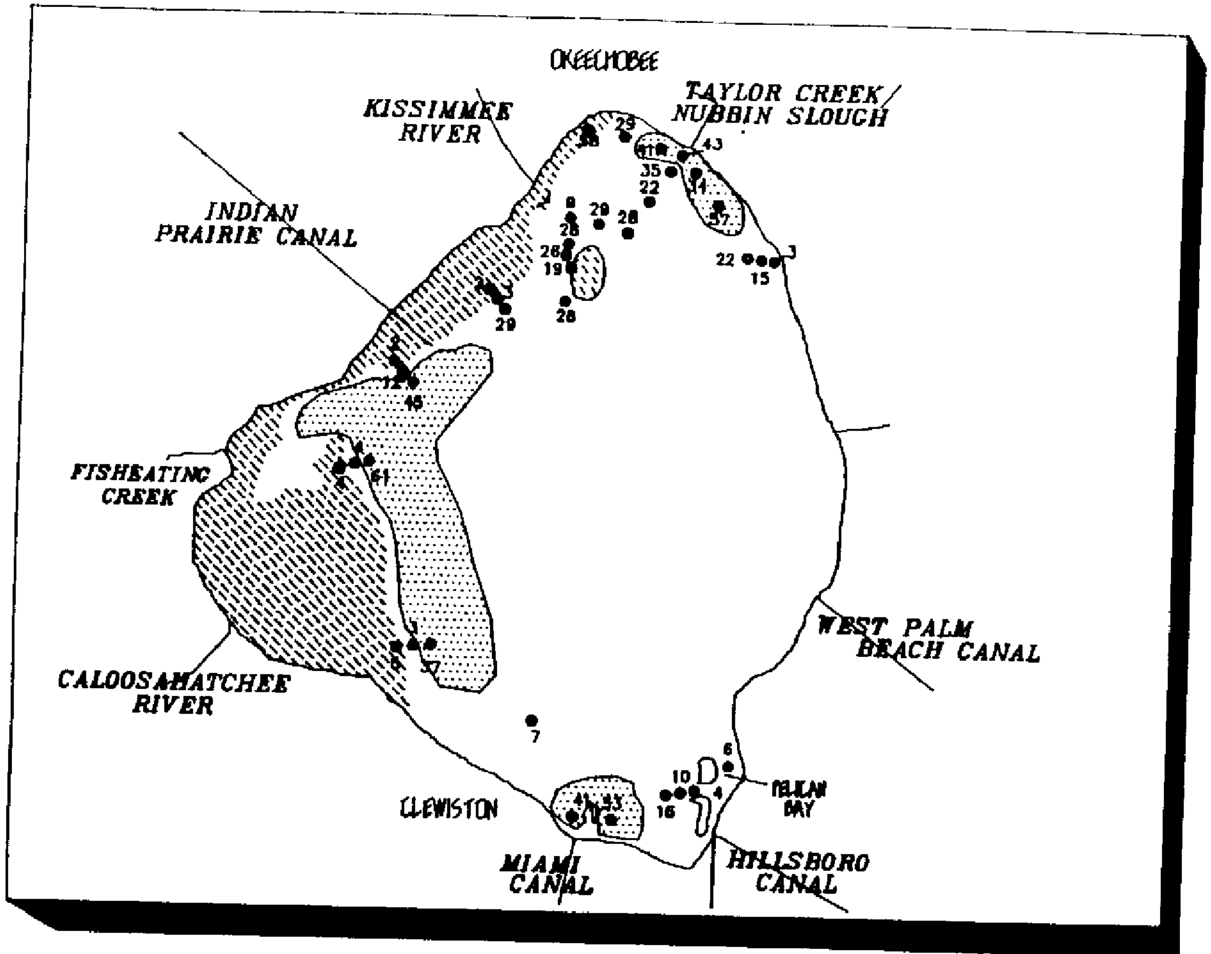
Ten phytoplankton samples were collected by helicopter. Chlorophyll analysis indicates that a bloom exists from the Kissimmee River west to Observation Shoal, a distance of about 20 miles. The eastward extent of the bloom has not been defined. The highest value was 89 mg/m3 on the north side of King's Bar. Algal identification was made from two samples collected near the Kissimmee River. Two blue-green algae, Anacystis and Anabaena, were the dominant organisms. A small fish kill composed mainly of bream and shad (about 100-200 fish) was also found at Eagle Bay Island east of the Kissimmee River and appears to be associated with a dense growth of hydrilla and periphyton (Cladophora).

LEGEND

- ● SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 05/22/87

Thirty-six phytoplankton samples from the littoral and open water zones were collected by boat on May 19 and 20. Bloom conditions exist in several open water areas from the north end to Fisheating Bay and Ritta Island. The offshore extent has not been defined. The highest chlorophyll concentration was 61 mg/m3. The intensity and size of this bloom appears to have increased since these areas were sampled two weeks ago. No highly concentrated accumulations of phytoplankton were observed.

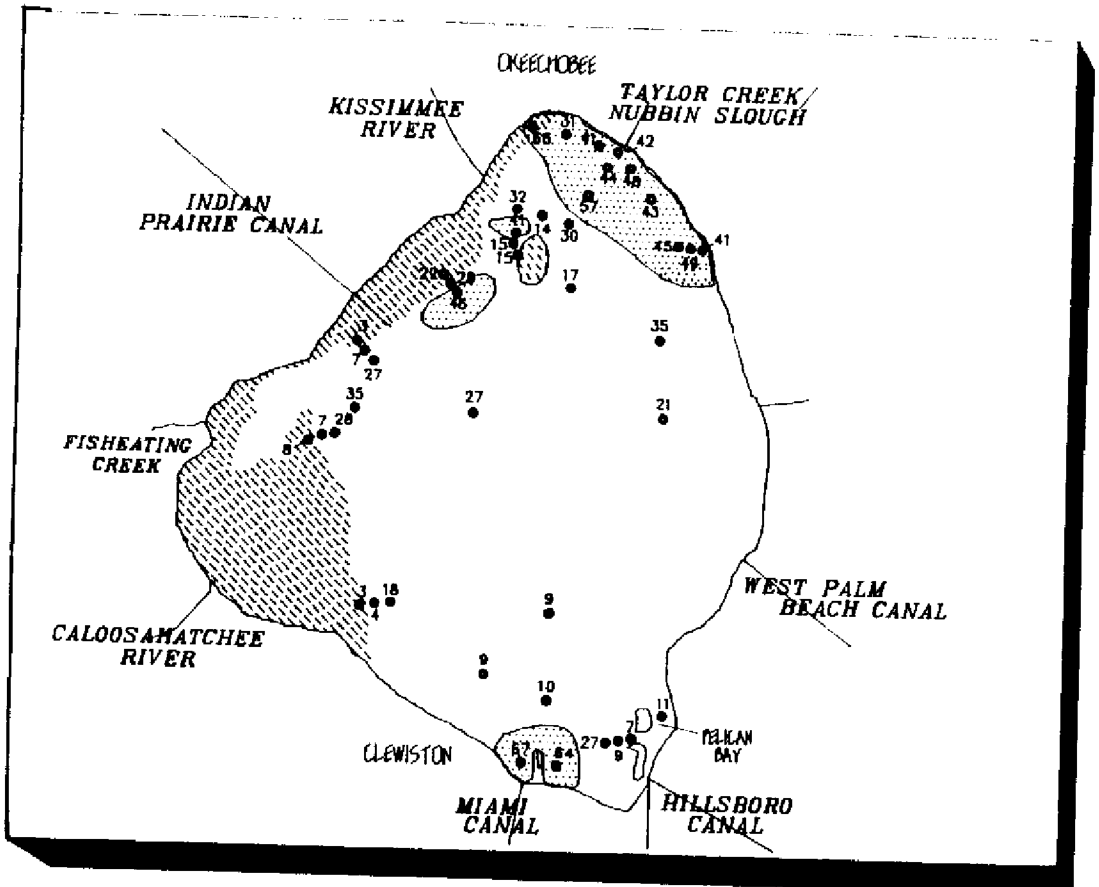
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 12 (05/20/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 06/08/87

Forty-three phytoplankton samples from the littoral and open water zones were collected by boat on June 2, 3, and 4. A low intensity bloom was found in the north end from the Kissimmee River to Henry Creek Lock. Other chlorophyll values above 40 mg/m3 were measured near King's Bar. The highest values were found in the south end near Ritta Island. No highly concentrated accumulations of phytoplankton were observed.

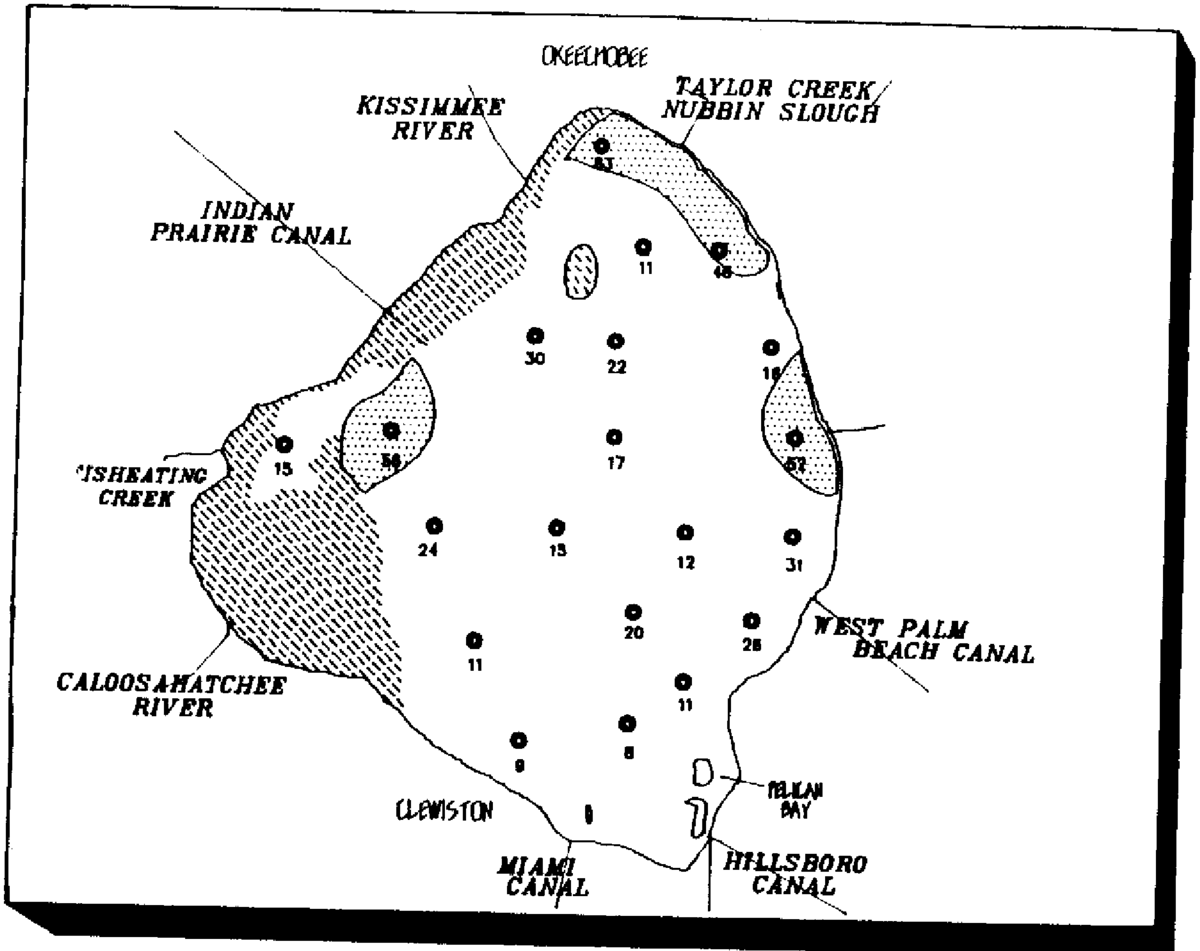
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 13 (06/2-4/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 06/09/87

Twenty phytoplankton samples were collected by helicopter on 06/08/87. An algal bloom comprised of Lyngbya limnetica and Schizothrix calcicola occurred in the extreme north end of the lake in association with one chlorophyll a value of 83 mg/m3. Both reported species are common components of the lake's algal flora. Two distinct blooms were also recorded at the mouth of Fisheating Bay (56 mg/m3) and west of Port Mayaca (52 mg/m3). These blooms were also comprised of algae that commonly occur within the lake throughout the year. Open water areas of the lake were highly turbid due to sediment resuspension as a result of 15–20 mph easterly winds.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 14 (06/08/87)

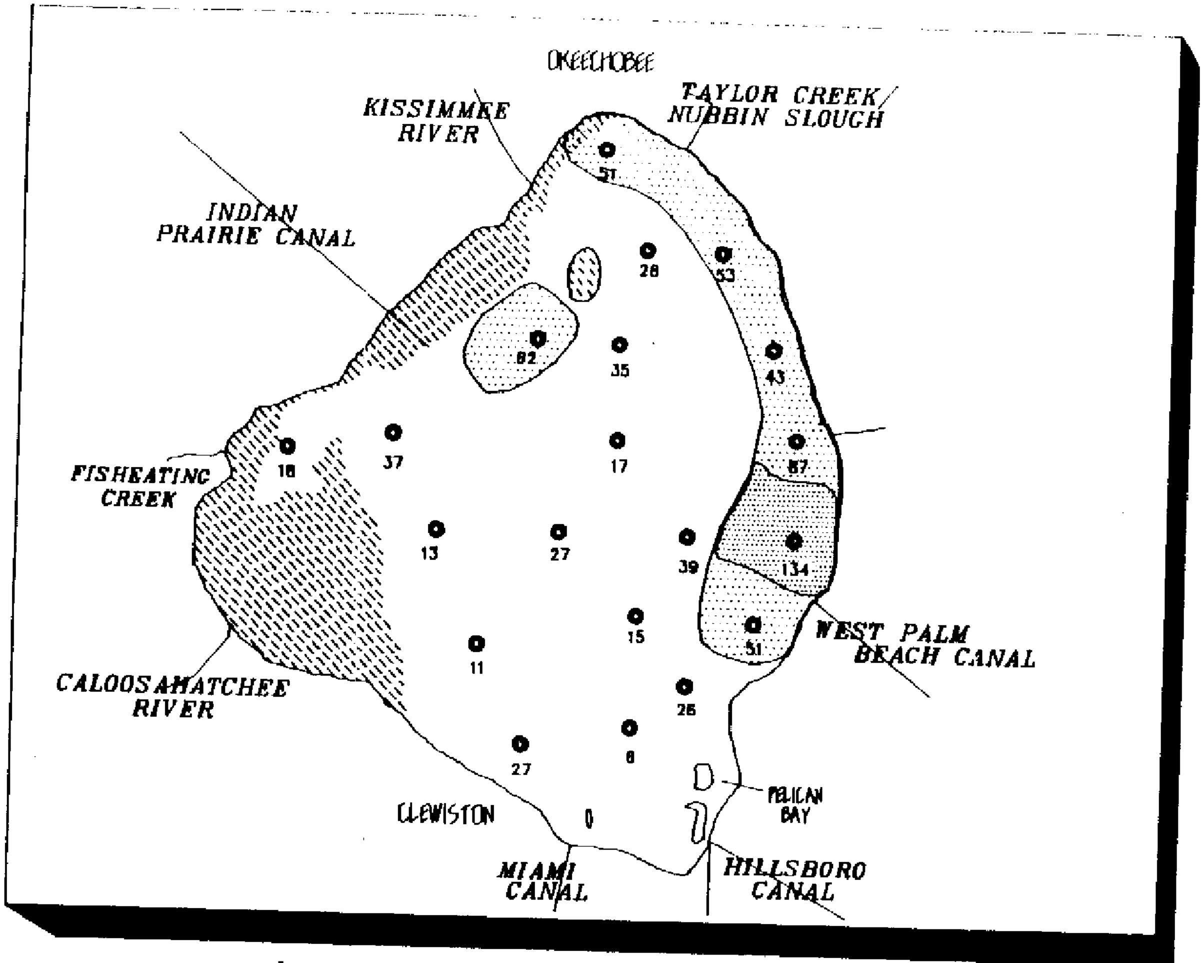
LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 15 (06/15/87)



LAKE WATCH 06/16/87

An intense bloom is located on the east side of the lake between Port Mayaca and Pahokee. This bloom is made up of Anabaena circinalis along with other species common to the lake. The highest measured chlorophyll value was 134 mg/m3. On June 11, a value of 122 mg/m3 was measured in the same area. This bloom has been present on the east side for a week, but has grown in intensity. Observations of the lake will continue this week.

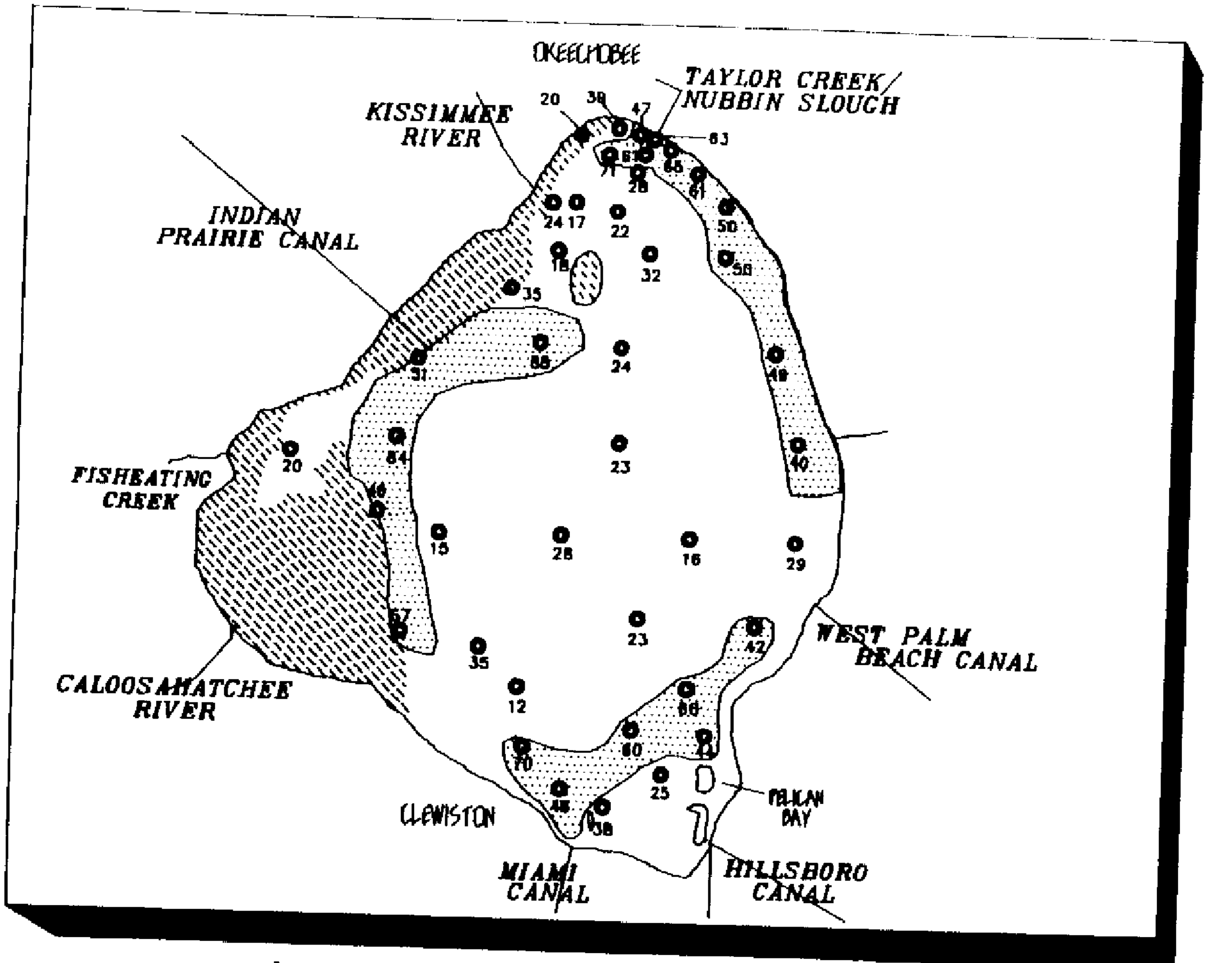
LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (Lake Average = 23.0 mg/m^3)

(milligrams per cubic meter)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 16 (06/16-22/87)

LEGEND

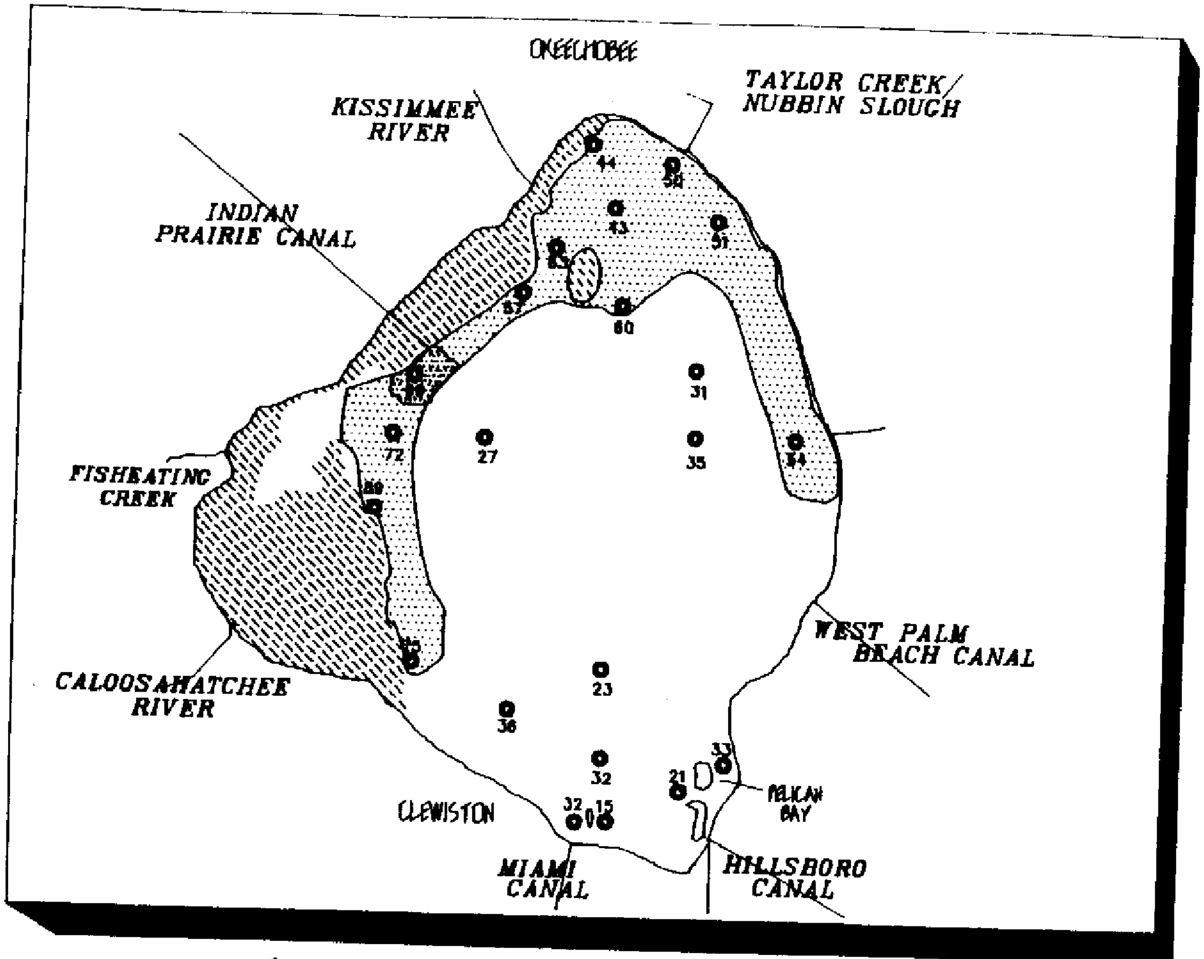
- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

LAKE WATCH 06/23/87

The data shown on this map are from samples collected between June 16 and June 22. The intense bloom that appeared on the east shore early last week had dispersed by last Friday. A bloom condition still exists in the east, and now blooms are also occurring on the south and west sides of the lake. The highest chlorophyll value measured was 88 mg/m3. No algal accumulations were found in the littoral zone and no adverse impacts from the blooms are evident.



SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 17 (06/24–25/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

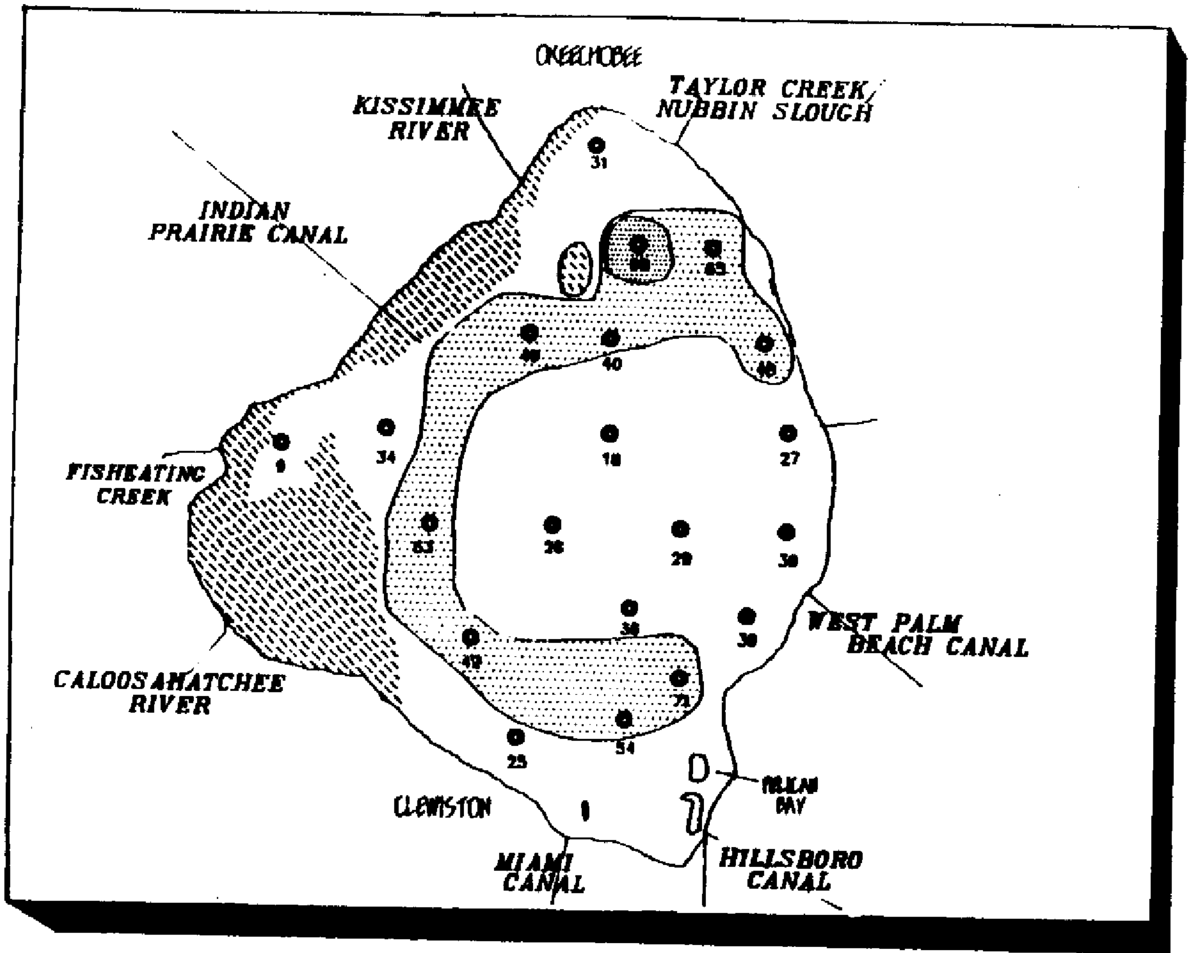
CHLOROPHYLL-A (Lake Average = 23.0 mg/m³)

(milligrams per cubic meter)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

LAKE WATCH 06/26/87

The latest water quality data from Lake Okeechobee were collected on June 24 and 25. An algal bloom still occupies the north, east, and west sides of the lake. A bloom condition was not evident on the south side. The most intense portion of the bloom is near the Indian Prairie Canal. The highest chlorophyll value measured was 99 mg/m3. No adverse impacts from this bloom were found.



LAKE WATCH 07/01/87

Twenty samples were collected by helicopter on Monday, June 29. An algal bloom is still present on the north, east, and west sides of the lake. This condition has existed for the last two weeks. The highest chlorophyll value measured was 98 mg/m3 in the lake's north end.

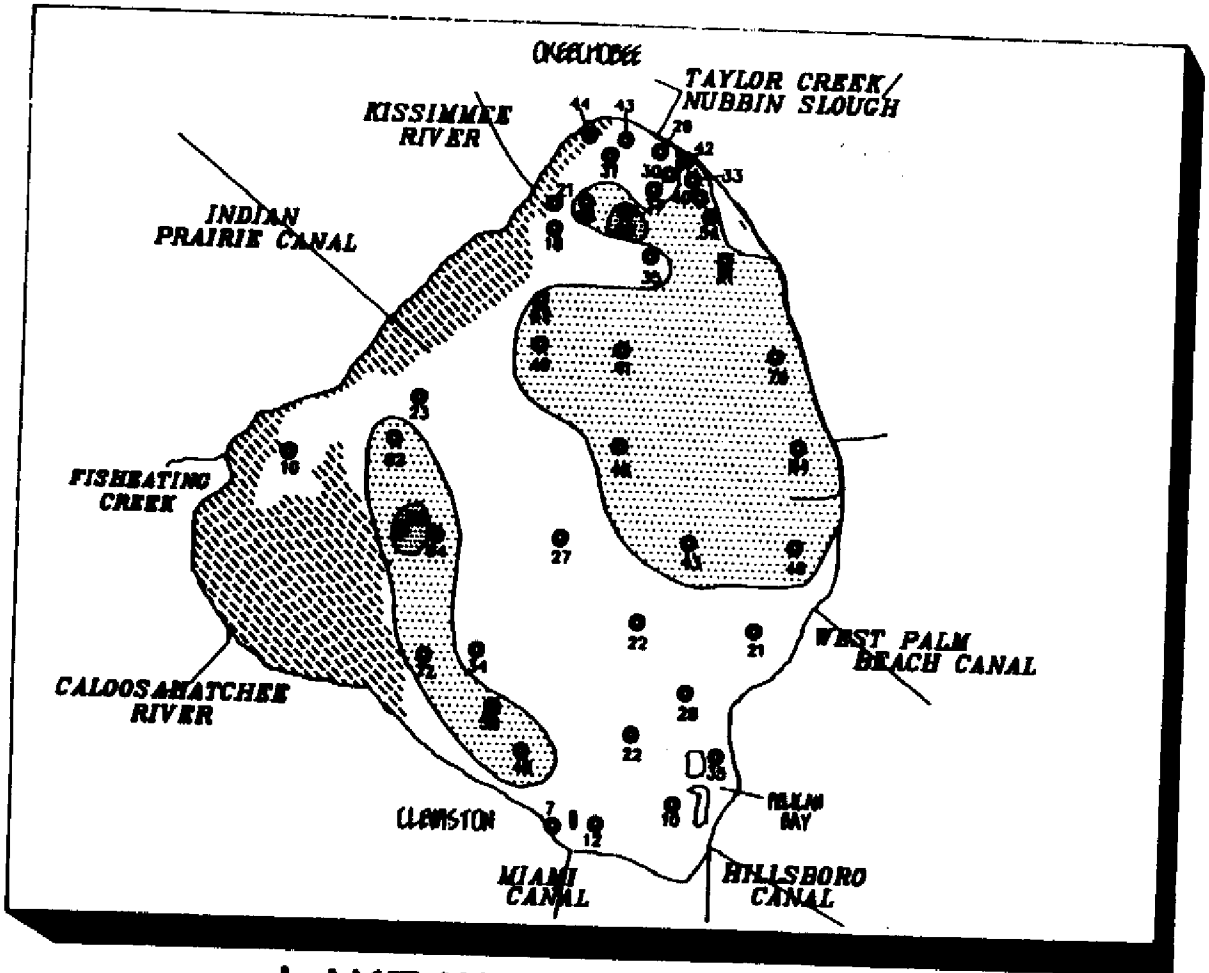
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 18 (06/29/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 07/07/87

Forty-two sites were sampled between June 30 and July 6. An algal bloom remains in the north and west sides of the lake. The highest chlorophyll levels were 99 mg/m3 in the north end and 90 mg/m3 near Observation Shoal. Compared to the previous week, the bloom covers a larger area of the eastern shore, but has receeded in the south end. Chlorophyll values from the middle of the lake were just above the minimum considered to be a bloom. The bloom was comprised of blue greens and diatom species commonly found in the lake, but did not include Anabaena. No adverse ecological impacts had been observed as a result of the present bloom.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 19 (06/30-07/06)

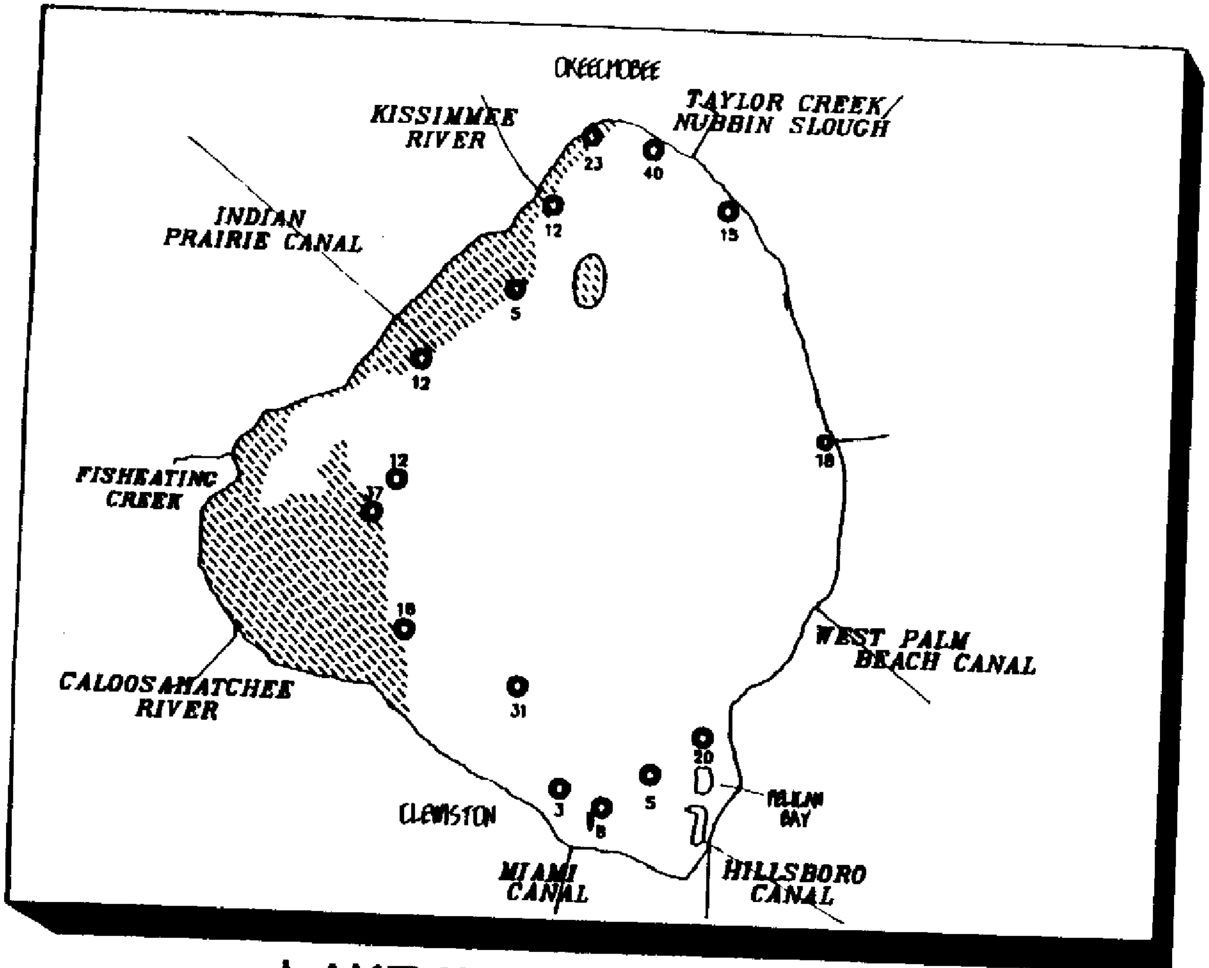
LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 20 (07/09/87)



LAKE WATCH 07/13/87

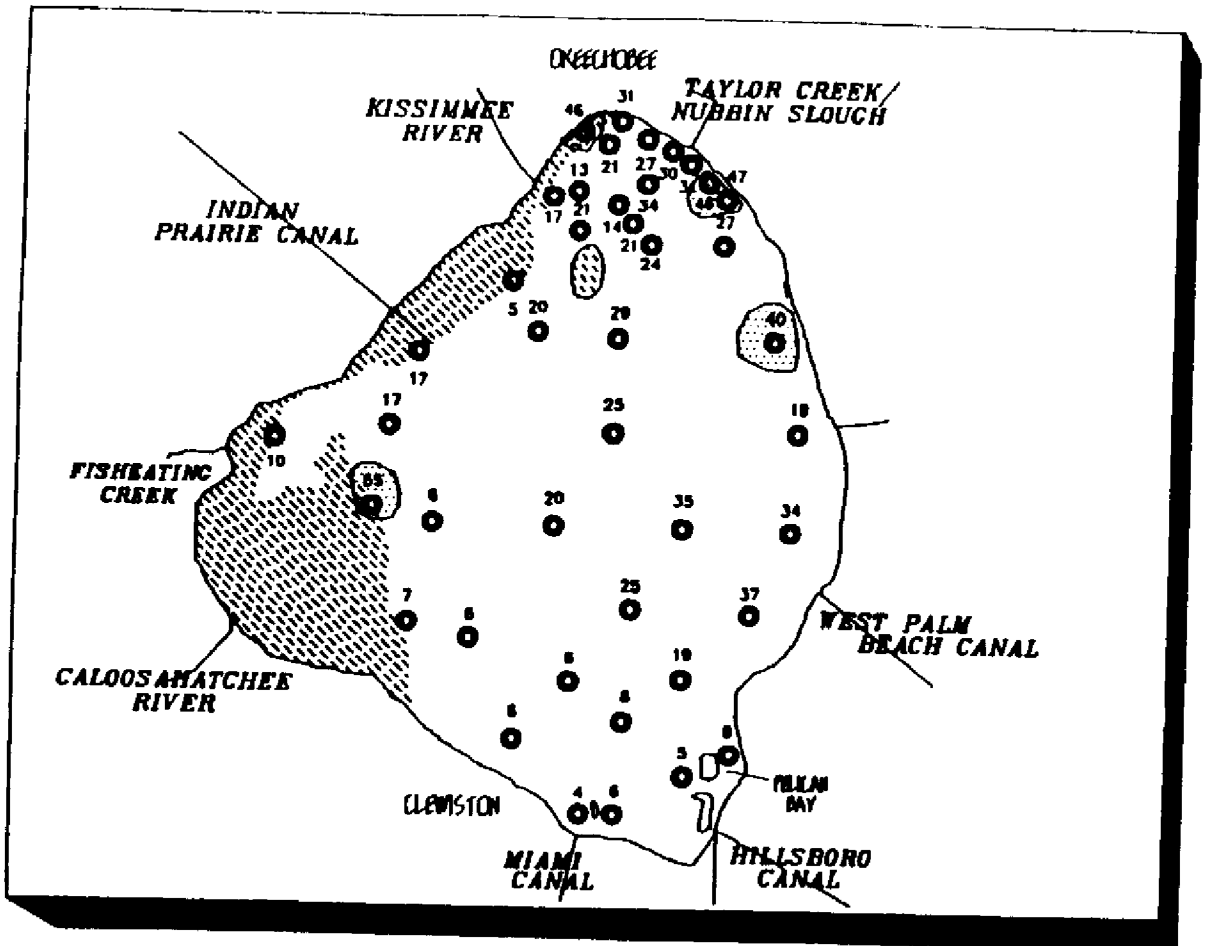
Samples collected on Thursday, July 9 showed that algal populations have decreased substantially since the last observation on July 6. No large-scale bloom was found; the highest chlorophyll value measured was 40 mg/m3 near Taylor Creek /Nubbin Slough. These data were confirmed visually by helicopter today. Results from today's samples will be reported later this week. It is not uncommon for Lake Okeechobee to experience a mid-summer decline in phytoplankton. More blooms can be expected in the coming weeks.

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 07/20/87

Samples at 42 sites were collected between July 13 and 16 by boat and helicopter. Only 5 sites had chlorophyll values of 40 mg/m3 or above. The highest value was 55 mg/m3. These data confirm that the algal bloom that was present earlier this month has subsided. More blooms are expected later this summer.

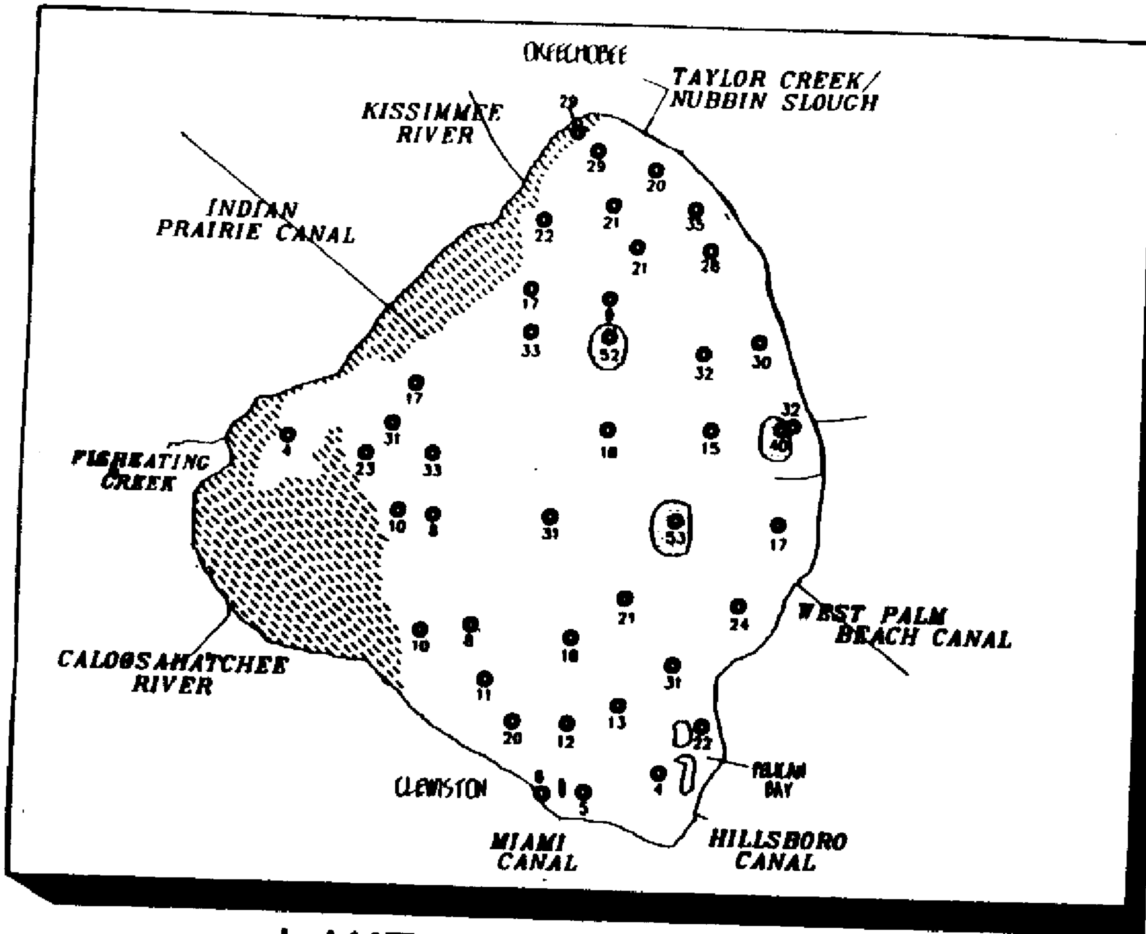
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 21 (07/13–16/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL–A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 22 (07/20–23/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

LAKE WATCH 07/24/87

Samples at 43 sites between July 20 and 23 showed that the phytoplankton condition had not changed from the previous week. Only 3 sites had chlorophyll values of 40 mg/m3 or above, indicating the presence of a visible bloom. These sites are in the central portion of the lake. The highest value was 53 mg/m3.

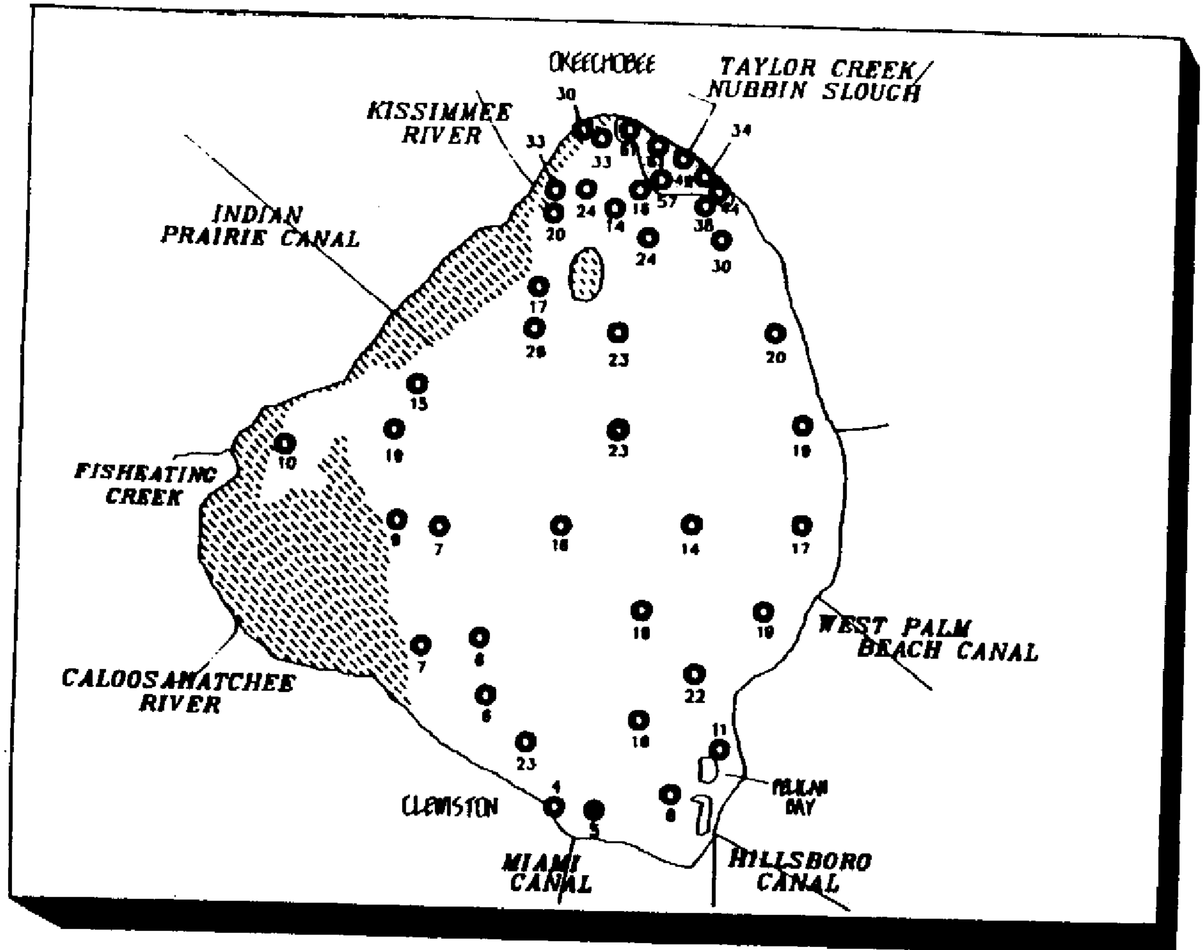
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 23 (07/27–29/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (Lake Average = 23.0 mg/m³)
(milligrams per cubic meter)

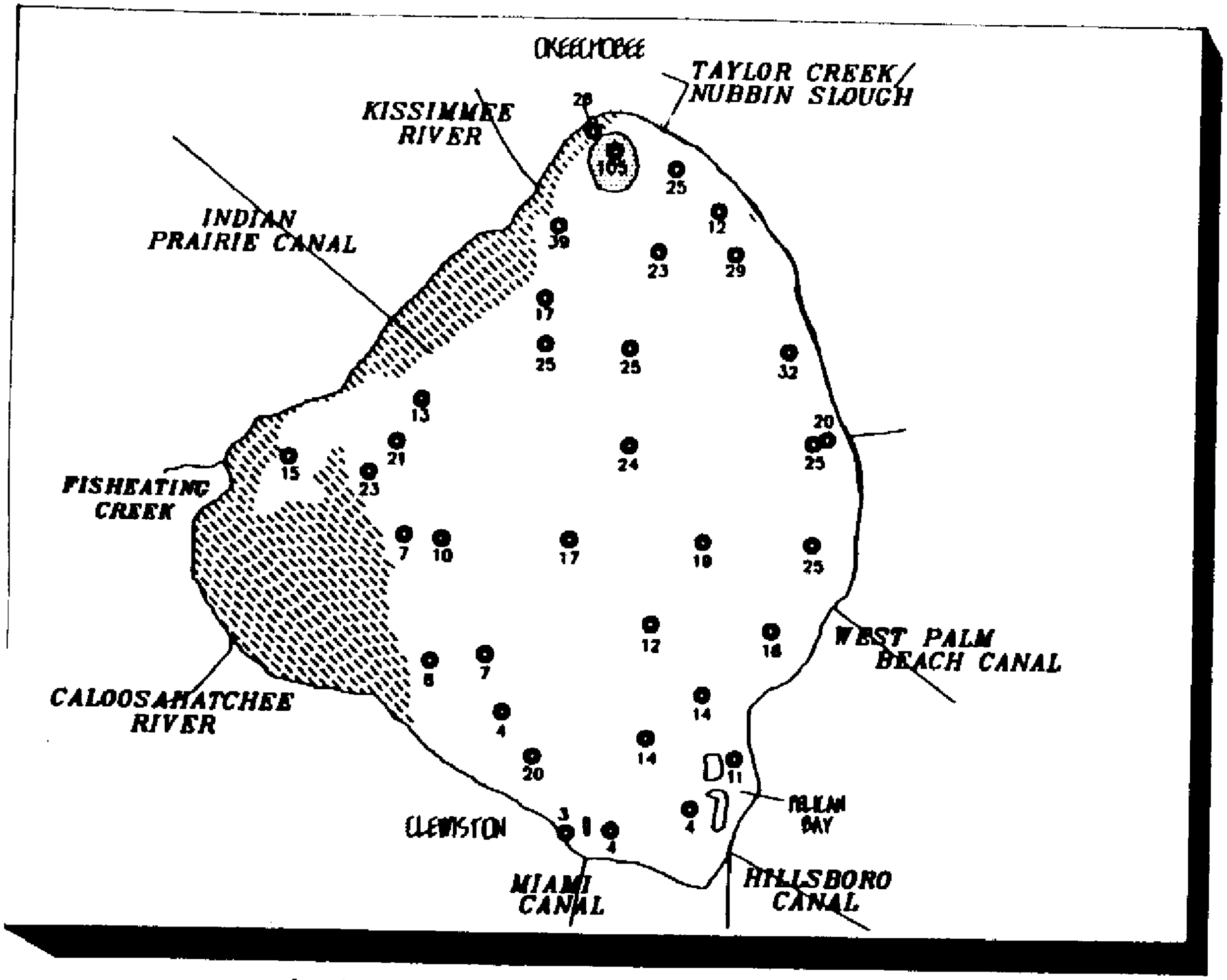
- < 40 no distinct bloom
- 40 – 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 07/31/87

Forty-two sites were sampled by boat and by helicopter between July 27 and 29. An algal bloom covered a small area near the Taylor Creek/Nubbin Slough basin. The highest Chlorophyll value was 61 mg/m3. Concentrations were relatively low in other areas of the lake.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 24(08/03–06/87)



LAKE WATCH 08/07/87

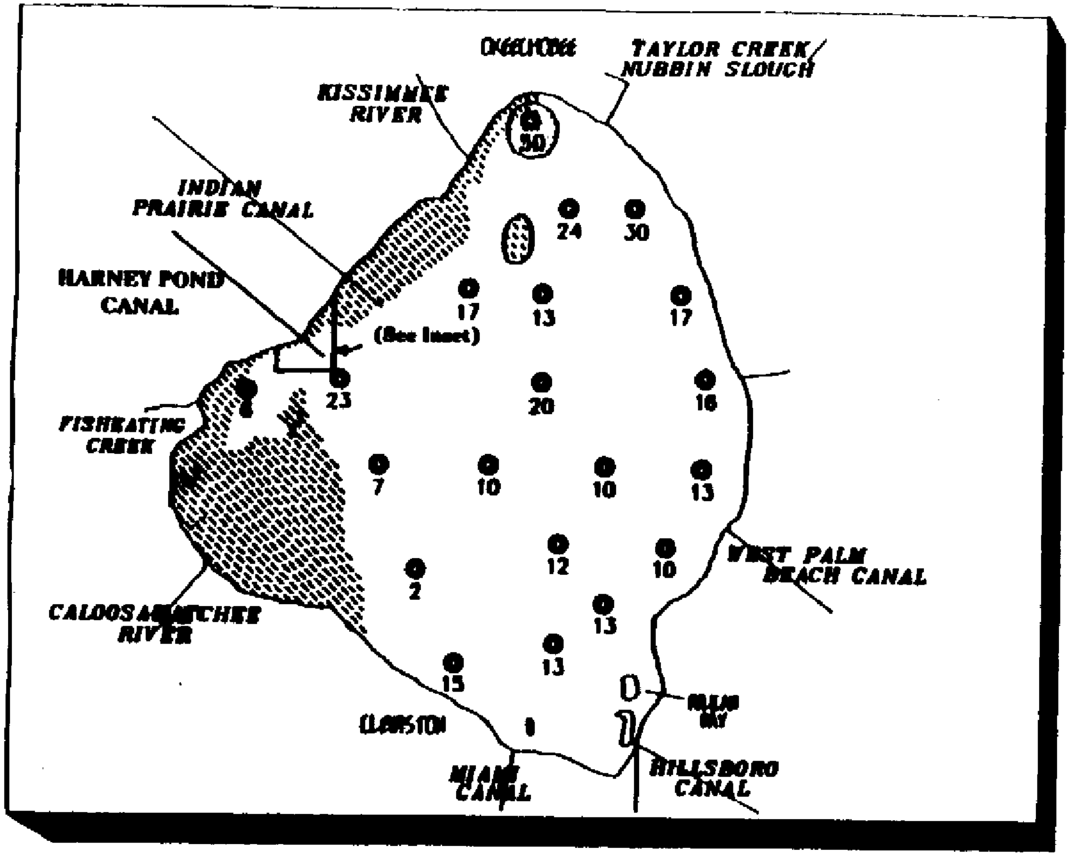
An algal bloom composed of common blue–green and diatom species covered a small area in the lake's north end. One sample site had a chlorophyll value of 105 mg/m3. This site is about a mile offshore. Samples taken closer to shore, as well as all other samples collected this week, measured below 40 mg/m3. The south and west sides of the lake were exceptionally clear of algae and turbidity.

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- ‹ 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 08/12/87

Twenty stations were sampled for Lake watch on August 10 over the entire lake. Only one site in the north end had a bloom condition present (chlorophyll = 50 mg/m^3). Conditions have not changed from the previous week. Most of the lake remains relatively clear of phytoplankton.

A bloom covering about 500 acres on the west side of Harney Pond Canal was investigated August 12. The bloom is confined to a hydrilla bed (hydrilla presently covers most of Fisheating Bay) and appears to be unrelated to a fish kill found on the east side of the canal (see attached inset). Chlorophyll values ranged from 48 to 103 mg/m^3 within the bloom area. The predominant bloom organisms are Microcystis sp. and Anabaena circinalis. These patchy blooms are frequently found associated with hydrilla.

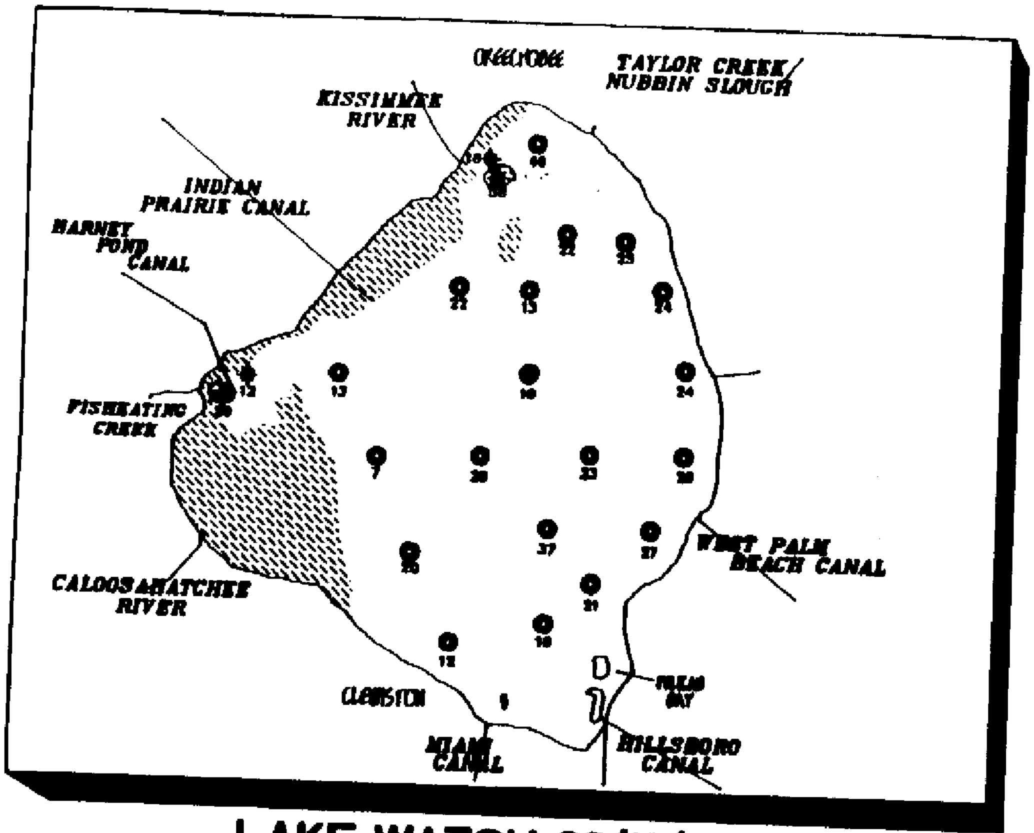
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 25(08/10–12/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (Lake Average = 23.0 mg/m^3)
(milligrams per cubic meter)

- < 40 no distinct bloom
- 40 – 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 08/18/87

Although chlorophyll levels in the algae bloom located in the Harney Pond area are declining, a sample collected 08/13/87 was sent to Wright State University in Ohio for analysis. The sample was found to contain a toxic strain of <u>Microcystis</u>, a blue-green algae, which could potentially be harmful in higher concentrations. No evidence of stress on Lake organisms has been observed in the area of the bloom.

Another <u>Microcystis</u> bloom in the north end of the Lake, in the Eagle Bay area, is being closely observed. A sample has been sent to Wright State University to determine whether this bloom contains toxic algae.

Chlorophyll concentrations were relatively low in other areas of the Lake.

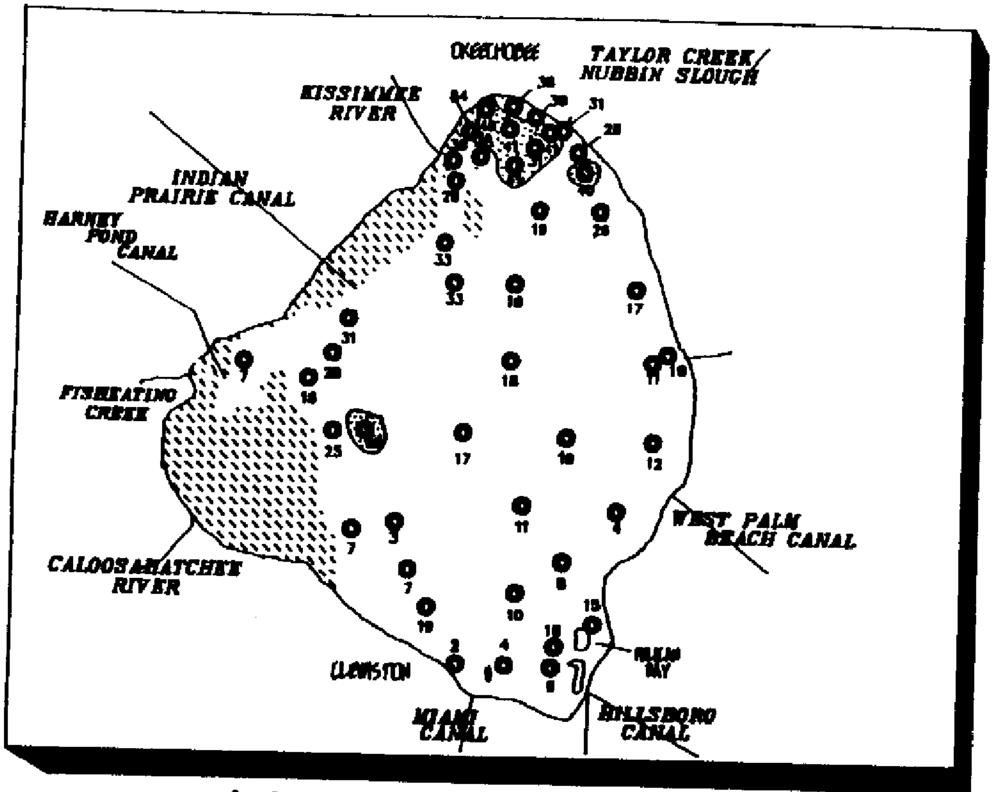
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE #26 (08/14-17/87)

LEGEND

- SPECIAL INTEREST AREAS
- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 08/28/87

Algal conditions in Lake Okeechobee have not changed appreciably from the previous week. Samples were collected on August 24, 25, and 26.

The bloom between Eagle Bay Island and Little Grassy is still confined to an area of about 200 acres of submersed vegetation, including hydrilla. A chlorophyll level of 84 mg/m3 was measured this week. A sample from August 18 was tested for algal toxins and found to be moderately toxic to laboratory mice. The algal species responsible for producing this toxin is a blue-green, Microcystic aeruginosa, that is common bloom-forming species in the lake. No dead fish or other organisms have been observed, however.

Chlorophyll values in the rest of the lake's north end are around 40 mg/m3. On the south and west sides, the water appears greenish due to low turbidity, but almost all chlorophyll values are below the bloom level.

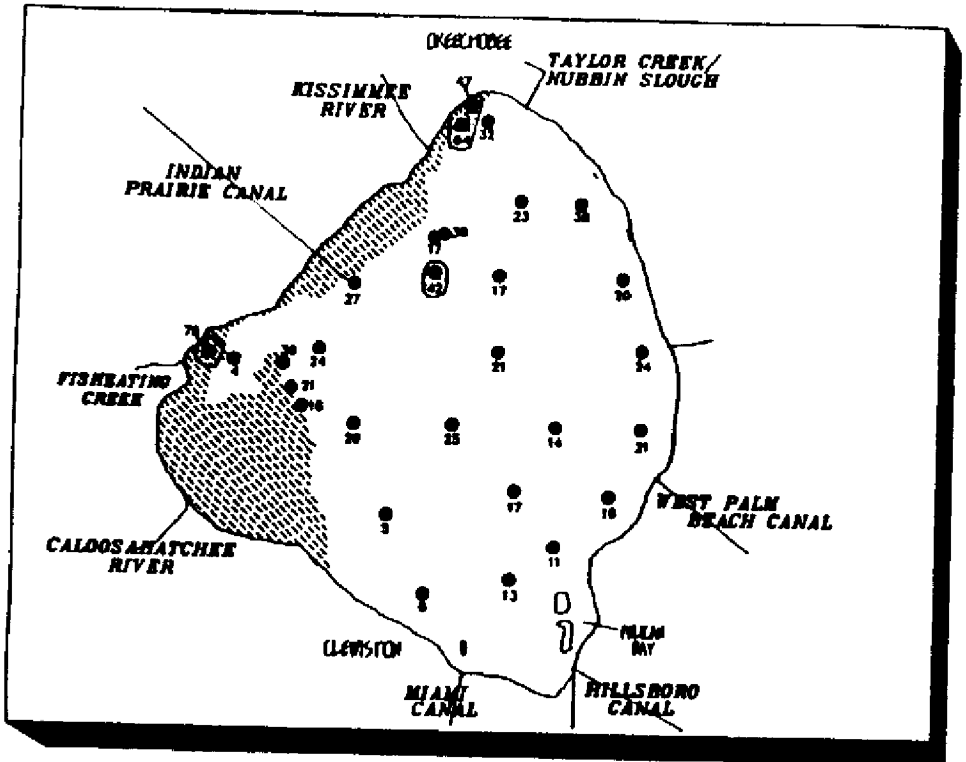
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE #27 (08/24-26/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (Lake Average = 23.0 mg/m^3)
(milligrams per cubic meter)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 09/01/87

Algal conditions on the lake have not changed appreciably during the month of August. Highest chlorophyll a values were again recorded in decaying submerged vegetation located near Harney Pond Canal (75 mg/M3) and Eagle Bay (64 mg/M3). On the whole, algal concentrations were highest in the extreme northern section of the lake, while chlorophyll a levels in the south, east and west sections of the lake existed well below the 40 mg/M3 bloom level.

The Eagle Bay bloom is still confined to submersed *Hydrilla* vegetation located 1.5 miles southwest of the Okeechobee Water Plant Intake. Examination of plankton samples collected from the vicinity of the intake structure on 8/24/87, 8/27/87, and 08/31/87 showed *Microcystis aeruginosa* to comprise less than one percent of the algal population and currently present no threat to the city's water supply. Monitoring of this site will continue until the *Microcystis* bloom in Eagle Bay subsides.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 28 (08/31/87)

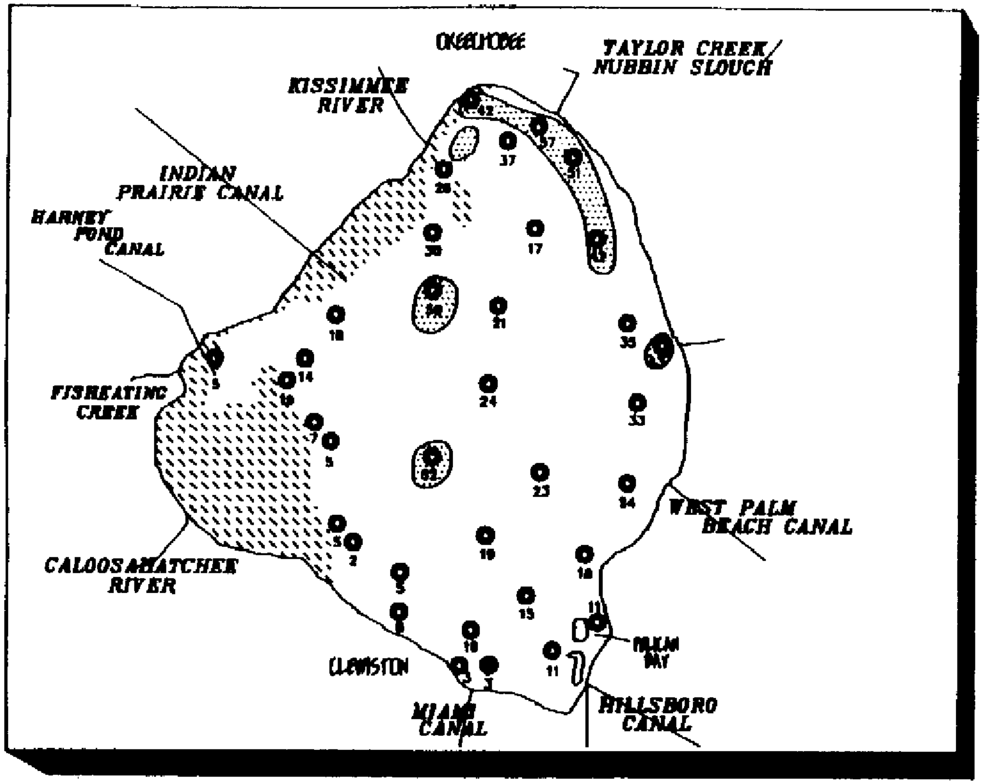
LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 – 90 distinct bloom
- 90+ possible adverse ecological impact

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE #29 (09/03–08/87)



LAKE WATCH 09/10/87

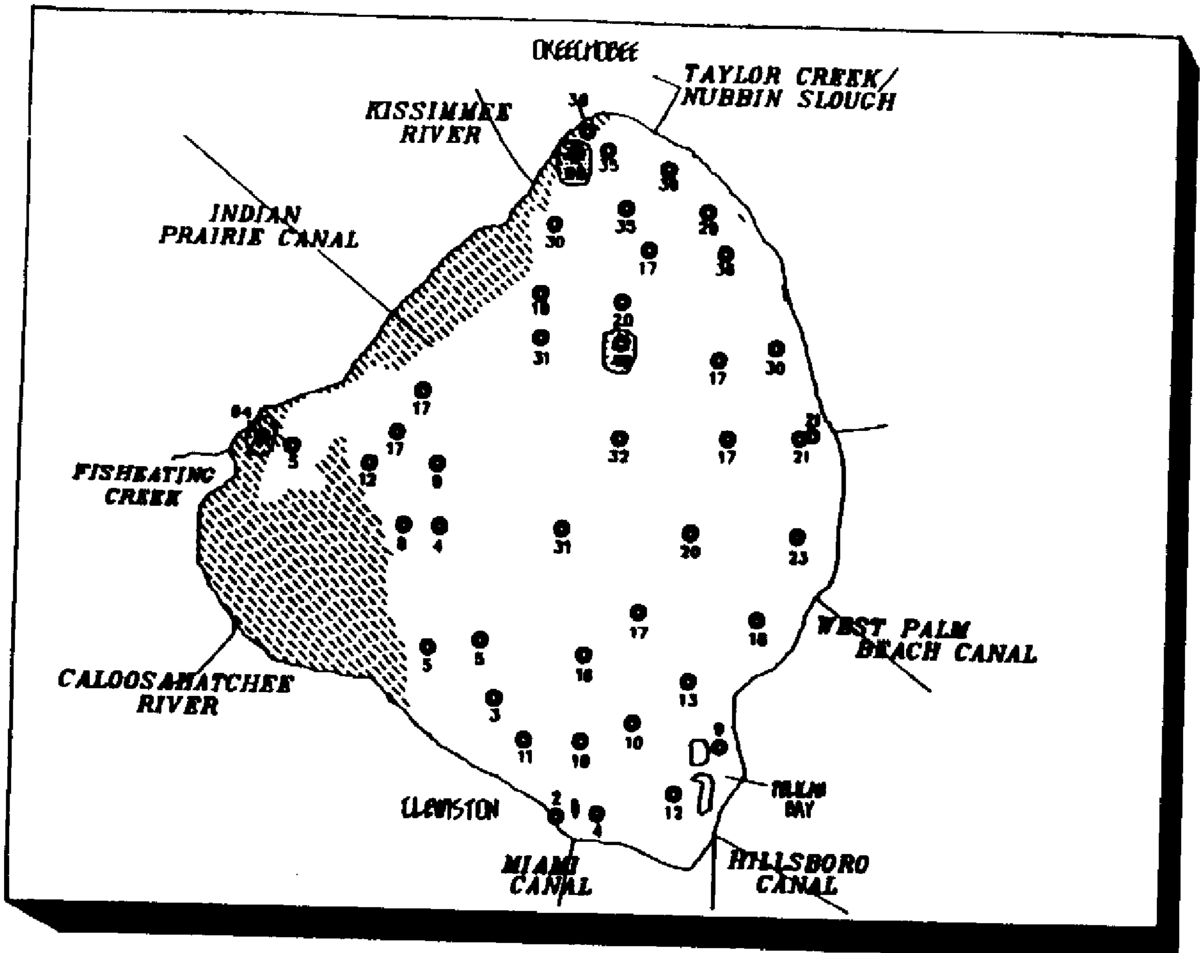
Samples were collected from nearshore areas on September 3 and offshore by helicopter on September 8. Seven sites had chlorophyll values above 40 mg/m3; the highest was 57 mg/m3. The bloom at Eagle Bay is still confined to the same area.
Microscopic examination of samples collected from the Okeechobee water plant intake on September 3 showed that <u>Microcystis aeruginosa</u> comprises less than one percent of the plankton and currently presents no threat to the city's water supply.

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 – 90 distinct bloom
- 90+ possible adverse ecological impact



SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 30 (09/14–17/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

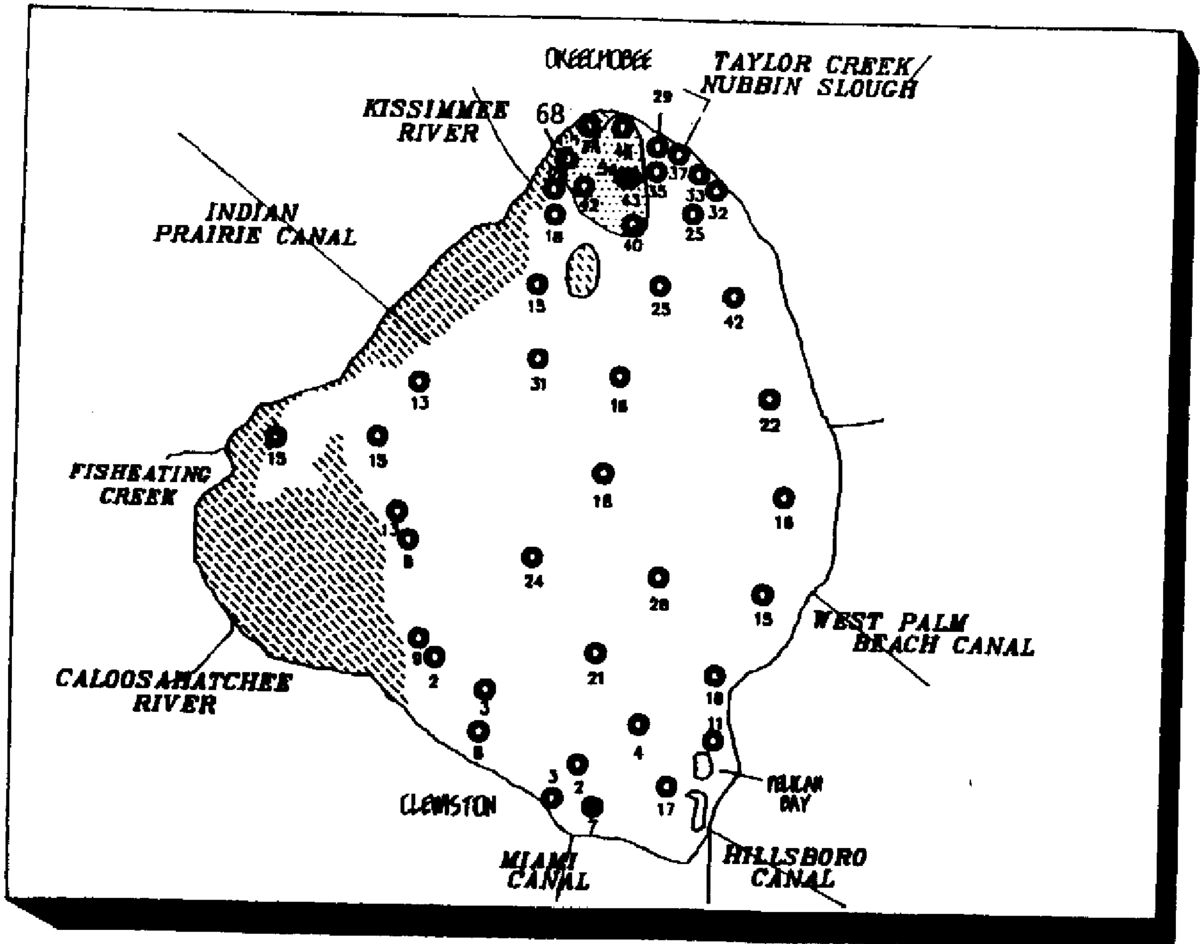
- ‹ 40 no distinct bloom
- 40 – 90 distinct bloom
- 90+ possible adverse ecological impact

LAKE WATCH 09/21/87

Samples collected on September 14 and 17 indicated no algal bloom on the lake except for the small bloom areas that persist near the Harney Pond Canal and Eagle Bay. Chlorophyll concentrations were highest in the Eagle Bay bloom (98 mg/m3 at the water surface).

Some of the lowest phytoplankton concentrations are found in the south end of the lake and water clarity there is good. However, bottom-growing algae are found in this area and tend to float to the surface, forming algal mats. These algal mats were found in South Bay this week.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 31 (09/21–23/87)



LAKE WATCH 09/28/87

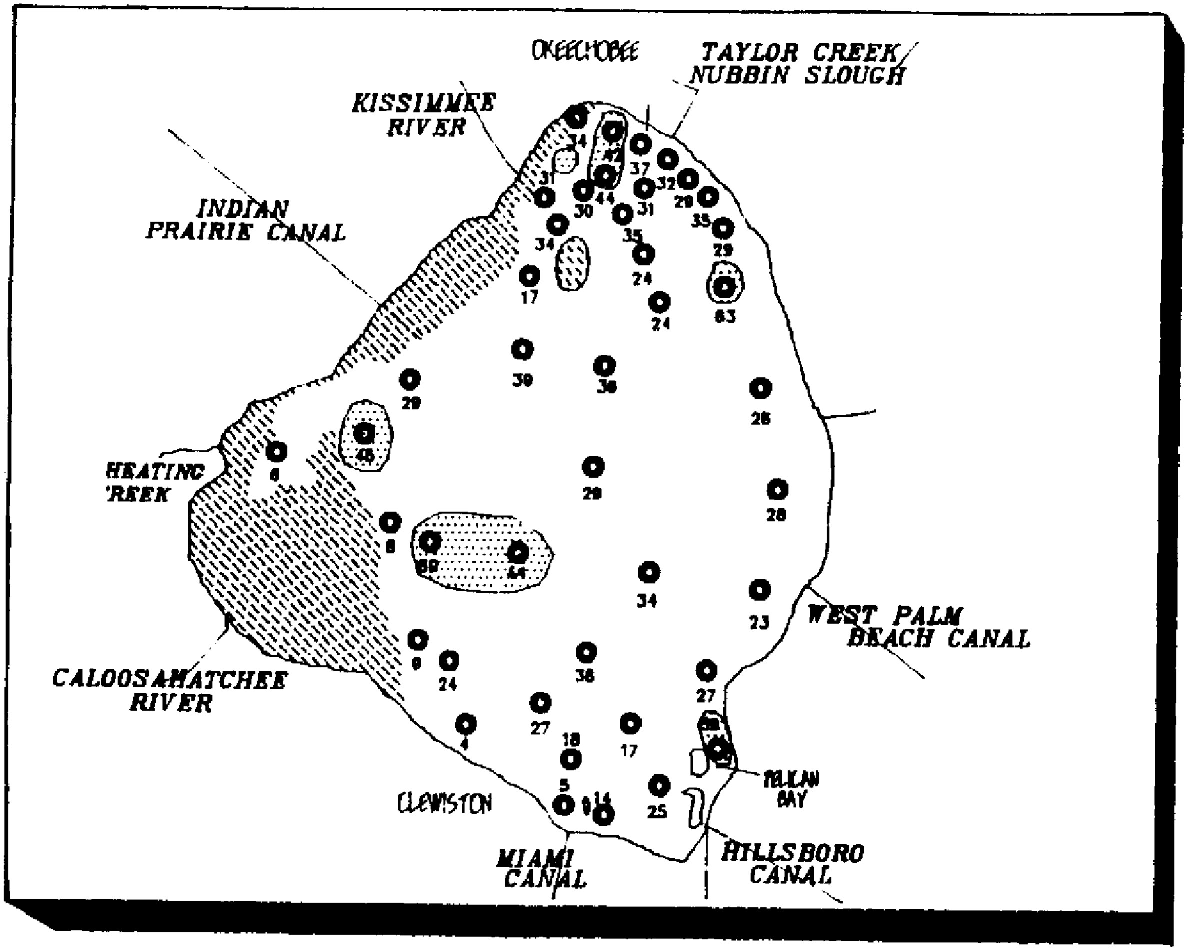
Samples collected on September 21–23 indicated a low level algal bloom exists in the north end. Four sites had chlorophyll values of 40 mg/m3 or more. The bloom at Eagle Bay Island is still present, but the small bloom near the Harney Pond Canal has cleared. Floating mats of bottom growing algae were found again in the south end of the lake. Water clarity there remains exceptionally good.

LEGEND

- ● SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 10/12/87

ANALYSIS OF CHLOROPHYLL SAMPLES COLLECTED ON OCTOBER 5,6 AND 7 SHOWED THAT 7 OF 42 SAMPLES WERE ABOVE THE 40 MG/M^3 THRESHOLD CONSIDERED INDICATIVE OF A BLOOM. THESE SITES ARE SCATTERED THROUGHOUT THE LAKE. THE EAGLE BAY BLOOM WAS STILL PRESENT; SAMPLES WILL BE COLLECTED FROM THERE THIS WEEK. NO ADVERSE ECOLOGICAL IMPACTS FROM THESE BLOOMS EXIST.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 32 (10/05–07/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m^3)

- < 40 no distinct bloom
- 40 – 90 distinct bloom
- 90+ possible adverse ecological impact

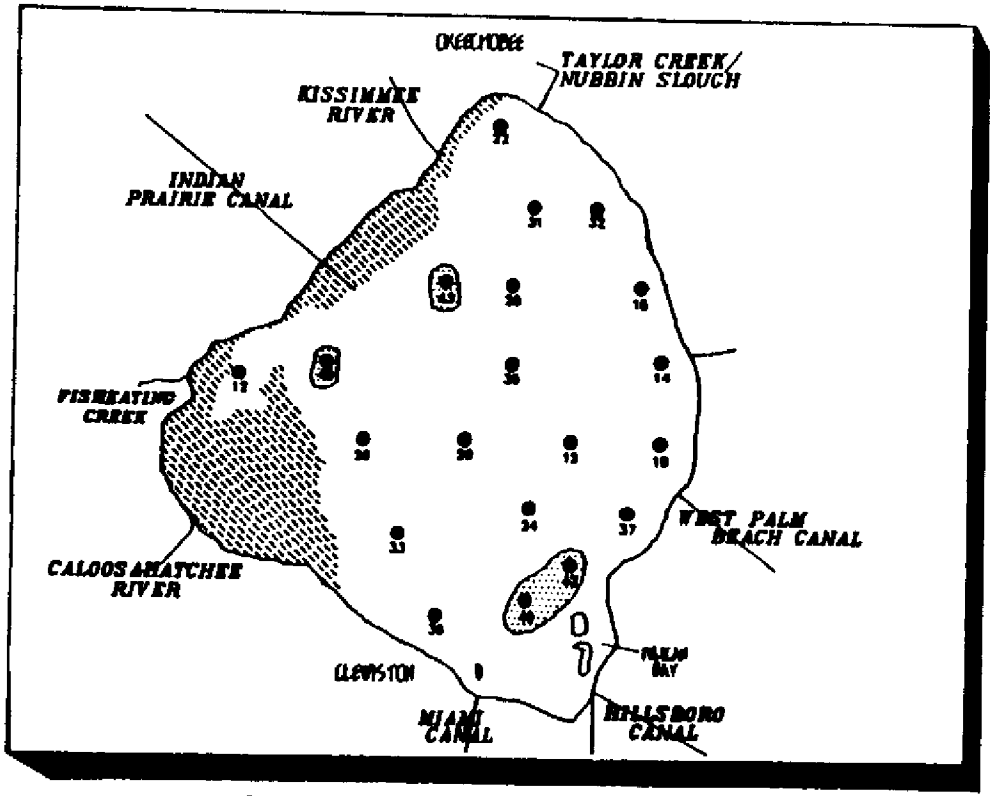
SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 33 (10/19/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (milligrams per cubic meter) (Lake Average = 23.0 mg/m³)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact

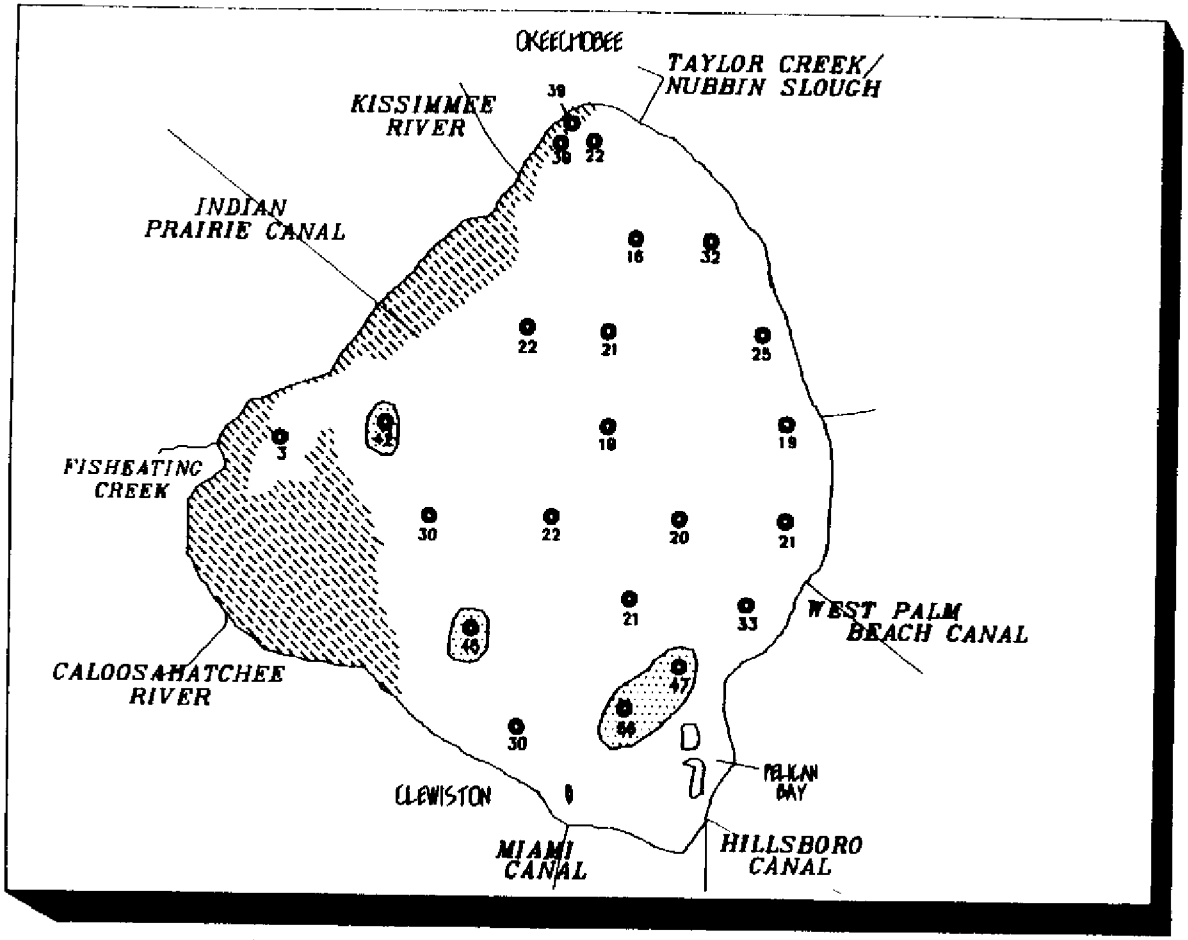


LAKE WATCH 10/23/87

Phytoplankton in Lake Okeechobee was at bloom levels at 4 of the 21 sites sampled by helicopter on October 19. These sites are located in the northwest and south portions of the lake. The highest chlorophyll value was 49 mg/m3. The area between Eagle Bay and Little Grassy was also sampled, and the chlorophyll value there indicates that the bloom that was present through the summer has now dispersed.

Windy weather during the last few weeks has stirred up lake sediment and the center of the lake is very turbid. Also, recent rains have resulted in higher inflows to the lake. These two events usually cause lake nutrient levels to rise, but since we are entering the cooler season, no extensive blooms are expected to occur. Lake Okeechobee usually experiences higher concentrations during the winter months.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE # 34 (10/26/87)



LAKE WATCH 10/30/87

Phytoplankton conditions in Lake Okeechobee changed little from last week. Algal chlorophyll measurements indicate that bloom levels exist at 4 of the 22 sites sampled by helicopter on October 16. These sites are on the west and south sides of the lake. The highest chlorophyll value was 56 mg/m3.

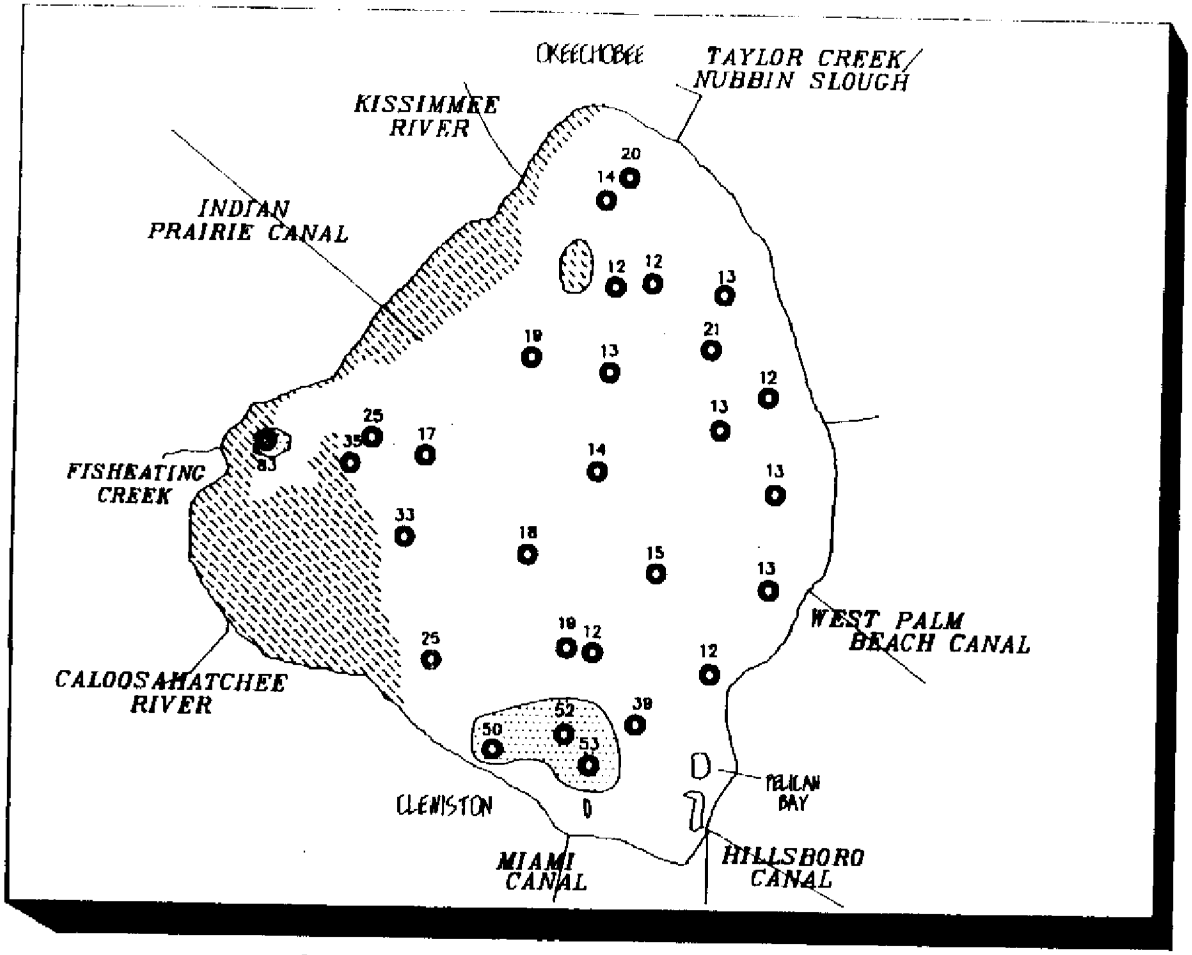
LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (Lake Average = 23.0 mg/m^3)

(milligrams per cubic meter)

- < 40 no distinct bloom
- 40 - 90 distinct bloom
- 90+ possible adverse ecological impact



LAKE WATCH 11/23/87

Samples collected at 28 sites on November 18–19 showed algal bloom conditions in Fisheating Bay and in the south end of the lake. The highest chlorophyll value measured was 83 mg/m3. No adverse impacts were associated with these blooms. Because no extensive blooms are expected to occur during the winter, the Lake Watch program will be curtailed until spring. The District will continue to monitor the lake monthly and report any unusual blooms if they arise.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT LAKE OKEECHOBEE UPDATE #35 (11/18–19/87)

LEGEND

- SAMPLING SITE
- ALGAL BLOOM
- LITTORAL ZONE

CHLOROPHYLL-A (Lake Average = 23.0 mg/m^3)

(milligrams per cubic meter)

- < 40 no distinct bloom
- 40 – 90 distinct bloom
- 90+ possible adverse ecological impact