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TECHNICAL REPORT A-78-2

LARGE-SCALE OPERATIONS MANAGEMENT TEST OF USE OF THE WHITE AMUR FOR CONTROL OF PROBLEM AQUATIC PLANTS

Report 1

BASELINE STUDIES

Volume VI

The Water and Sediment Quality of Lake Conway, Florida

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Report 1 of a Series

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LARGE-SCALE OPERATIONS MANAGEMENT TEST OF
USE OF THE WHITE AMUR FOR CONTROL OF
PROBLEM AQUATIC PLANTS

Report 1: Baseline Studies

Volume I: The Aquatic Macrophytes of Lake Conway, Florida

Volume II: The Fish, Mammals, and Waterfowl of Lake Conway, Florida

Volume III: The Plankton and Benthos of Lake Conway, Florida

Volume IV: Interim Report on the Nitrogen and Phosphorus Loading Characteristics of the Lake Conway, Florida, Ecosystem

Volume V: The Herpetofauna of Lake Conway, Florida

Volume VI: The Water and Sediment Quality of Lake Conway, Florida

Volume VII: A Model for Evaluation of the Response of the Lake Conway, Florida, Ecosystem to Introduction of the White Amur

Volume VIII: Summary of Baseline Studies and Data

Report 2: First Year Poststocking Results

Report 3: Second Year Poststocking Results

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Sampling and testing procedures utilized by the Orange County Pollution Control Department in collecting and analyzing water and sediment samples during the baseline data collection period of the Large-Scale Operations Management Test at Lake Conway, Fla., are documented in this report. Water quality data obtained during the baseline period, January 1976 - August 1977, are compiled for each of the 12 sampling stations. Mean values and standard

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deviations are included for all of the relevant parameters.

An analysis of water quality data showed little variability within each lake pool but indicated variations between the pools. Several water quality indicators were consistently lower in the South and Middle pools of Lake Conway. An increase in biochemical oxygen demand, chemical oxygen demand, solids, and nutrients occurred in the East and West pools of the system and a further increase in nutrients, solids, and chlorophyll concentrations was noted in Lake Gatlin.

In general, phytoplankton productivity levels were low throughout the Lake Conway system. Nutrient levels were also low, correlating well with the low plankton productivity. Future comparisons should give particular attention to assessing any changes in nutrient and productivity levels and community succession.

Significant seasonal variations were indicated for temperature, organic nitrogen, total phosphorus, and chlorophyll-a concentrations. A direct relationship existed between organic nitrogen and chlorophyll-a concentrations, whereas an inverse relationship was noted between temperature and total filterable phosphorus.

Sediment samples were collected on a quarterly basis and analyzed for various constituents. Since only limited sediment quality data were collected, only a cursory analysis is provided in this report. Seasonal variations in the parameter values are documented in this report.

Samples of aquatic macrophytes were collected during the prestocking period and analyzed for plant nutrients and heavy metals. These data were obtained so that evaluations relating to an overall nutrient budget in the lake system could be made.

PREFACE

Work described in this volume was performed under Contract No. DACW39-76-C-0084 and supplemental agreement No. P005 to that contract between the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, and the Orange County Pollution Control Board, Orlando, Florida.

This is one of eight volumes that constitutes the first of a series of reports documenting the Large-Scale Operations Management Test (LSOMT) of the use of the white amur for control of problem aquatic plants in Lake Conway, Florida. Report 1 presents the results of baseline studies of Lake Conway; subsequent reports will present first, second, and third year poststocking results, overall study conclusions, and management recommendations.

This volume was prepared by Mr. H. Douglas Miller, Canin/Miller Associates, Orlando, Florida. Messrs. Peter B. Ragsdale, James Adams, and Raymond T. Kaleel, Orange County Pollution Control Department, Orlando, Florida, assisted in report preparation and were responsible for data collection. Mr. J. Bateman was the Director of the Orange County Pollution Control Department during the study. Mr. T. Sawicki, Assistant Director, Orange County Pollution Control Department, was the Project Manager.

The study was monitored at WES in the Environmental Laboratory (EL) under the general supervision of Dr. John Harrison, Chief of EL, and Mr. B. O. Benn, Chief of the Environmental Systems Division, and under the direct supervision of Mr. J. L. Decell, Manager, Aquatic Plant Control Research Program. Mr. R. Theriot, EL, was the LSOMT Project Manager during this phase of the study. Mr. J. Kennedy, GL, was responsible for data base management.

Commanders and Directors of WES during the period of this study were COL J. L. Cannon, CE, and COL Nelson P. Conover, CE. Technical Director was Mr. F. R. Brown.

This report should be cited as follows:

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BASELINE STUDIES

The Water and Sediment Quality of Lake Conway, Florida

PART I: INTRODUCTION

1. The U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, is conducting a Large-Scale Operations Management Test (LSOMT) to study the ecological effects of the introduction of the white amur (*Ctenopharyngodon idella*) in Lake Conway, Florida, to control the aquatic macrophyte hydrilla (*Hydrilla verticillata*, Royle). As one of the study participants, the Orange County Pollution Control Department, Orlando, Florida, has the responsibility for monitoring water and sediment quality and reporting the test results regularly to WES. Other agencies participating in the study are the Florida Department of Natural Resources; the University of Florida Department of Environmental Engineering; the University of Florida Center for Wetlands Research; the Florida Game and Fresh Water Fish Commission; and the University of South Florida.

2. The Lake Conway chain consists of five distinct and interconnected pools (Figure 1) totaling 739 ha in area with an associated drainage area of 32.9 sq km. Average elevation of the lake is 26.2 m mean sea level (msl). Water elevations have tended to drop in recent years, mainly attributable to a lack of rain and a regional increase in the consumption of groundwater. The lake system is nearly surrounded by residential development and supports a substantial amount of water-oriented activities, including fishing and waterskiing.

3. This report documents the materials and methods utilized by the Orange County Pollution Control Department in collecting and analyzing water and sediment and aquatic macrophyte samples taken from Lake Conway. The chemical and biological data on water and sediment samples

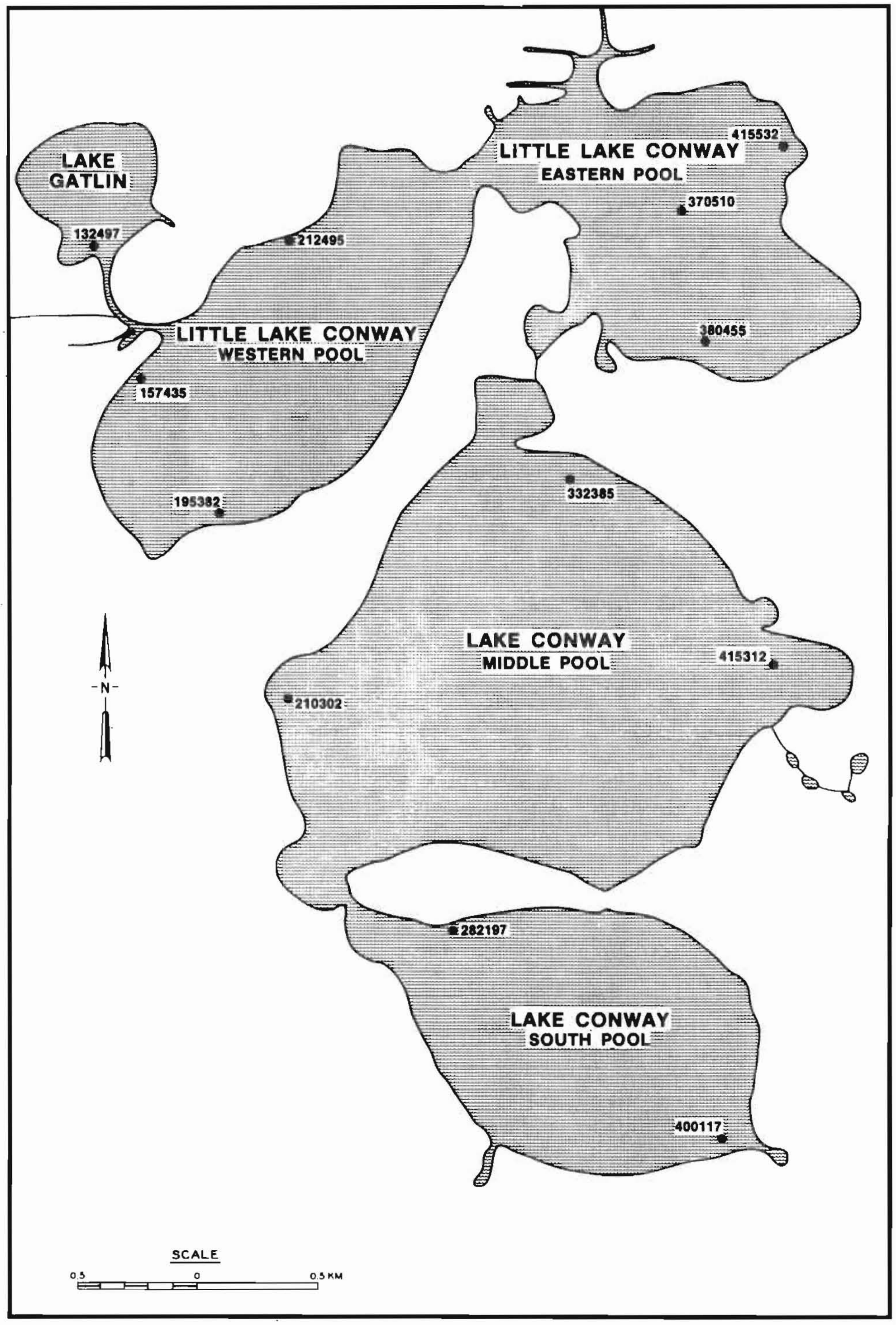

Figure 1. LSOMT sampling station locations

obtained by the Orange County Pollution Control Department during the prestocking or baseline period are herein compiled and analyzed.

4. Data collection was initiated in January 1976 and continued through August 1977, at which time (9 September 1977) Lake Conway was stocked with white amur. This 20-month interval will serve as the baseline data collection period for making future comparisons of water and sediment quality to determine the possible effects of stocking Lake Conway with the white amur.

PART II: METHODS AND MATERIALS

Sampling Stations

5. Eleven sampling stations except station 370510 have been monitored on a monthly basis since January 1976. The location of each station is shown in Figure 1. The stations are located near the shoreline in areas where substantial aquatic weed growth occurs. Water depth at the 11 stations varies from less than 2 m up to 6 m. In addition to these stations, OCPCD obtains additional water quality information from other stations in Lake Conway as a part of Orange County's ongoing water quality monitoring program. Station 370510 is one of these stations and was selected to be included in the report because of its location in one of the deeper areas of Lake Conway. Test results from all stations have been reported to WES on a regular basis since January 1976.

Sampling Procedures

6. Initially, at each station individual water samples were obtained at three depths: near the surface, mid-depth, and near the bottom. This procedure was modified early in the program at stations 332385 and 380455 (Figure 1) due to shallow water depths. Only near-surface and/or near-bottom samples are taken under the modified procedure at these stations. At stations where water depths have receded to less than 3.1 m but are more than 2 m, the mid-depth sample is eliminated. The date, time, location, sample depth, and water depth are recorded as each sample is collected.

7. Sediment samples are collected at each station on three occasions to represent fall, winter, and summer conditions.

8. Water samples are obtained by the use of Kemmerer sampling bottles. This procedure ensures that each sample is collected at a predetermined and known depth. An Ekman dredge is used for obtaining sediment samples.

Testing Procedures

9. Monthly bulk water samples are tested for the following:

Turbidity	Orthophosphorus	Sodium
Total Phosphorus	Total Solids	Potassium
Organic Nitrogen	Volatile Suspended Solids	Magnesium
Nitrate Nitrogen	Fixed Suspended Solids	Chlorophyll-a (Func)
Nitrite Nitrogen	Biochemical Oxygen Demand	Chlorophyll-a (Non-Func)
Ammonia Nitrogen	Chemical Oxygen Demand	Carotenoids
Alkalinity	Copper	Chlorophyll-a
Acidity	Iron	Chlorophyll-b
Chlorides	Lead	Chlorophyll-c
Hardness	Calcium	Productivity

Temperature, conductivity, Secchi disk, pH, redox, and dissolved oxygen are tested in situ. Sediment samples are returned to the laboratory and analyzed to determine the following parameters:

Total Nitrogen	Copper	Total Organic Carbon	Iron
Total Phosphorus	Lead	Chemical Oxygen Demand	

10. The water and sediment quality tests are performed in the Orange County Pollution Control Department's laboratory facilities. A portable Hydrolab is used to measure sample depth, dissolved oxygen, pH, temperature, conductivity, and oxidation-reduction potential. During the initial stages of the project the Hydrolab was not available; therefore, samples for dissolved oxygen were fixed in the field and analyzed by the Winkler method; pH and conductivity were measured as shown in Table 1.

11. All water and sediment quality tests are performed according to the procedures outlined in either Standard Methods for the Examination of Water and Wastewater (APHA 1976) or Methods for Chemical Analysis of Water and Wastes (U. S. Environmental Protection Agency (EPA) 1974) or are performed in accordance with procedures mutually agreed to by the

Orange County Pollution Control Department and WES (Table 1).

12. Water and sediment quality test results are compiled manually on a standard reporting form and submitted to WES for computer input. The computer printout sheets are reviewed by Orange County Pollution Control Department personnel to ensure that all data entries are correct. All errors, deletions, and ommissions are reported to WES and a final corrected printout sheet is then produced.

13. All data collected during the baseline period are on file at WES and also at the Orange County Pollution Control Department.

PART III: BASELINE DATA COMPILATION AND ANALYSIS

Water Quality

14. To produce a workable baseline report it is important to organize the data into a format that allows for relatively simple future data comparisons. Initially, the data must be sorted into usable and unusable categories. Key parameters must be identified and analyses applied to put the data into a comparison-oriented format.

15. A review of water quality data collected from January 1976 through August 1977 revealed several parameters that consistently were detected in trace amounts, but levels too low to accurately record using the authors' analytical techniques. Table 2 lists these parameters and the minimum reporting values.

16. Water samples were obtained at several stations from various levels in the water column depending on the depth. The procedure used to provide a workable summary of the large volume of water quality data included random selection of one representative sampling station, computing the mean value for all parameters measured over the 20-month baseline period for each depth, and comparing this mean value to all other stations. If the mean values varied less than 5 percent, it was assumed that little variability existed due to change in depth. Parameters showing no variability are listed in Table 3 with the corresponding percent of variability measured.

17. Table 4 lists the mean value and standard deviation for all parameters and all sampling stations over the duration of the baseline period. Table 5 presents the mean value and standard deviation for the 11 stations combined.

18. Parameters exhibiting variability due to depth included dissolved oxygen (DO), pH, turbidity, and chlorophyll-a, and are summarized in Table 6.

19. The 11 sampling stations (Figure 1) are located in four distinct pools of Lake Conway and in Lake Gatlin. In general, parameters associated with sampling stations located in the same pool are very

consistent. However, there are noticeable variations in water quality parameters from one pool to another at any given time. Water quality is consistently higher in the South and Middle pools of Lake Conway, with an increase in biochemical oxygen demand (BOD), chemical oxygen demand (COD), solids, and nutrients in the East and West pools. A further increase in nutrients, solids, and chlorophyll concentrations is associated with Lake Gatlin.

20. Representative parameters have been selected to graphically display water quality variations between the pools. These parameters include hardness, magnesium, organic nitrogen, BOD, total solids, and chlorophyll-a concentrations. Figures 2-7 graphically depict the mean values and standard deviation, by sampling station, for these selected parameters, respectively. Sampling stations are positioned on the X-axis, beginning with the Lake Gatlin station, and proceed to the West, East, Middle, and South pool sampling stations. Figures 2-7 generally display the trend of improving water quality as one proceeds from Lake Gatlin to the South pool of Lake Conway.

21. A general trend of decreasing chlorophyll-a concentration is apparent from Lake Gatlin to the South pool (Figure 7). The highest chlorophyll-a concentration was measured in Lake Gatlin (25 mg/m^3) and the lowest in Middle pool (1 mg/m^3). The average chlorophyll-a concentration was highest in Lake Gatlin (11.6 mg/m^3), while the lowest average chlorophyll-a value was measured in the South pool (4.4 mg/m^3). Figures 8-12 indicate the seasonality of chlorophyll-a concentration for each pool as compared with temperature, total filterable phosphorus, and organic nitrogen. A general trend towards a fall maxima is discernible except in the Middle pool which exhibited a summer maxima.

22. Primary productivity estimates were performed at the 11 stations once every 2 months. The data documented primary production attributable to the phytoplankton community and was provided to the University of Florida for input to the Ecological Response Model reported by Ewel et al., Vol VII of this series.

23. Nitrate and ammonia nitrogen concentrations did not show a great amount of variation during the baseline period. The low

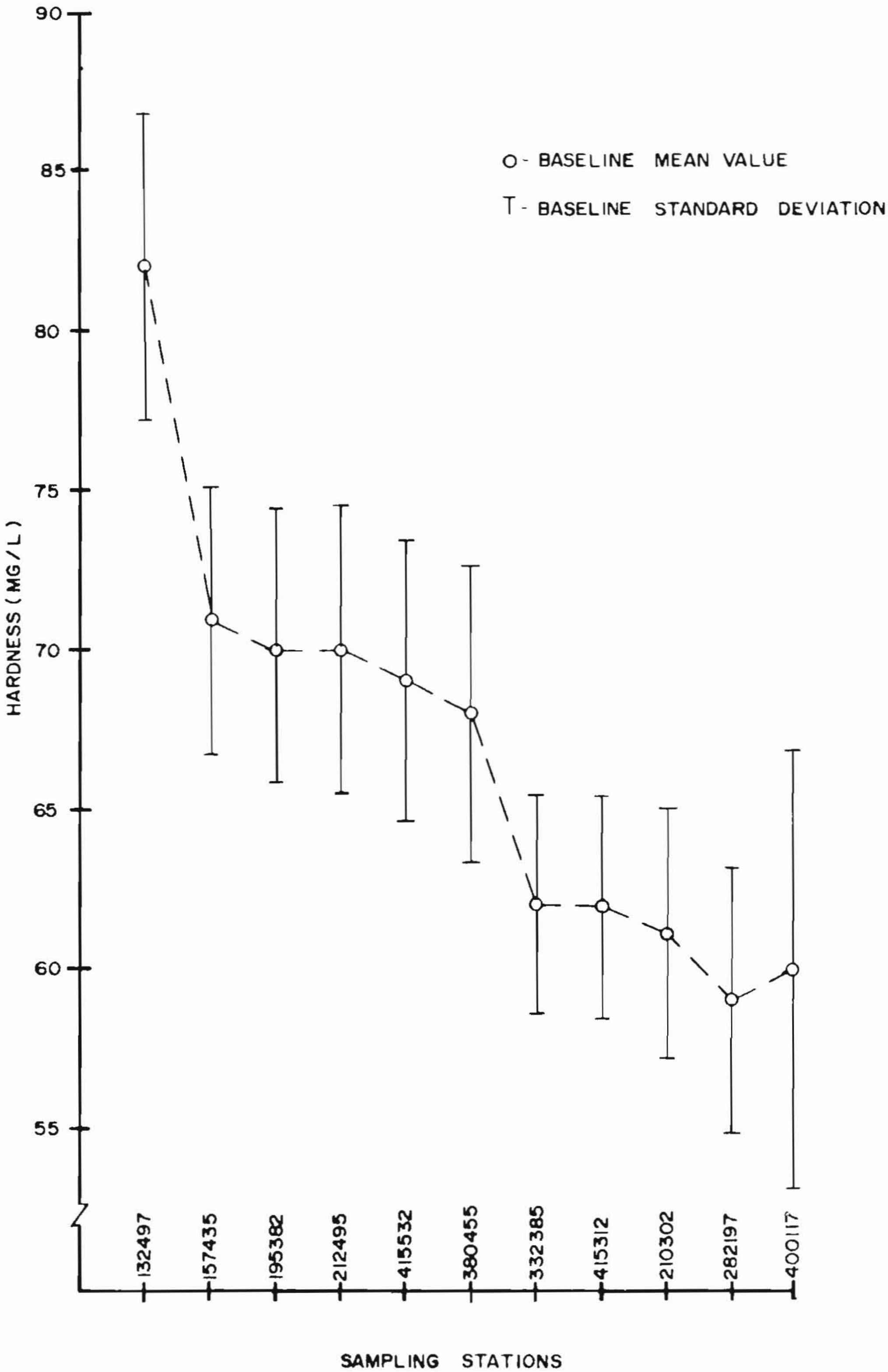

Figure 2. Trends in hardness concentrations

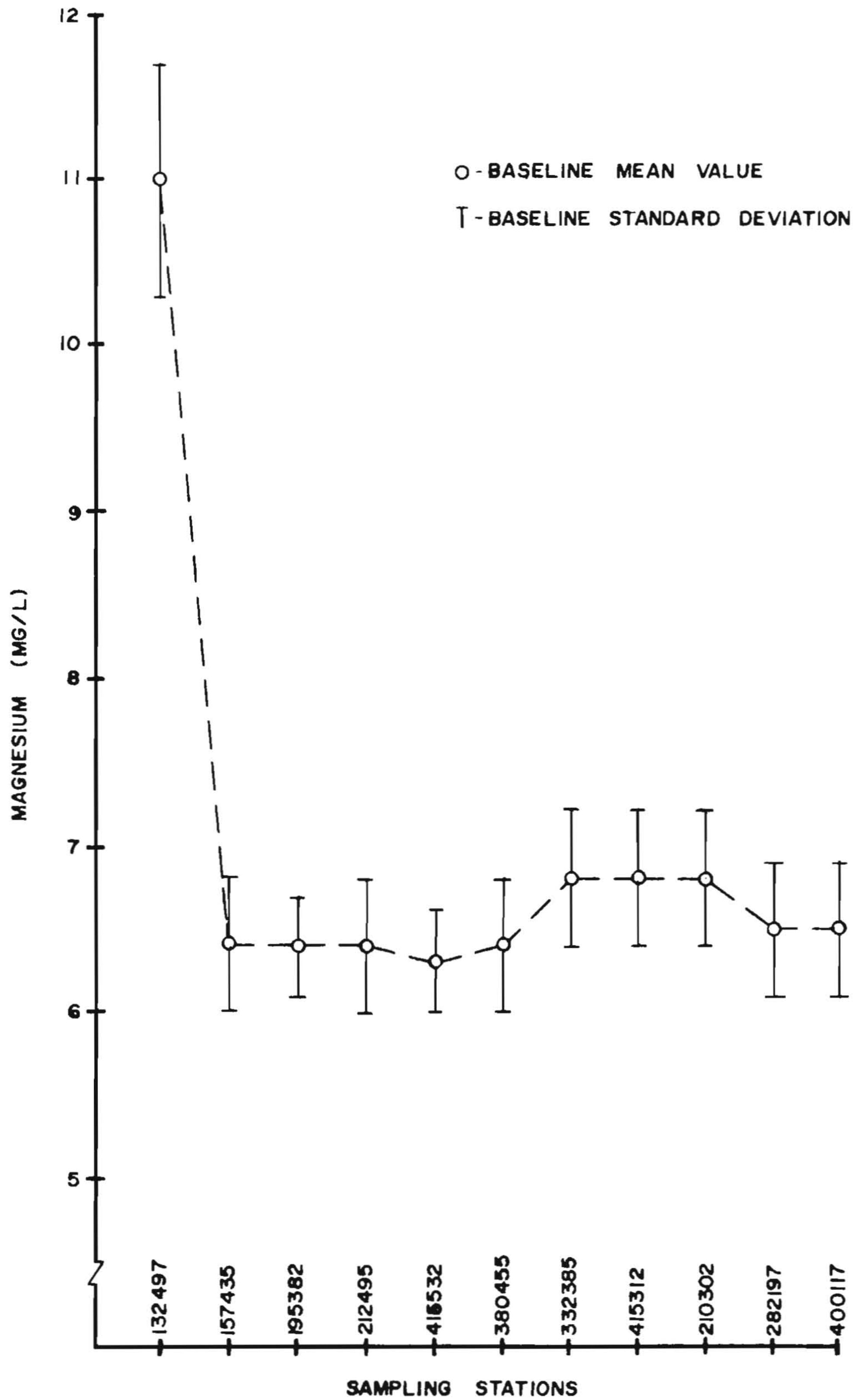

Figure 3. Trends in magnesium concentrations

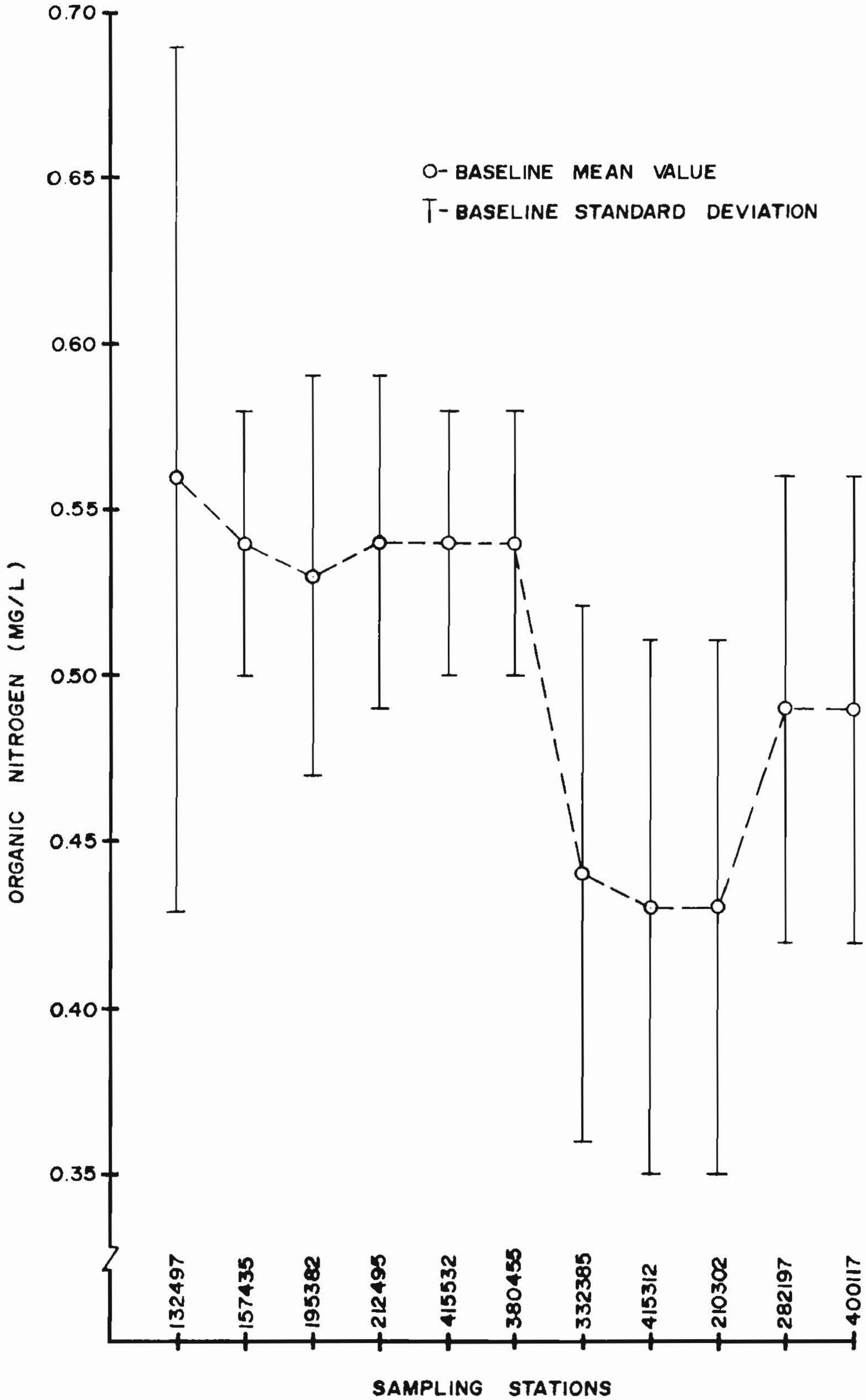

Figure 4. Trends in organic nitrogen concentrations

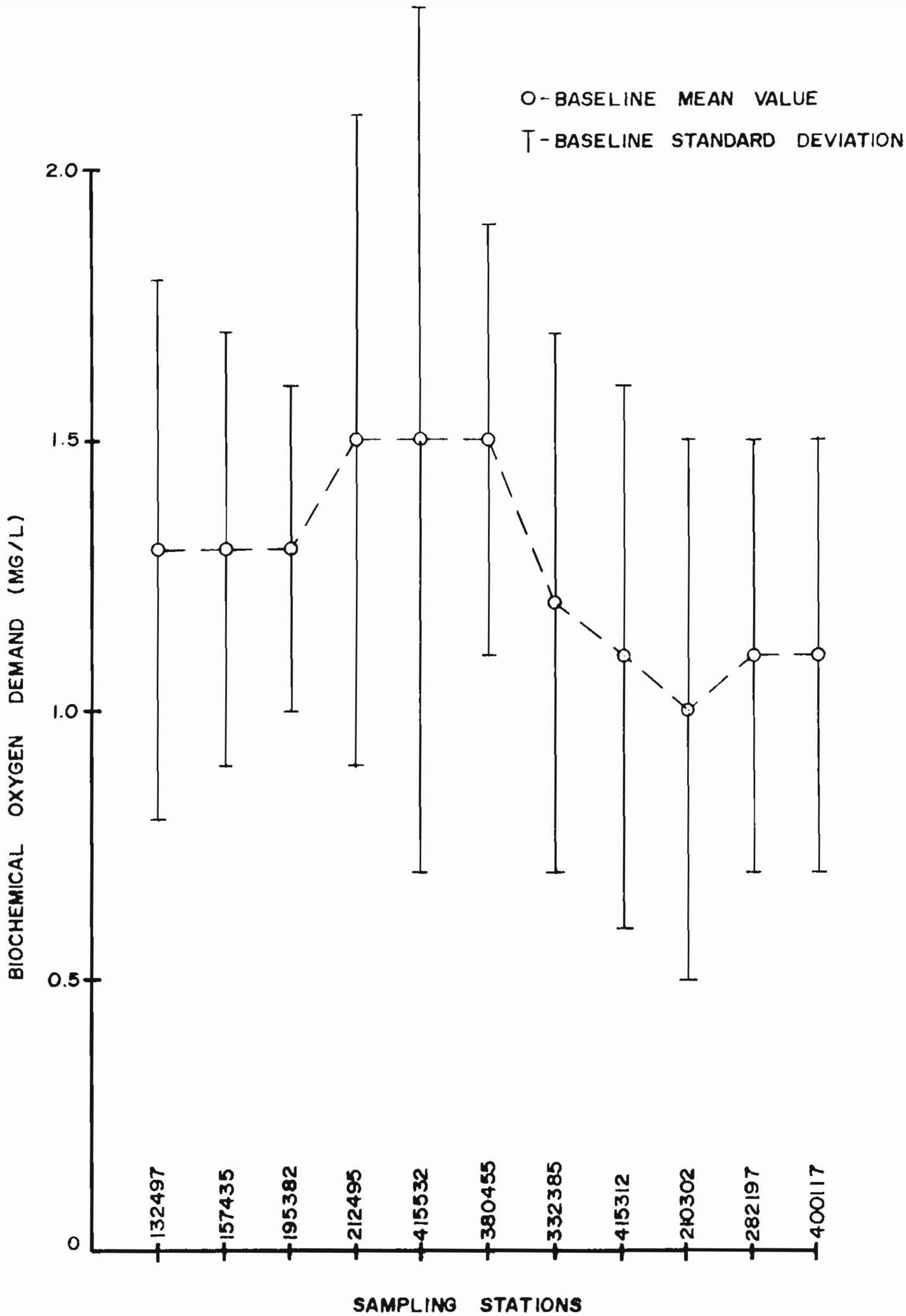

Figure 5. Trends in BOD concentrations

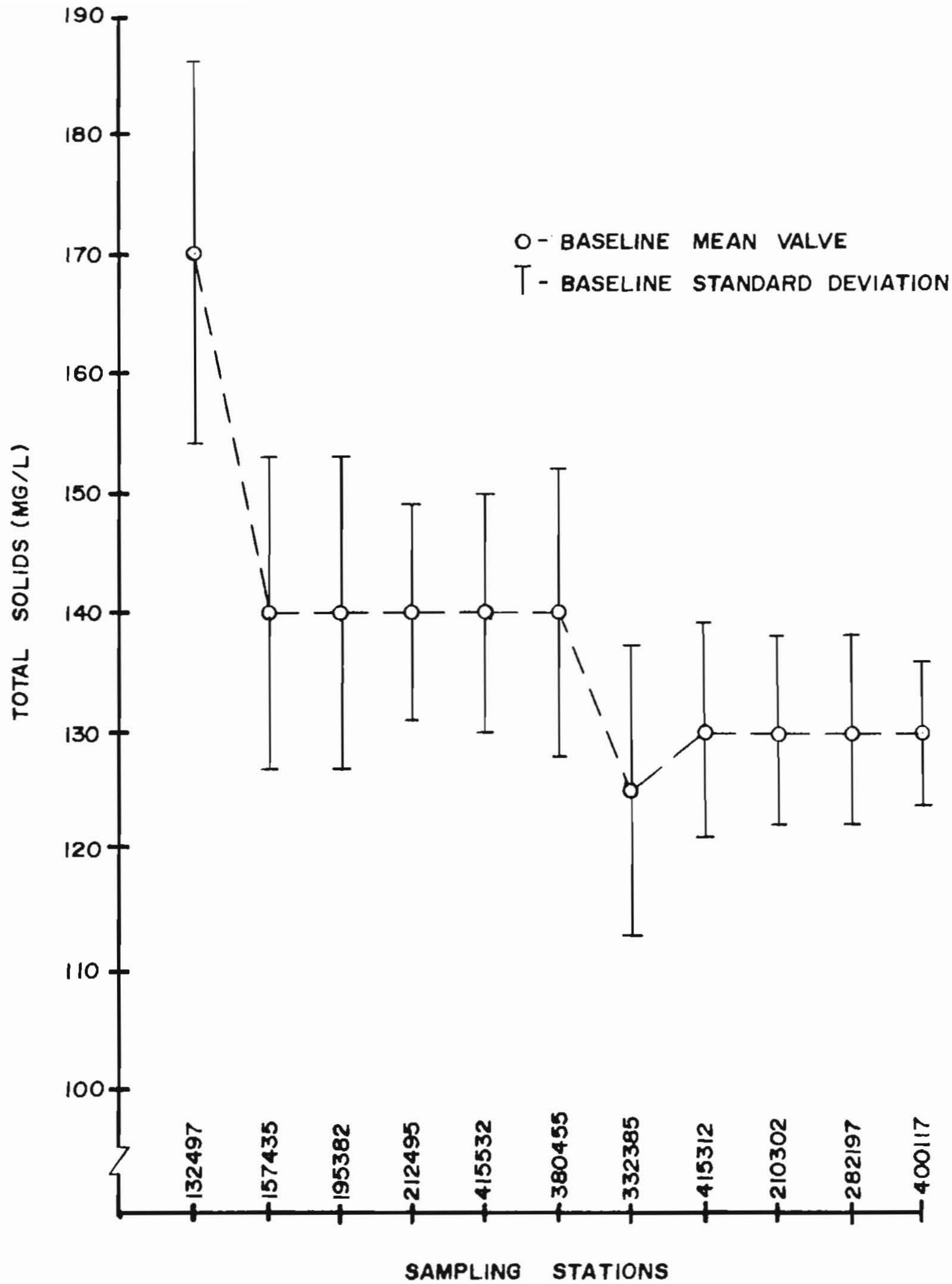

Figure 6. Trends in total solids concentrations

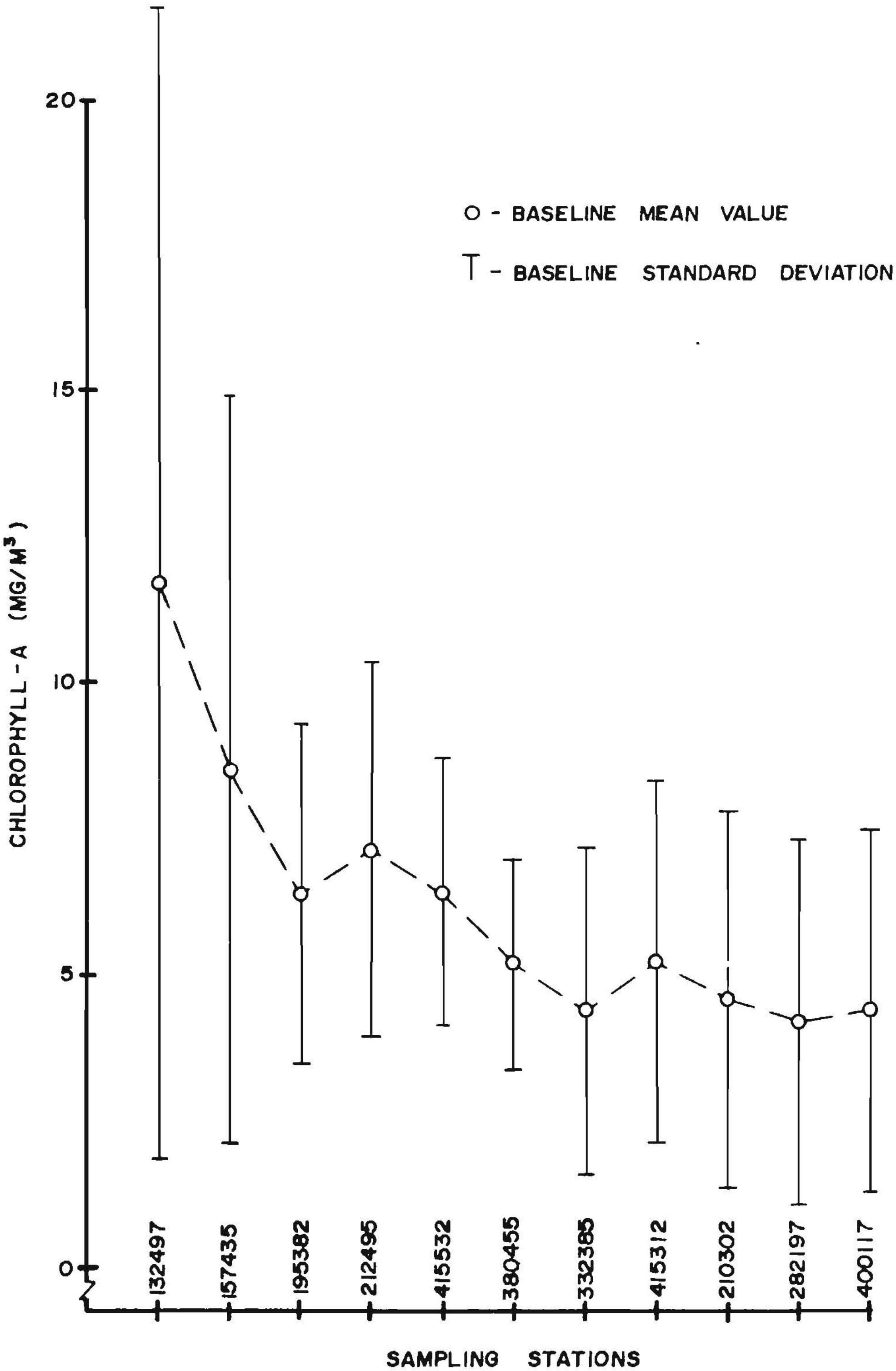

Figure 7. Trends in chlorophyll-a concentrations

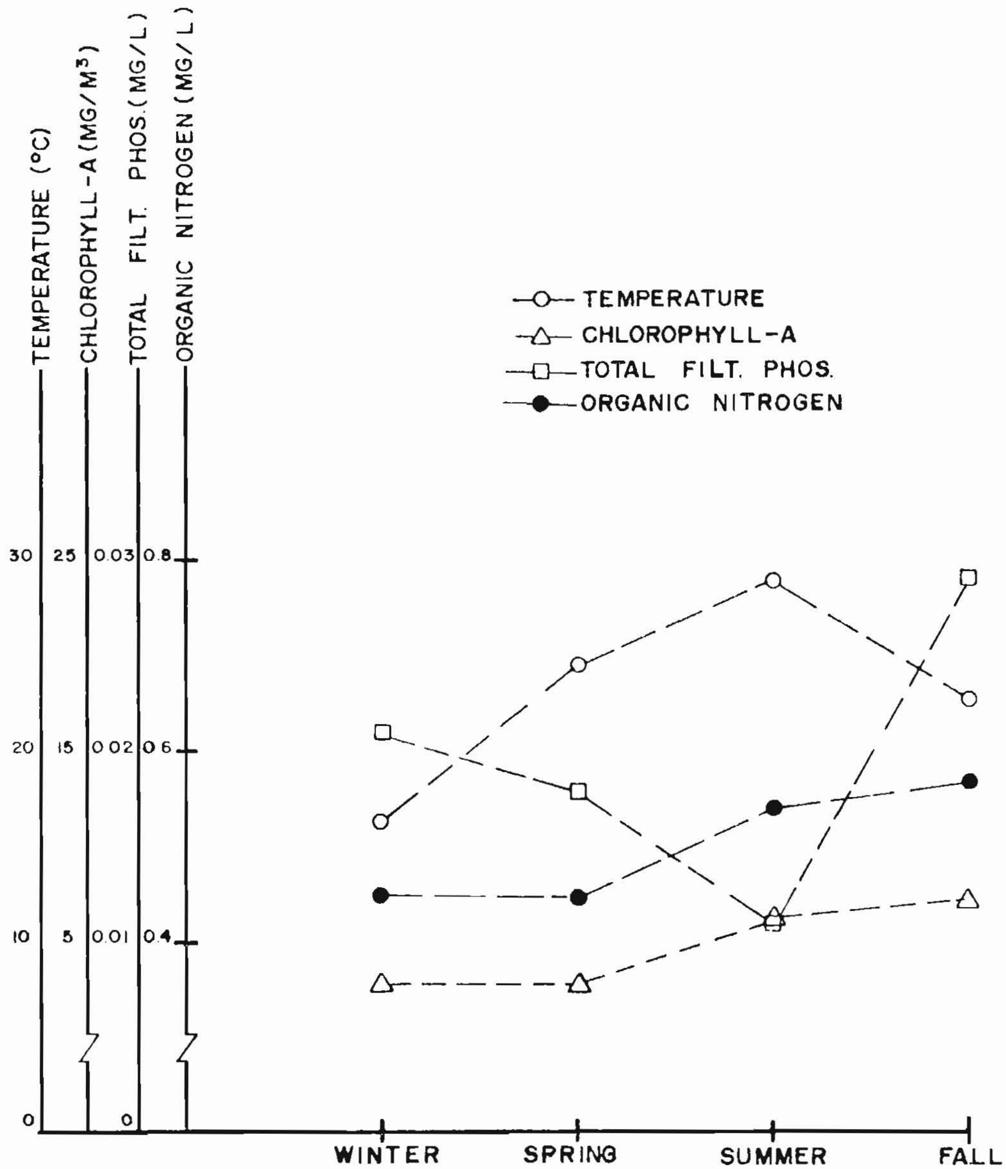

Figure 8. Correlation of selected parameters for sampling station 400117, Lake Conway South pool

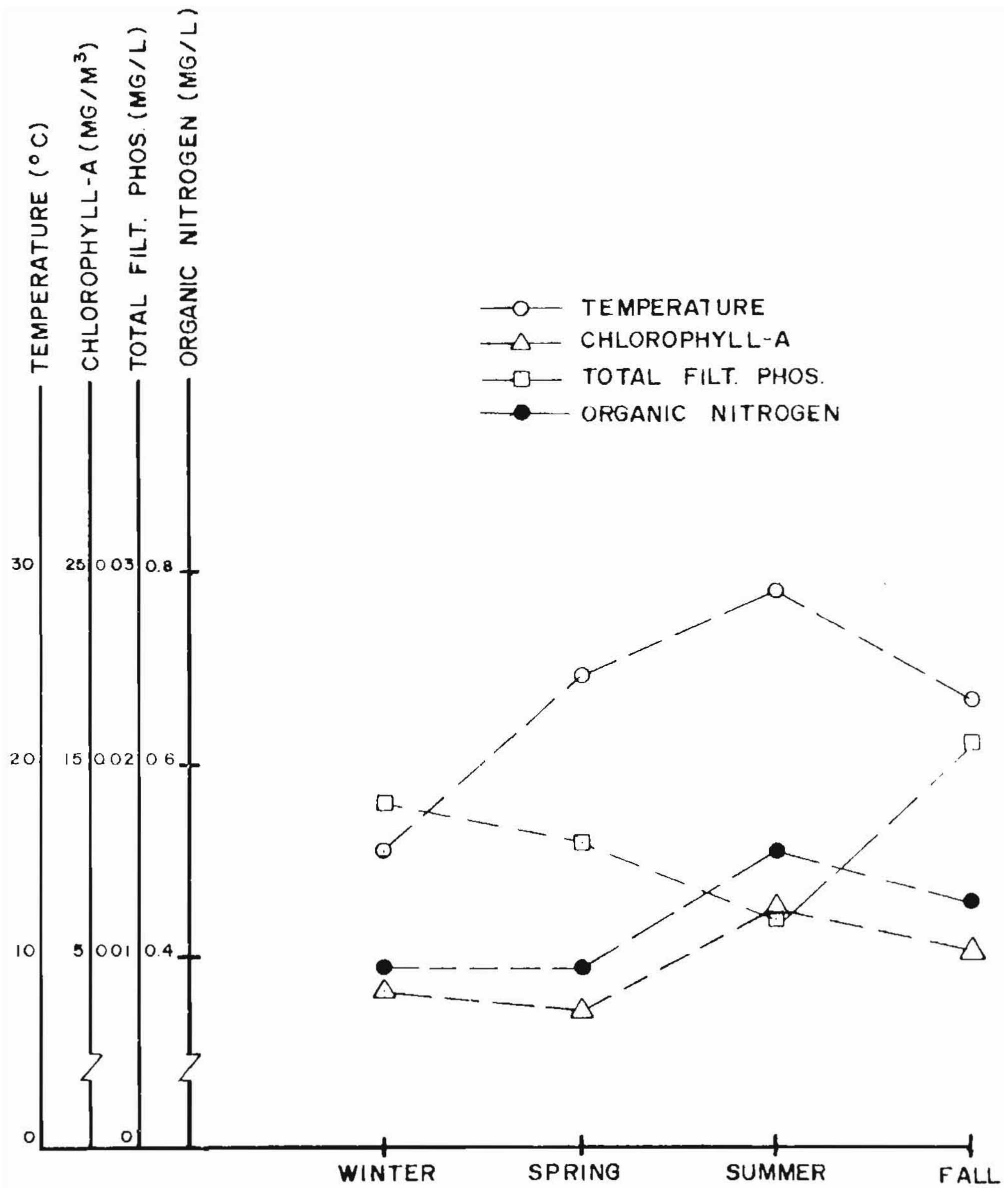

Figure 9. Correlation of selected parameters for sampling station 210302, Lake Conway Middle pool

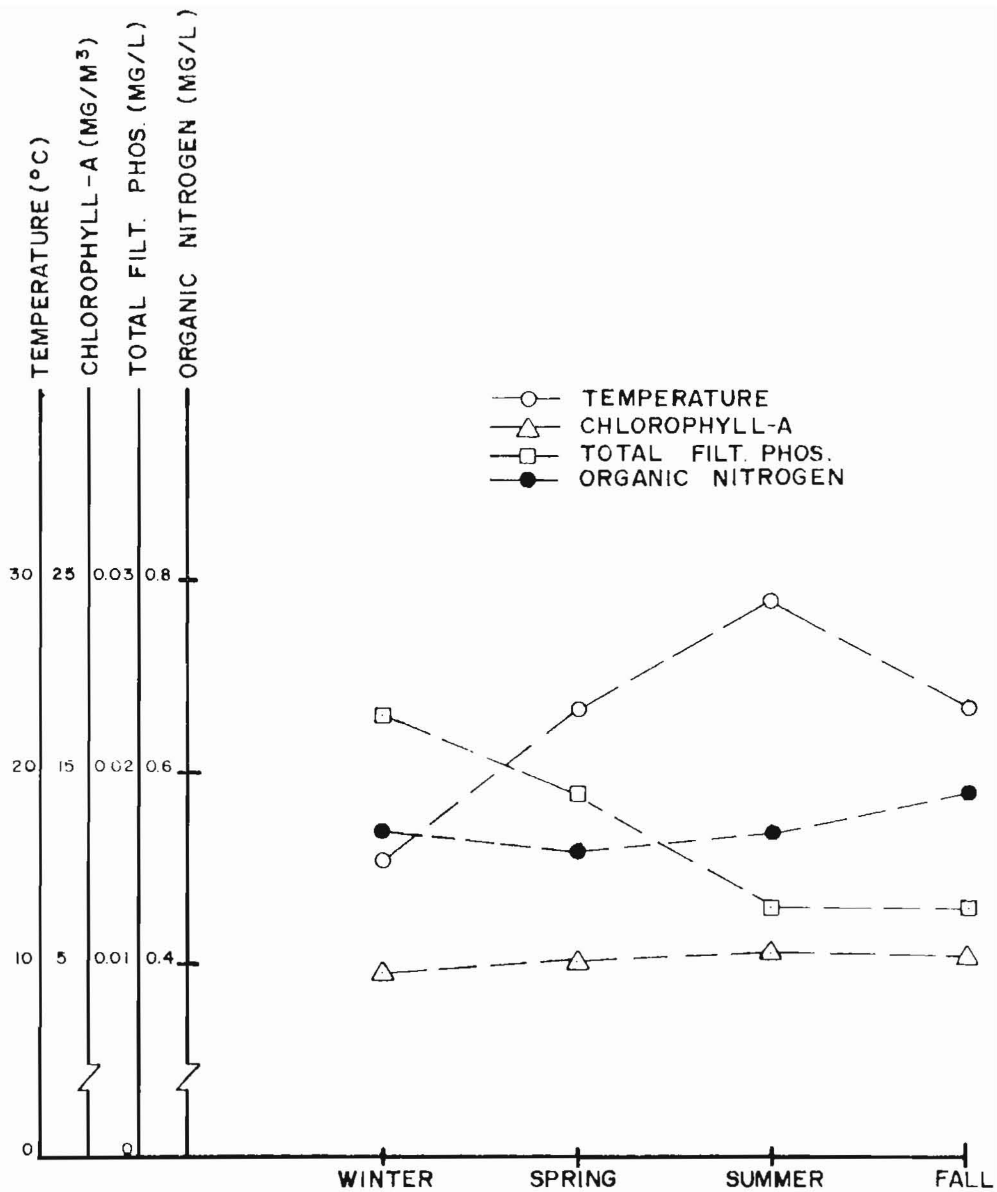

Figure 10. Correlation of selected parameters for sampling station 380455, Lake Conway East pool

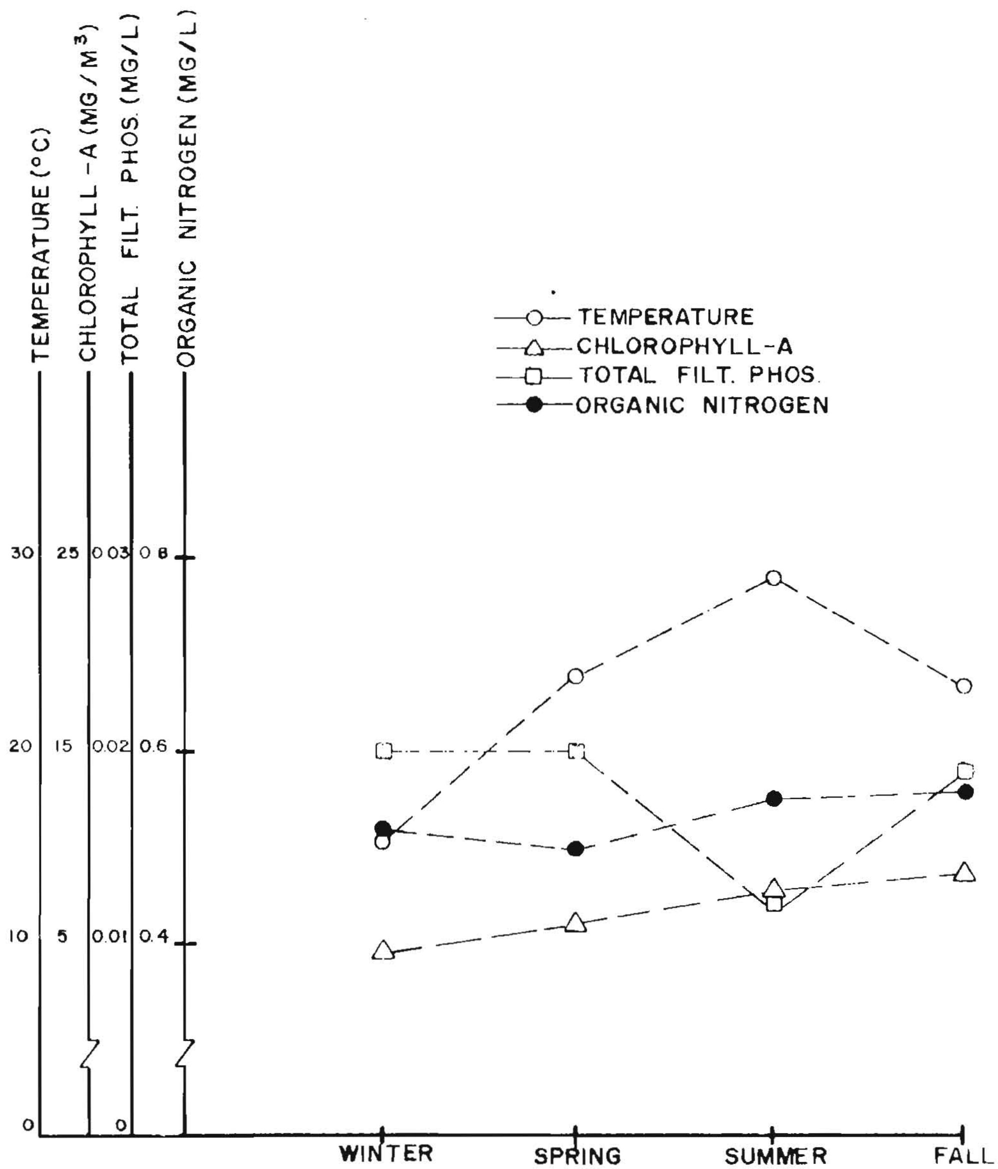

Figure 11. Correlation of selected parameters for sampling station 195382, Lake Conway West pool

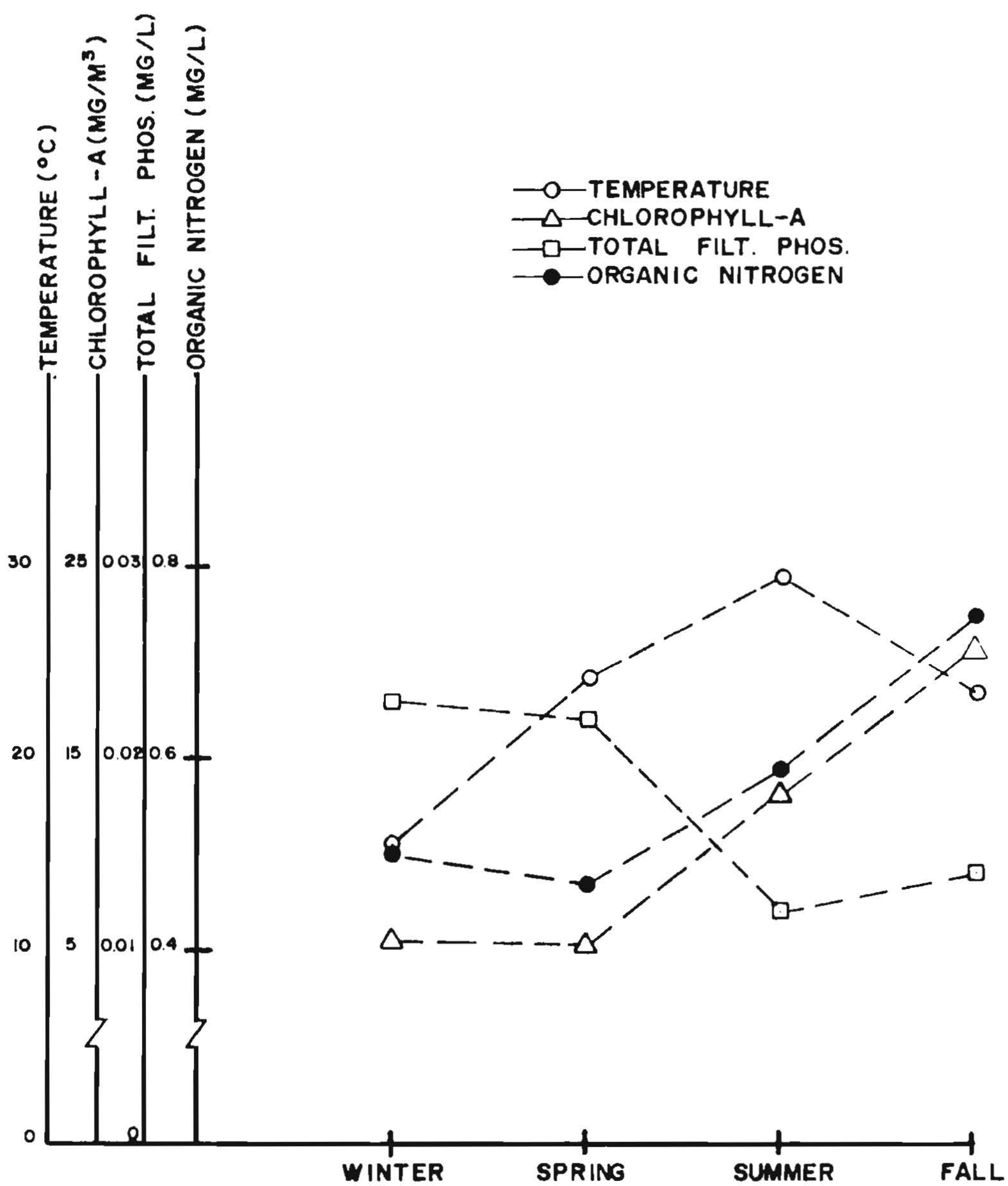

Figure 12. Correlation of selected parameters for sampling station 132497, Lake Gatlin

concentrations of inorganic nitrogen are attributed to rapid uptake and utilization by the large standing crop of macrophyte vegetation and associated epiphytes.

24. On several occasions, ammonia (NH3) and organic nitrogen (Org-N) have shown an increase in concentration with depth, as shown below, for the South pool (400117) and East pool (370510).

South Pool
27 September 1976
400117

Depth m	Temp °C	DO mg/ℓ	NH3 mg/ℓ	Org-N mg/ℓ
0.5	27.5	7.1	0.050	0.66
2.1	27.5	7.0	0.050	0.64
4.3	27.5	6.5	0.050	1.00

East Pool
30 September 1976
370510

Depth m	Temp °C	DO mg/ℓ	NH_3 mg/ℓ	Org-N mg/ℓ
0.5	28.5	8.2	0.050	0.64
4.1	28.5	6.7	0.050	0.59
9.1	27.5	0.2	0.140	0.63

25. East pool data (Station 370510) indicate that ammonia is possibly being recycled from the sediments. Ammonia derived from this source is transient and is either converted to nitrate, is rapidly used by the biota, or else is further reduced to molecular nitrogen. Because persistent stratification was not documented, further reduction to molecular nitrogen is unlikely.

26. A review of organic nitrogen data for the September 1976 sampling period revealed that the vertical distribution observed in the South pool (Station 400117) also occurred at stations in the Middle pool (415312 and 332385) and West pool (212495 and 157435). Figures 8-12 show a general trend of increasing organic nitrogen during summer and early fall months. Annual net losses and gains of nutrients should be calculated as more data are compiled.

27. Figures 13 and 14 compare nitrogen data and chlorophyll-a for the South pool (Station 400117) and Lake Gatlin (Station 132497). Data points for the respective parameters are mean values of near-surface samples, mid-depth samples, and near-bottom samples. Data from station 400117 indicate that phytoplankton is synthesizing nitrogen as the total nitrogen concentration increases in the water column. Nitrate remained

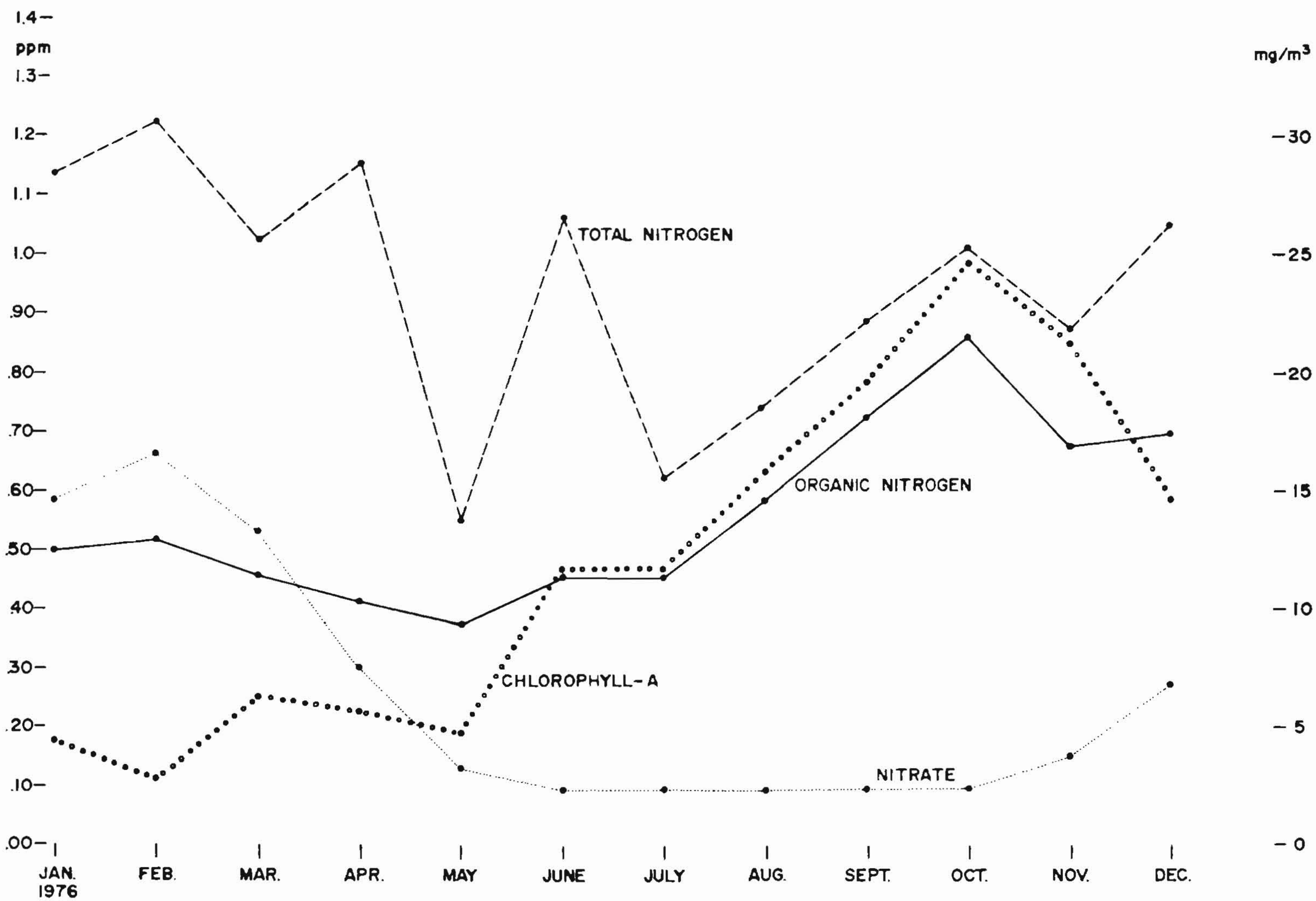

Figure 13. Trends in nitrogen and chlorophyll-a, Lake Gatlin (132497)

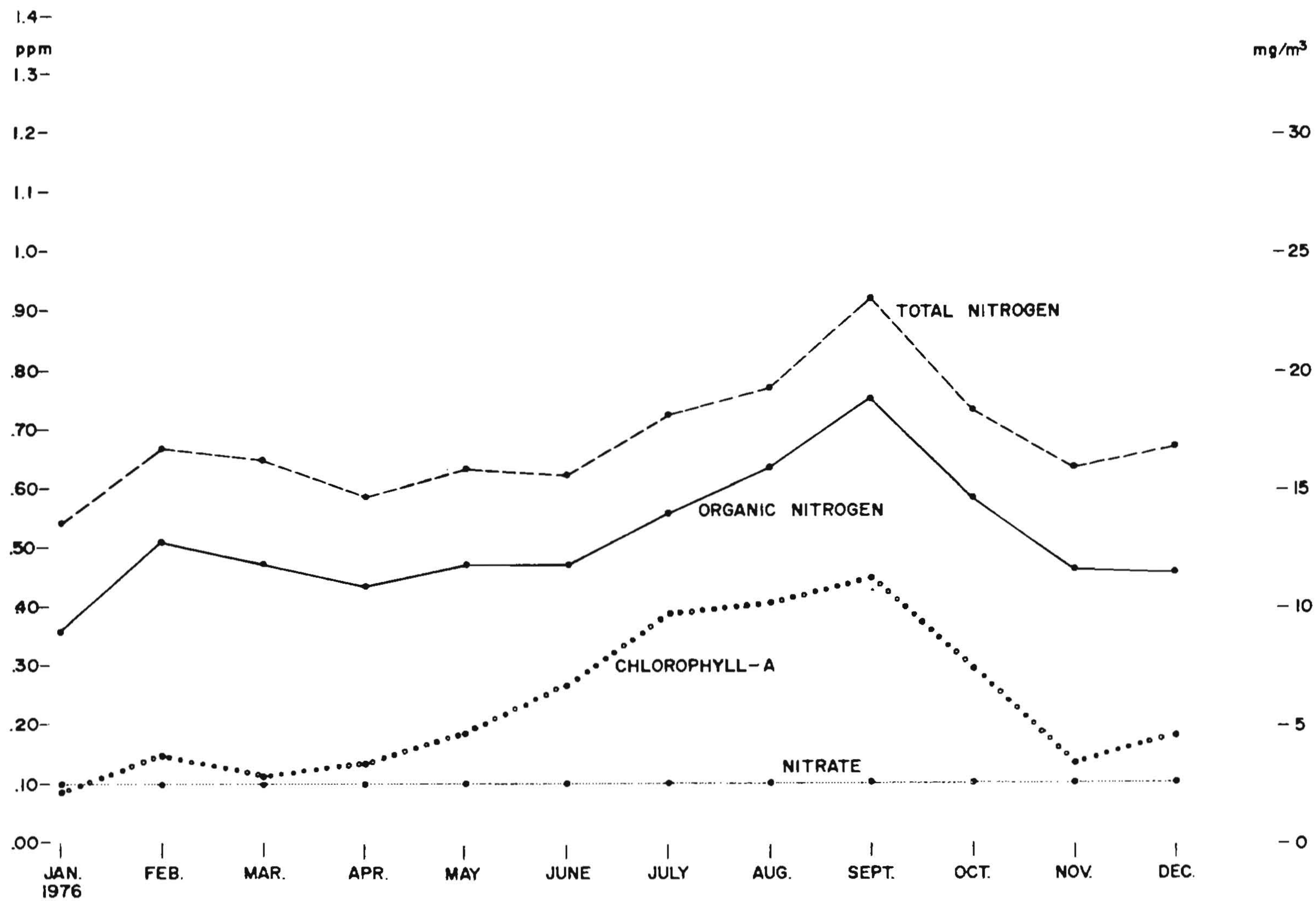

Figure 14. Trends in nitrogen and chlorophyll-a, Lake Conway South pool (400117)

below or at the minimum detection limits during the baseline study period in the South pool.

28. Comparative data for Lake Gatlin (Figure 13) indicate that the phytoplankton is converting nitrate to organic nitrogen. During the warmer months, nitrate is rapidly converted to organic nitrogen thus reducing the concentration of nitrate to levels below detection with a concomitant increase in organic nitrogen. When phytoplankton declines in the winter, nitrate concentrations increase in the water column and organic nitrogen concentration decreases.

29. A mean concentration at the minimum detectable level of 0.01 mg/ℓ was computed for total filterable phosphorus (TFP), or soluble phosphorus, from samples collected at the 11 sampling stations. Selected ranges of TFP concentration (regardless of depth) by month and major pools are shown below:

Location	Date 1/19/76	7/27/76	3/21/77
Gatlin	0.02-0.03	0.01	0.02-0.02
West	0.02-0.02	0.01	0.02-0.01
East	0.01-0.02	0.01	0.01
Middle	0.01	0.01	0.01
South	0.01-0.02	0.01	0.01

30. Soluble phosphorus for all stations ranged from <0.10 to 0.04 mg/ℓ. Significantly higher concentrations of phosphorus were detected in the water column in the winter months than in the summer months.

31. The unfiltered phosphorus (total phosphorus) varied concomitantly with the soluble fraction. The above-tabulated data and Figures 8-12 show the general seasonal trend of total filtered phosphorus.

32. Vertical distribution of soluble phosphorus for a given station was remarkably consistent. However, on several occasions, increasing concentrations with increasing depth were observed. Historical data were somewhat higher when compared to the mean value reported for Lake Conway. The following selected TFP values (in milligrams per litre) illustrate these differences:

	Date			
	8/25/75	2/23/76	9/27/76	11/17/76
	370510	210302	415312	132497
Near surface	0.02	0.02	0.01	0.01
Mid-depth	0.04	0.02	0.01	0.01
Near bottom	0.04	0.03	0.01	0.03

33. While conditions for a persistent thermocline were not documented during the baseline period, dissolved oxygen concentrations less than 1 mg/ℓ were occasionally encountered above the mud-water interface. When the water column began to cool from summer maximum temperatures, dissolved oxygen concentrations near the lake bottom were often higher than the concentrations in the overlying water. This was noted at near-shore stations in all pools except Lake Gatlin.

34. Inspection of physical and chemical parameter data shows a slight variation occurring from month to month. Hardness and alkalinity values are considered to be in a normal range for surface waters in central Florida (St. John's Water Management District 1977) with water hardness varying from slightly soft to moderately hard. Mineral content is generally consistent throughout Lake Conway, although Lake Gatlin exhibits a higher concentration of magnesium. Total dissolved solids concentrations are low and are indicative of the low dissolved mineral and chloride concentrations typical to central Florida. Biochemical oxygen demand values are low, with surface dissolved oxygen concentration averaging better than 95 percent saturation at all stations. Mid-depth samples exhibit similar saturation values. Bottom saturation shows more variability; however, significant differences in water depth from station to station make comparison difficult.

35. Only a few water quality indicators exhibit seasonal variations. Dissolved oxygen concentration follows the change in water temperature and the corresponding high solubility levels. Figure 15 graphically depicts this in the case of the Middle pool, as an increase in dissolved oxygen is followed by a corresponding decrease in temperature. Other parameters that vary seasonally include organic nitrogen, total phosphorus, temperature, and chlorophyll-a (Figures 8-12).

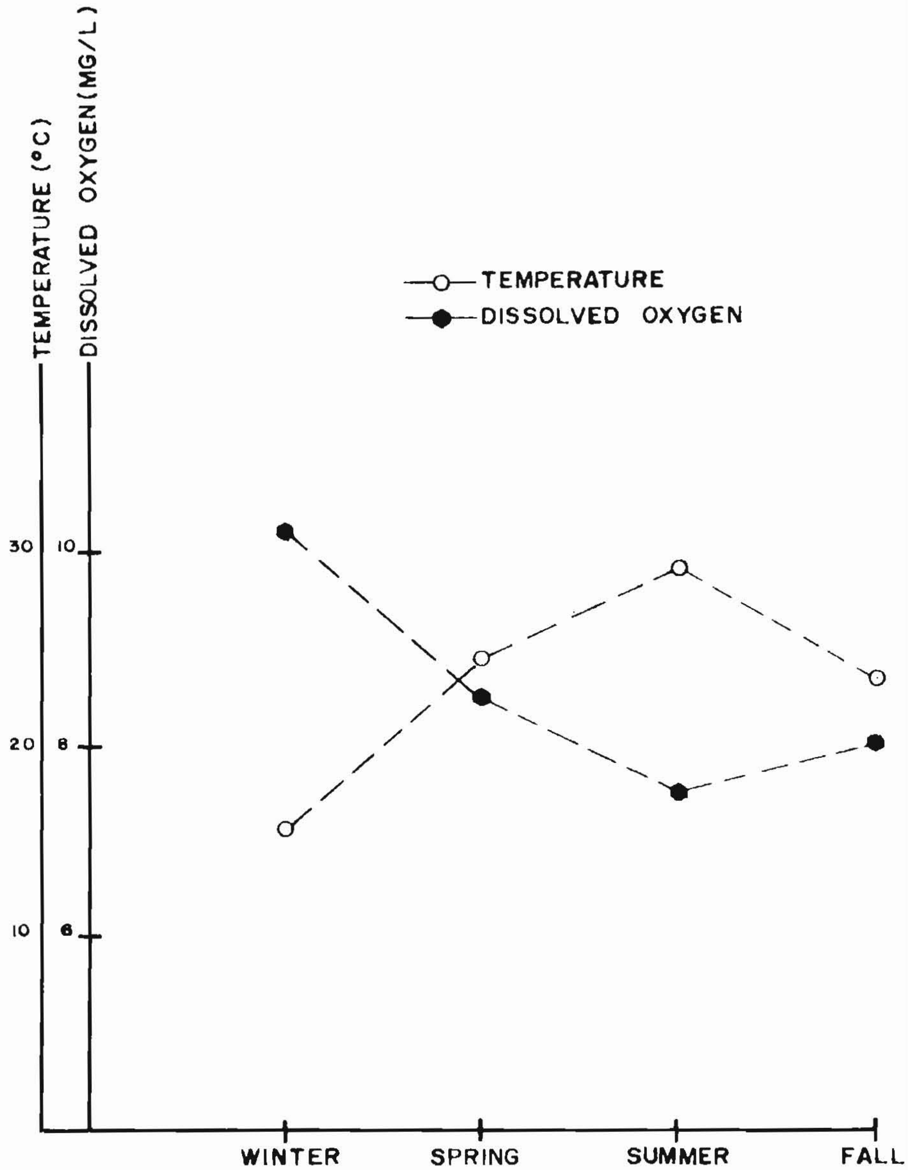

Figure 15. Comparison of dissolved oxygen versus temperature, Middle pool station 210302

36. Inspection of Figures 8-12 indicates a positive relationship between seasonal levels of organic nitrogen and chlorophyll-a. Figure 12, the Lake Gatlin station, shows this relationship more dramatically due to the much higher parameter levels that occur.

37. An inverse relationship was noted between temperature and total filterable phosphorus. Aquatic weed growth is greatest during the warmer months, with the filterable phosphorus tied up in plant biomass. During the colder months the phosphorus is released back into the water column as the plants die and decay.

Sediment Quality

Data compilation

38. Sediment data were collected on three occasions during the baseline period at the 11 designated sampling stations in October, January, and July, representing the fall, winter, and summer conditions, respectively.

39. Sediment quality data are presented in Table 7. Table 8 is a compilation of the data in the form of mean values and standard deviations.

Data analysis

40. The nitrogen and phosphorus values follow no predictable pattern from station to station (Table 7). Total nitrogen concentrations range from 0.24 to 12.0 mg/g. Total phosphorus levels vary from 0.10 to 2.0 mg/g, with all values, except one, less than 0.9 mg/g.

41. Copper and lead concentrations peak in the summer and reach minimum levels in the winter samples. Copper concentrations vary over a rather wide range from less than 1 up to 95 μg/g.

42. Lead concentrations display a similar pattern to that of copper. Sediment collected in October 1976 contained lead concentrations ranging from 3.3 to 52.0 μg/g, while the January 1977 samples had lower concentrations of lead ranging from 0.010 to 0.058 μg/g.

43. The TOC concentrations varied over a wide range. Values from 1.7 to 83.0 mg/g were obtained during the baseline period (Table 7).

Due to problems concerning sediment particle sizes and consistencies, COD analyses were substituted for TOC tests on 13 July 1977 to avoid reproducibility problems.

44. The wide range of iron levels observed in the sediments (30 to 3600 μg/g) is within the normal range for central Florida lakes (St. John's Water Management District 1977).

Aquatic Macrophytes

45. Table 9 presents the data relating to nutrient, organic, and other chemical contents of selected aquatic macrophytes associated with the Lake Conway system. These data were analyzed by the Orange County Pollution Control Department and used by other LSOMT contractors in assessing the overall nutrient budget of the lake system and in ecosystem modeling efforts.

PART IV: CONCLUSIONS

46. Analysis of the chemical, physical, and biological water quality data shows generally consistent results within each lake pool, but some variability between the pools. Higher concentrations of most parameters occur in Lake Gatlin, with progressively smaller concentrations of dissolved solids, nutrients, chlorophyll-a, BOD, and COD in the West pool, East pool, and Middle pool. The South pool exhibits the lowest concentrations of these parameters.

47. Several parameters show little variability with change in sampling depth (Table 3), while dissolved oxygen, pH, turbidity, and chlorophyll-a exhibit greater variation. Parameters found to vary seasonally include organic nitrogen, total phosphorus, dissolved oxygen, temperature, and chlorophyll-a. Magnesium concentration increases sharply in Lake Gatlin.

48. An analysis of the sediment quality data shows mostly random variations in parameter levels. This is the case with nitrogen, phosphorus, TOC, COD, and iron concentrations. Copper and lead concentrations appear to vary seasonally, but due to the limited amount of data collected during the baseline period, no firm conclusions can be made.

REFERENCES

American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 1976. Standard Methods for the Examination of Water and Wastewater, 14th edition, Washington, D. C.

St. John's River Water Management District. 1977. Water Resource Management Plan Phase 1. Palatka, Fla.

U. S. Environmental Protection Agency. 1974. Methods for Chemical Analysis of Water and Wastes, Cincinnati, Ohio.

Table 1

Analytical Methods for Chemical and Physical Parameters on Water Samples

Parameter	Method	Reference
pH	Orion Model 401 Ionanlyzer in the lab, or a Hydrolab Monitor Model 6D12 in the field	
Conductivity	Beckman Model RC 16B2 conductivity bridge in lab, or Hydrolab Monitor in the field	APHA (1976)
Dissolved oxygen	YSI Model 51A Oxygen Meter, Hydrolab Monitor, or Winkler wet chemical technique	APHA (1976)
Temperature	YSI Model 51A Oxygen Meter or Hydrolab Monitor	
Oxidation-reduction potential	Hydrolab Monitor	
Color	Sample centrifuged and compared against standard chloroplatinate solution at 420 mm on a Bausch and Lomb Spectronic 88	APHA (1976)
Turbidity	Hach Turbidimeter Model 2424 standardized with formazin suspensions	APHA (1976)
Alkalinity	Titration with standard acid using color indicators	APHA (1974)
Total Kjeldahl Nitrogen (TKN)	Manual semi-micro digestion followed by analysis of ammonium on neutralized samples by alkaline phenol method on AutoAnalyzer	EPA (1974)
Ammonium	Alkaline phenol method on AutoAnalyzer	EPA (1974)
Nitrate	Cadmium (wire) reduction method on AutoAnalyzer	
Total phosphorus	Sample digested with ammonium persulfate and measured using the single reagent molybdenum blue test on a Bausch and Lomb Spectronic 88 at 880 nm	APHA (1976)
Orthophosphate	Measured at 880 nm using the molybdenum blue test on a Bausch and Lomb Spectronic 88	APHA (1976)
Total, inorganic, and dissolved organic carbon	Measured by combusting samples in a Beckman Model 915 TOC Analyzer with analysis in a Beckman Model 865 Infrared Analyzer. TC - IC = OC. DOC by filtering sample*	APHA (1976)
Cations (calcium, EPA (1974) magnesium, sodium, potassium)	Varian Model 1200 atomic absorption spectrophotometer	
Sulfate	Methylthymol blue method of Technicon AutoAnalyzer	APHA (1976)
Chloride	Ferricyanide method on Technicon AutoAnalyzer	APHA (1976)

* TOC = total organic carbon; TC = total carbon; IC = inorganic carbon; OC = organic carbon; and DOC = dissolved organic carbon.

Table 2

Minimum Detection Level of Parameters

Parameter	Detectable Level, mg/ℓ
Nitrate nitrogen*	0.100
Nitrite nitrogen*	0.010
Ammonia nitrogen*	0.050
Orthophosphorus*	0.010
Copper*	0.010
Iron	0.050
Lead	0.010

* Occasionally measured in amounts exceeding detectable level.

Table 3

Parameters Found to Have No Significant Variability Due to Changes in Depth

Parameter	Percent Variability
Temperature	1
Conductivity	1
Alkalinity	1
Hardness	2
Calcium	1
Sodium	1
Potassium	1
Magnesium	0
Organic nitrogen	2
Biochemical oxygen demand	5
Chemical oxygen demand	5
Total solids	2
Total phosphorus (filtered)	3
Total phosphorus (unfiltered)	3
Volatile suspended solids	5
Carotenoids	5

Table 4

Means (X) and Standard Deviation (SD) of the Various Parameters from the Individual Stations in the Lake Conway System

Parameter	South Pool 400117 X	South Pool 400117 SD	South Pool 282197 X	South Pool 282197 SD	Middle Pool 210302 X	Middle Pool 210302 SD	Middle Pool 415312 X	Middle Pool 415312 SD	Middle Pool 332385 X	Middle Pool 332385 SD
Temperature, °C	23.2	5.8	23.3	5.7	23.4	5.7	23.2	5.8	23.1	5.0
Conductivity, μmho/cm	210.0	12.0	210.0	12.0	210.0	9.0	210.0	10.0	215.0	8.0
Alkalinity, mg/ℓ	32.0	1.4	32.0	1.7	37.0	1.3	37.0	1.1	37.0	1.3
Hardness, mg/ℓ	60.0	5.8	59.0	4.1	61.0	3.9	62.0	3.5	62.0	3.4
Calcium, mg/ℓ	13.0	1.8	13.0	1.3	13.0	1.2	14.0	1.4	14.0	1.2
Sodium, mg/ℓ	15.0	0.9	15.0	0.9	15.0	1.0	15.0	1.1	15.0	1.1
Potassium, mg/ℓ	4.0	0.3	4.0	0.3	3.5	0.2	3.5	0.2	3.5	0.3
Magnesium, mg/ℓ	6.5	0.4	6.5	0.4	6.8	0.4	6.8	0.4	6.8	0.4
Secchi disk, m	2.9	0.7	3.3	1.1	2.9	0.6	3.1	0.8	2.1	0.4
Organic nitrogen, mg/ℓ	0.49	0.07	0.49	0.07	0.43	0.08	0.43	0.08	0.44	0.08
Biochemical oxygen demand, mg/ℓ	1.1	0.4	1.1	0.4	1.0	0.5	1.1	0.5	1.2	0.5
Chemical oxygen demand, mg/ℓ	16.0	4.0	15.0	5.0	14.0	4.0	15.0	4.0	14.0	3.0
Total solids, mg/ℓ	130.0	6.0	130.0	8.0	130.0	8.0	130.0	9.0	125.0	12.0
Total phosphorus (filt.), mg/ℓ	0.017	0.007	0.016	0.007	0.016	0.007	0.017	0.007	0.15	0.005
Total phosphorus (unfilt.), mg/ℓ	0.025	0.009	0.023	0.008	0.022	0.007	0.024	0.009	0.022	0.008
Volatile suspended solids, mg/ℓ	1.7	1.2	1.8	1.2	1.5	0.9	1.3	0.8	1.5	0.9
Carotenoids, mg/m^3	3.1	2.8	3.0	2.7	3.2	2.6	3.4	2.4	3.2	2.7

(Continued)

Table 4 (Concluded)

	Station											
	East Pool				West Pool						Gatlin	
	380455		415532		212495		195382		157435		132497	
Parameter	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Temperature, °C	23.1	5.6	23.3	5.7	23.2	5.7	23.2	5.7	22.9	5.5	23.6	5.7
Conductivity, μmho/cm	230.0	7.0	230.0	6.0	230.0	7.0	235.0	8.0	235.0	7.0	270.0	12.0
Alkalinity, mg/ℓ	42.0	2.8	43.0	2.3	44.0	2.3	44.0	2.5	44.0	2.5	40.0	3.6
Hardness, mg/ℓ	68.0	4.6	69.0	4.4	70.0	4.5	70.0	4.4	71.0	4.1	82.0	4.8
Calcium, mg/ℓ	17.0	1.2	17.0	1.7	18.0	1.6	17.0	1.6	18.0	1.6	14.0	1.8
Sodium, mg/ℓ	15.0	1.0	15.0	1.0	15.0	0.9	15.0	0.9	15.0	1.1	16.0	2.5
Potassium, mg/ℓ	4.1	0.3	4.1	0.3	4.2	0.3	4.3	0.2	4.3	0.3	5.3	0.3
Magnesium, mg/ℓ	6.4	0.4	6.3	0.4	6.4	0.4	6.4	0.3	6.4	0.4	11.0	0.7
Secchi disk, m	1.3	0.2	2.4	0.5	2.5	0.8	2.3	0.5	2.4	0.9	2.1	0.7
Organic nitrogen, mg/ℓ	0.54	0.04	0.54	0.04	0.54	0.05	0.53	0.06	0.54	0.04	0.56	0.13
Biochemical oxygen demand, mg/ℓ	1.5	0.4	1.5	0.8	1.5	0.6	1.3	0.3	1.3	0.4	1.3	0.5
Chemical oxygen demand, mg/ℓ	18.0	4.0	16.0	4.0	15.0	4.0	16.0	3.0	16.0	3.0	15.0	5.0
Total solids, mg/ℓ	140.0	12.0	140.0	10.0	14.0	9.0	140.0	13.0	140.0	13.0	170.0	16.0
Total phosphorus (filt.), mg/ℓ	0.018	0.007	0.017	0.007	0.018	0.007	0.017	0.006	0.017	0.005	0.018	0.006
Total phosphorus (unfilt.), mg/ℓ	0.027	0.012	0.025	0.011	0.026	0.008	0.025	0.007	0.027	0.008	0.028	0.009
Volatile suspended solids, mg/ℓ	2.1	1.0	2.0	1.0	2.1	0.9	1.9	1.1	1.6	0.7	2.5	1.8
Carotenoids, mg/m^3	3.8	2.1	4.6	2.6	5.4	3.3	5.2	3.6	5.4	3.5	6.5	4.8

Table 5

Lake Conway* Baseline Data Compilation

Parameter	Mean Value	Standard Deviation
Temperature	23.2 °C	5.7 °C
Conductivity	225 μmho/cm	9 μmho/cm
Alkalinity	39 mg/ℓ	2.1 mg/ℓ
Hardness	67 mg/ℓ	4.3 mg/ℓ
Calcium	15 mg/ℓ	1.5 mg/ℓ
Sodium	15 mg/ℓ	1.1 mg/ℓ
Potassium	4.1 mg/ℓ	0.3 mg/ℓ
Magnesium	6.9 mg/ℓ	0.4 mg/ℓ
Secchi disk	2.5 m	0.7 m
Organic nitrogen	0.50 mg/ℓ	0.07 mg/ℓ
Biochemical oxygen demand	1.3 mg/ℓ	0.5 mg/ℓ
Chemical oxygen demand	15 mg/ℓ	4 mg/ℓ
Total solids	140 mg/ℓ	11 mg/ℓ
Total phosphorus (filtered)	0.017 mg/ℓ	0.006 mg/ℓ
Total phosphorus (unfiltered)	0.025 mg/ℓ	0.009 mg/ℓ
Volatile suspended solids	1.8 mg/ℓ	1.0 mg/ℓ
Carotenoids	4.2 mg/m^3	3.0 mg/m^3

* Based on data collected at all 11 sampling stations.

Table 6

Lake Conway Baseline Data

Station No.	Surface		Mid-Depth		Bottom	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
			Dissolved Oxygen, mg/ℓ			
400117	8.6	1.2	8.4	1.1	8.1	1.2
282197	8.6	1.2	8.4	1.1	7.4	2.2
210302	8.7	1.2	8.6	1.2	8.4	1.3
415312	8.7	1.2	8.6	1.3	8.0	1.5
332385	8.6	1.1	--	--	8.6	1.1
380455	8.3	1.4	--	--	8.4	1.4
415532	8.6	1.1	8.5	1.0	7.8	1.3
212495	8.6	1.0	8.4	0.9	8.2	0.9
195382	8.4	1.0	8.3	1.0	8.0	1.0
157435	8.4	1.0	7.9	1.2	5.5	3.9
132497	8.6	1.0	8.5	0.7	7.1	1.9
Average for Lake Conway	8.6	1.1	8.4	1.1	7.8	1.6
			pH			
400117	7.5	0.3	7.5	0.3	7.4	0.4
282197	7.6	0.3	7.5	0.4	7.2	0.4
210302	7.7	0.3	7.7	0.3	7.7	0.3
415312	7.7	0.3	7.7	0.3	7.5	0.3
332385	7.7	0.3	--	--	7.6	0.3
380455	7.6	0.3	--	--	7.6	0.2
415532	7.6	0.4	7.6	0.5	7.4	0.5
212495	7.6	0.4	7.6	0.4	7.6	0.4
195382	7.7	0.3	7.7	0.3	7.6	0.3
157435	7.7	0.3	7.5	0.3	7.2	0.5
132497	7.8	0.5	7.7	0.5	7.4	0.4
Average for Lake Conway	7.7	0.3	7.6	0.4	7.5	0.4

(Continued)

Table 6 (Concluded)

Station No.	Surface		Mid-Depth		Bottom	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
			Turbidity, NTU*			
400117	1.5	1.1	1.4	0.9	1.5	1.0
282197	1.4	1.0	1.3	0.8	1.3	0.8
210302	1.3	0.9	1.3	1.1	1.3	1.0
415312	1.2	0.6	1.2	0.7	1.4	0.9
332385	1.6	1.6	--	--	1.3	0.8
380455	1.4	0.5	--	--	1.5	0.6
415532	1.5	0.6	1.5	0.8	1.8	1.4
212495	1.6	0.6	1.7	0.7	1.8	0.7
195382	1.5	0.6	1.4	0.5	1.5	0.6
157435	1.5	0.6	1.5	0.7	1.7	0.7
132497	1.8	0.8	1.8	0.9	1.8	0.8
Average for Lake Conway	1.5	0.8	1.5	0.8	1.5	0.8
			Chlorophyll-a, mg/m^3			
400117	4.6	3.1	4.2	3.3	4.3	2.8
282197	4.2	2.9	4.3	3.4	4.2	3.0
210302	4.6	3.0	4.5	3.3	4.8	3.3
415312	4.9	2.8	4.8	2.9	5.8	3.6
332385	4.5	3.0	--	--	4.3	2.7
380455	5.0	1.7	--	--	5.4	2.0
415532	6.3	2.2	6.3	2.1	6.5	2.5
212495	7.0	3.1	7.4	3.5	6.9	3.1
195382	6.5	2.9	6.1	2.6	6.6	3.2
157435	6.9	3.1	8.4	7.2	10.2	9.0
132497	13.1	12.6	11.5	9.9	10.4	9.0
Average for Lake Conway	6.1	3.7	6.4	4.0	6.3	3.3

* NTU = Nephelometric Turbidity Units.

Table 7

Baseline Sediment Chemical

Quality Data

Date	Station No.	Total Nitrogen mg/g	Total Phosphorus mg/g	Copper μg/g	Lead μg/g	TOC mg/g	COD mg/g	Iron μg/g
18 Oct 76	400117	0.800	0.024	3.500	15.000	18.000	No Data	42.000
17 Jan 77	400117	1.500	0.260	0.016	0.043	23.000	No Data	650.000
13 Jul 77	400117	3.410	No Data	26.000	No Data	*	81.000	680.000
18 Oct 76	282197	0.240	0.100	0.880	3.400	1.700	No Data	30.000
17 Jan 77	282197	0.240	0.260	0.009	0.045	11.000	No Data	500.000
13 Jul 77	282197	0.600	0.110	2.000	No Data	*	9.200	290.000
18 Oct 76	210302	3.7000	0.620	32.000	52.000	80.000	No Data	1200.000
17 Jan 77	210302	2.400	0.660	0.042	0.043	22.000	No Data	1000.000
13 Jul 77	210302	5.900	0.440	91.000	No Data	*	140.000	1600.000
18 Oct 76	415312	0.830	0.160	0.930	4.000	6.700	No Data	103.000
17 Jan 77	415312	1.000	0.320	0.004	0.051	14.000	No Data	550.000
13 Jul 77	415312	1.000	No Data	22.000	No Data	*	120.000	980.000
18 Oct 76	332385	2.000	0.790	10.000	27.000	45.000	No Data	890.000
17 Jan 77	332385	3.200	2.000	0.017	0.033	42.000	No Data	950.000
13 Jul 77	332385	0.520	0.200	0.010	No Data	*	10.000	120.000
18 Oct 76	380455	1.700	0.810	21.000	23.000	32.000	No Data	450.000
17 Jan 77	380455	5.300	0.680	0.058	0.029	45.000	No Data	1000.000
13 Jul 77	380455	1.610	No Data	12.000	No Data	*	33.000	430.000
18 Oct 76	415532	1.700	0.260	22.000	13.000	60.000	No Data	406.000
17 Jan 77	415532	8.700	0.490	0.110	0.045	83.000	No Data	2000.000
13 Jul 77	415532	2.100	0.430	22.000	No Data	*	66.000	570.000

(Continued)

* Discontinued analysis.

Table 7 (Concluded)

Date	Station No.	Total Nitrogen mg/g	Total Phosphorus mg/g	Copper μg/g	Lead μg/g	TOC mg/g	COD mg/g	Iron μg/g
18 Oct 76	212495	1.900	0.380	11.000	20.000	32.000	No Data	540.000
17 Jan 77	212495	0.600	0.500	0.008	0.045	11.000	No Data	600.000
13 Jul 77	212495	1.600	0.340	10.000	No Data	*	39.000	560.000
18 Oct 76	195382	2.800	0.310	16.000	29.000	52.000	No Data	540.000
17 Jan 77	195382	1.600	0.490	0.014	0.058	26.000	No Data	550.000
13 Jul 77	195382	3.500	0.310	19.000	No Data	*	80.000	620.000
18 Oct 76	157435	0.500	0.120	2.400	9.7000	5.8000	No Data	340.000
17 Jan 77	157435	0.250	0.260	0.004	0.014	3.700	No Data	NO DATA
13 Jul 77	157435	12.000	0.140	95.000	No Data	*	360.000	3600.000
18 Oct 76	132497	0.530	0.890	11.000	3.300	6.200	No Data	430.000
17 Jan 77	132497	0.970	0.170	0.011	0.010	8.300	No Data	550.000
13 Jul 77	132497	1.100	No Data	15.000	No Data	*	33.000	500.000

Table 8

Summary of Baseline Sediment Quality Data

Parameter	Mean Value	Standard Deviation
Total nitrogen, mg/g	2.66	2.69
Total phosphorus, mg/g	0.44	0.37
Copper, μg/g	13.49	22.60
Lead, μg/g	9.08	13.65
Total organic carbon,* mg/g	28.6	24.1
Chemical oxygen demand,** mg/g	88.3	99.5
Iron, μg/g	727	670

* Discontinued following January 1977.
** Represents July 1977 data only.

Table 9

Baseline Aquatic Macrophyte

Content Data

Date	Station No.	Plant Species	Water percent	TOC mg/g	PO_4-P mg/g	N mg/g	Cu mg/g
7- 1-76	400117	Hydrilla	93	260	1.0	17	70
7- 1-76	400117	Nitella	78	370	2.0	26	60
1-17-77	400117	Nitella	93	250	1.3	31	33
4- 6-77	400117	Nitella	96	380	0.62	34	47
7-11-77	400117	Nitella	--	330	1.6	31	30
7- 1-76	282197	Nitella	78	350	1.3	25	80
1-17-77	282197	Nitella	85	300	1.4	22	62
4- 6-77	282197	Potamogeton	88	430	0.49	19	44
4- 6-77	282197	Nitella	95	350	0.97	25	36
7-11-77	292197	Nitella	--	290	0.76	23	24
7-11-77	282197	Potamogeton	--	320	0.94	13	15
7- 1-76	210302	Hydrilla	92	260	1.2	20	70
7- 1-76	210302	Nitella	95	340	1.9	29	70
1- 7-77	210302	Nitella	95	270	1.5	35	43
1- 7- 77	210302	Potamogeton	91	280	1.8	26	33
4- 6-77	210302	Nitella	94	470	0.87	26	35
7-11-77	210302	Nitella	--	360	1.2	25	29
7- 1-76	415312	Nitella	96	250	1.6	34	38
4- 6-77	415312	Ceratophyllum	92	420	1.2	24	23
4- 6-77	415312	Nitella	94	370	1.2	21	27
7-12-77	415312	Nitella	--	320	1.5	25	23
7-12-77	415312	Ceratophyllum	--	370	1.6	24	10
7- 1-76	332385	Nitella	95	300	1.5	29	90
1-17-76	332385	Nitella	95	270	1.3	36	32
4- 7-77	332385	Nitella	95	390	0.87	20	22
4- 7-77	332385	Potamogeton	90	370	1.2	16	77

(Continued)

Table 9 (Continued)

Date	Station No.	Plant Species	Water percent	TOC mg/g	PO_4-P mg/g	N mg/g	Cu mg/g
7-12-77	332385	Nitella	--	330	1.3	31	35
7-12-77	332385	Potamogeton	--	290	1.3	19	14
7- 6-76	380455	Potamogeton	87	320	0.90	19	60
7- 6-76	380455	Vallisneria	94	420	0.96	26	70
7- 6-76	380455	Nitella	92	380	1.1	28	70
1- 7-77	380455	Potamogeton	93	330	1.1	23	18
4- 7-77	380455	Potamogeton	90	370	1.2	21	20
7-14-77	380455	Potamogeton	--	340	1.0	16	22
7-14-77	380455	Nitella	--	320	1.7	32	--
7- 6-76	415532	Hydrilla	92	290	1.1	20	50
1-17-77	415532	No Plants Recovered from Station					
4- 7-77	415532	No Plants Recovered from Station					
7-14-77	415532	No Plants Recovered from Station					
7- 6-76	212495	Hydrilla	95	320	1.2	24	80
1- 7-77	212495	No Plants Recovered from Station					
4- 7-77	212495	No Plants Recovered from Station					
7-14-77	212495	No Plants Recovered from Station					
7-27-76	195382	Nitella	96	380	0.56	27	90
1- 7-77	195382	Nitella	95	240	1.0	28	25
4- 7-77	195382	Potamogeton	92	320	1.7	24	16
4- 7-77	195382	Nitella	94	380	0.62	20	36
7-13-77	195382	Potamogeton	--	320	0.94	16	15
7-13-77	195382	Nitella	--	300	1.3	25	29
1-17-77	157435	No Plants Recovered from Station					
4- 7-77	157435	Potamogeton	93	350	2.0	35	40
4- 7-77	157435	Hydrilla	93	370	1.7	21	90
7-13-77	157435	Hydrilla	--	290	0.94	15	90

(Continued)

Table 9 (Concluded)

Date	Station No.	Plant Species	Water percent	TOC mg/g	PO_4-P mg/g	N mg/g	Cu mg/g
1-17-77	132497	No Plants Recovered from Station					
4- 7-77	132497	No Plants Recovered from Station					
7-14-77	132497	No Plants Recovered from Station					

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Large-scale operations management test of use of the white amur for control of problem aquatic plants : Report 1 : Baseline studies : Volume VI : The water and sediment quality of Lake Conway, Florida / by H. Douglas Miller ... [et al.] (Canin/Miller Associates and Orange County Pollution Control Department). -- Vicksburg, Miss. : U.S. Army Engineer Waterways Experiment Station ; Springfield, Va. : available from NTIS, 1981.

33, [13] p. : ill. ; 27 cm. -- (Technical report / U.S. Army Engineer Waterways Experiment Station ; A-78-2, Report 1, Volume 6)

Cover title.

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"Prepared for U.S. Army Engineer District, Jacksonville and Office, Chief of Engineers, U.S. Army under Contract No. DACW39-76-C-0084."

"Monitored by Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station."

Large-scale operations management test : ... 1981.
(Card 2)

At head of title: Aquatic Plant Control Research Program.

Bibliography: p. 33.

1. Aquatic weeds. 2. Lake Conway (Fla.) 3. Sediment, Suspended. 4. Water quality. I. Miller, H. Douglas. II. Canin/Miller Associates. III. Orange County Pollution Control Department. IV. Aquatic Plant Control Research Program. V. United States. Army. Corps of Engineers. Office of the Chief of Engineers. VI. U.S. Army Engineer Waterways Experiment Station. Environmental Laboratory. VII. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; A-78-2, Report 1, Volume 6.

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