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AQUATIC FIELD SURVEYS AT VOLUNTEER ARMY AMMUITION PLANT CHATTANOOGA, TENNESSEE

FINAL REPORT

J.H.SULLIVAN, JR., H.D.PUTNAM, M.A.KEIRN,
D.R.SWIFT AND B.C.PRUITT, JR.

JUNE, 1977

SUPPORTED BY
U.S. ARMY RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON, D.C. 20314

J. GARETH PEARSON, PROJECT OFFICER

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WATER AND AIR RESEARCH, INC.
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Volunteer Army Ammunition Plant is a TNT manufacturing facility located northwest of Chattanooga, Tennessee. Wastewater from VAAP drains northward into a series of treatment lagoons and is discharged into the head of Waconda Bay after undergoing pH adjustment with lime.

In each of two field surveys conducted during the summer of 1975, sampling was carried out at 20 locations in Waconda Bay and in two similar

reference bays unaffected by munitions plant effluent. Both chemical and biological analyses were conducted. Water and sediment samples were analyzed for major ions, nutrients, and munitions residues. Biological components selected were periphyton, phytoplankton, and benthic macro-invertebrates.

Data gathered during the summer show that nitrobodies, nitrogen compounds, and dissolved solids discharged in the VAAP waste maintain a chemical environment in upper Waconda Bay significantly different from the other study areas. Distinct gradients were observed for conductivity, hardness, sulfate, and chlorides beginning where wastes entered the receiving waters to downbay areas.

Munitions residues during the survey ranged to 345 ppb at the point of waste entry to near zero, one-half to three-quarters of a mile downbay. The data reported as the median and concentration ranges for 2,4-DNT, 2,6-DNT, and TNT showed no consistent pattern for any of the three compounds related to distance from the outfall. Dinitrotoluene compounds, however, made up the largest portion of the total residue concentration.

Biologic response by periphyton and macroinvertebrates was observed in similar areas of Waconda Bay where chemical characteristics were altered. Diatoms, a major part of the periphyton assemblage, were more sensitive to munitions wastes than were macroinvertebrates. In both surveys, population densities of diatoms on artificial substrates were reduced at the bayhead and elevated where NO_3-N levels promoted biostimulation.

Because the observed biologic responses were to a mixed waste input, it was not possible to determine precisely the concentration of the individual materials causing the responses. However, at the bayhead where toxicity was noted in both the periphyton and macrobenthic communities, median munitions concentrations (α-TNT + 2,4-DNT + 2,6-DNT) in June and August were 123 and 56 ppb, respectively, with individual samples as high as 345 ppb. Little reduction was noted in the concentrations of the specific munitions measured from the outfall to distances downbay of approximately three-eighths of a mile. Since the biologic response significantly shifted from toxic to biostimulatory, it is unlikely that the toxicity was due specifically to any of these three compounds which persisted in the environment. Nevertheless, it was observed that when munitions concentrations dropped below 20 ppb, no further biologic responses were evident. At munitions concentrations between 40 and 80 ppb, slight biostimulatory effects were noted.

Based on these results, it is concluded that environmental impact of TNT waste effluent would be minimal if the combined concentration of α-TNT, 2,4-DNT, and 2,6-DNT did not exceed 20 ppb in the receiving waters.

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AQUATIC FIELD SURVEY

AT

VOLUNTEER ARMY AMMUNITION PLANT, CHATTANOOGA, TENNESSEE

FINAL REPORT

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EXECUTIVE SUMMARY

In June and August, 1975, water quality surveys were conducted to determine the impact of liquid wastes from Volunteer Army Ammunition Plant at Chattanooga, Tennessee. This TNT manufacturing plant discharges wastes into Waconda Bay which is a part of the Lake Chickamauga Reservoir on the Tennessee River. The purpose of the study was to develop information that would aid in the rational development of effluent standards for the munitiors industry.

In each of the two surveys, sampling was carried out at 20 locations in Waconda Bay and in two similar reference bays unaffected by munitions-plant effluent. Both chemical and biological analyses were conducted. Water and sediment samples were analyzed for major ions, nutrients, and munitions residues. Biological components selected were periphyton, phytoplankton, and benthic macroinvertebrates.

The relative sizes of Waconda Bay, Reference Bay A, and Huss Lowe Slough are 235, 52, and 71 acres, respectively. Mean depth is about 10 feet for all three bays. Stormwater runoff from residential areas and VAAP enter Waconda Bay. The watershed of Reference Bay A is largely residential and that of Huss Lowe Slough forested.

Flushing of the three bays is caused by: 1) runoff, 2) stage fluctuations, and, in the case of Waconda Bay, 3) effluent from VAAP. Drainage areas for Waconda Bay and Huss Lowe Slough are each approximately nine times the area of the bay. For Reference Bay A the drainage basin is about 21 times the bay area. Present estimates for flushing of Waconda Bay are about 20 percent per month.

One week prior to the June survey the plant was closed by a labor dispute. Production was not resumed until after the August survey. During May, however, plant production was 1.3 million pounds of TNT. Effluent from this manufacture caused significant water quality changes in Waconda Bay. Data gathered during the summer show that nitrobodies, nitrogen compounds, and dissolved solids discharged in the VAAP waste maintain a chemical environment in upper Waconda Bay significantly different from the other study areas. Distinct gradients were observed for conductivity, hardness, sulfate, and chlorides beginning at Station A (effluent input) to downbay areas. Effluent from the plant appeared to move principally along the west shore of Waconda Bay. The data reflect this trend which is consistent with the morphometry of the upper bay, viz. deep water to the west and shallow water to the east.

Periodic discharges of TNT and nitrobodies historically have exceeded the 0.3 mg/l NPDES permit limits. Analyses conducted for monitoring purposes in 1974 showed TNT levels ranging above 1 mg/l in the upper bay. Munitions residues during the 1975 June and August survey ranged to 345 ppb at Station A to near zero, one-half to three-quarters of a mile downbay. The data reported, as the median value and concentration ranges for 2,4-DNT, 2,6-DNT, and TNT, showed no consistent pattern for any of the three compounds related to distance from the outfall. Dinitrotoluene compounds, however, made up the largest portion of the total residue concentration. Highest levels of compounds were always observed on the west side of Waconda Bay.

Significant nitrogen enrichment occurred in Waconda Bay. Gradients of nitrate, nitrite, organic nitrogen, and ammonia were observed in the upper bay with maximum concentrations up to 5 mg N/l. Elevated levels of these substances existed from the waste entry to a point one-half mile downbay.

Selected heavy metal analyses were made which included iron, lead, cadmium, hexavalent chromium, copper, nickel, and zinc. Results indicated that the concentration was insufficient to cause biotoxicity.

Biologic response by periphyton and macroinvertebrates was observed in similar areas of Waconda Bay where chemical characteristics were altered. At Station A, the bayhead, toxic effects were noted in both communities. Diatoms, a major part of the periphyton assemblage, were more sensitive to munitions wastes than were macroinvertebrates. In both the June and August data, population densities of diatoms on artificial substrates were reduced at Station A and elevated at Station B-1 and B-2. Analysis of variance showed significant differences between station means in three of the four samplings.

Diatom community structure was altered at the bayhead relative to the other study areas. One hundred species of diatoms representing 23 genera were recorded from the artificial substrates placed in Lake Chickamauga in June. *Achnanthes-Fragilaria-Synedra-Gomphonema* was the most common diatom association. At Station A this pattern shifted to *Achnanthes-Nitzschia-Synedra*. In terms of total numbers of species, Station A had the least (14) compared to an average of 36 for Waconda Bay, 37 for Huss Lowe Slough, and 28 for Reference Bay A. Shifts in diatom species associations, viz. the reduction of species number and the increase of those pollutant tolerant, correlate with total munitions residues and NO_3-N at Station A.

Data for chlorophyll *a* and biomass for periphyton collected on artificial substrates generally agreed with the cell count data. In both June and August, Station A had low chlorophyll *a* and biomass as compared to all other stations. Correspondingly, Stations B-1 and B-2 generally showed the highest levels of chlorophyll *a* and biomass. Analysis of variance showed that in most cases for the June and August 2-week and 4-week incubation periods the differences in mean values between stations for these parameters were significant. Further statistical analysis using Tukey's least significant difference technique showed that in most cases Station A was significantly different from Stations B-1 and B-2. These data suggest that inhibition of microbial growth occurs in the area of the waste outfall. Biomass of both autotrophs and heterotrophs is reduced although the former is suppressed to a greater degree. The increase in cell counts, biomass, and chlorophyll a at Stations B-1 and B-2 suggest biostimulation.

Data from Hester-Dendy artificial substrates and bay sediments showed that chironomids and oligochaetes were the predominate macroinvertebrates. Chironomids preferentially colonized the artificial substrates and accounted for nearly 80 percent of the total population. Oligochaetes attained higher populations in the sediments. As observed in the periphyton, the density and number of macroinvertebrate taxa were lowest at Station A ranging from 100 to 400 and 6 to 13, respectively, on Hester-Dendy units. Effects of the munitions waste were also evident at Station B via a biostimulation response of photosynthetic autotrophs. Algae colonizing the H-D plates served as food for chironomids and populations increased two orders of magnitude over Station A.

Invertebrates inhabiting natural substrates were reduced in number of organisms and species in the area of the outfall suggesting inhibition by VAAP waste. Results of both surveys indicate a residual toxicity in bay sediments which continued during the summer period following plant shutdown in May. Examination of the data suggests that recovery in natural substrates lags behind that on the Hester-Dendy plates and that the increase in chironomids associated with primary production at Station B was not reflected in the sediments. Sediment chemistry shows munitions residues at Stations A and B. Other materials from VAAP likely deposit in the sediments contributing either by themselves to growth inhibition or behaving synergistically with other compounds.

An analysis of the phytoplankton showed a total of 71 species as representative of the study area. Algal association shifted during the investigation. During June diatoms were the predominant groups with common to dominant species of Melosira ambigua, M. distans, and Fragilaria crotonensis. In August, blue-green algae dominated the plankton. Important species were Schizothrix calicola and Anacystis incerta.

Phytoplankton populations (cells/ml) were generally higher during the second survey. Mean cell densities ranged from approximately 1,300 to 2,600 in June as compared to 2,100 to 5,400 in August. Application of an analysis of variance and Tukey's test show that a significant difference at the 1 percent level existed during August. Since the cell number was higher in these upper bay stations, biostimulation from available nitrogen is suggested. In June cell counts were slightly reduced at Station A and elevated at Stations B-1, B-2, and C-1. However, these differences were not statistically significant. Possibly the combined effects of toxicity and biostimulation were more nearly balanced. By August, the toxicity factors had diminished in the absence of new loading, and phytoplankton populations were stimulated by the residual high level of nitrogen compounds. This trend was also reflected in the other biological compartments examined.

The response is more subtle in the phytoplankton, and, in terms of the number of plankton species recorded per station, no significant trends were observed that could be attributable to munitions waste. Mean values for numbers of species per station ranged from 44 to 53 during the June survey and from 52 to 55 species per station for the August survey. The highest value recorded through the study was 71 species at Station B-1 (August 11, 1975); the lowest, 35 species at Station U-2 (June 9, 1975).

Because the observed biologic responses were to a mixed waste input, it is not possible to determine precisely the concentrations of the individual materials causing the responses. However, at the bayhead where toxicity was noted in both the periphyton and macrobenthic communities, median munitions concentrations (α-TNT + 2,4-DNT + 2,6-DNT) in June and August were 123 and 56 ppb, respectively, with individual samples as high as 345 ppb. Little reduction was noted in the concentrations of the specific munitions measured from the bayhead to transect B. Since the biologic response significantly shifted from toxic to biostimulatory, it is unlikely that the toxicity was due specifically to any of these three compounds which persisted in the environment. Nevertheless, it was observed that when munitions concentrations dropped below 20 ppb, no further biologic responses were evident. At munitions concentrations between 40 and 80 ppb, as at transect C, slight biostimulatory effects were noted.

Based on these results, it is concluded that environmental impact of TNT waste effluent would be minimal if the combined concentration of α-TNT, 2,4-DNT, and 2,6-DNT did not exceed 20 ppb in the receiving waters.

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INTRODUCTION

The U.S. Army Medical Research and Development Command has supported field and laboratory research for the development of environmental standards for munitions related residues. A significant portion of this effort has been directed toward field assessments at the various munitions facilities within the United States. These studies have been for the purpose of evaluating impact on the various biotic compartments in freshwater systems in order to establish effluent levels in receiving waters consistent with the maintenance of environmental quality.

To meet these objectives, Water and Air Research, Inc. conducted field investigations at Volunteer Army Ammunition Plant during the summer of 1975.

Volunteer Army Ammunition Plant is a TNT manufacturing facility located northwest of Chattanooga, Tennessee (Figures 1 and 2). This facility is a 7300 acre contractor-operated government munitions manufacturing plant that produces trinitrotoluene. A portion of the reservation is leased to Farmers Chemical Associates, Inc., manufacturers of nitric acid, ammonia and nitrogenous fertilizers. Wastewater from VAAP drains northward into a series of treatment lagoons and is discharged into the head of Waconda Bay after undergoing pH adjustment with lime.

The purpose of this investigation was to define the environmental impact of effluent from Volunteer Army Ammunition Plant on Lake Chickamauga during the summer period. The assessment was conducted using selected physical, biological and chemical techniques for the development of guidelines to prevent water quality degradation.

The scope of work included both biologic and chemical sampling during the months of June and August. Water and sediments were characterized to include major ions, nutrient concentrations, and munitions specific residue. Biological compartments selected for examination were periphyton, phytoplankton, and benthic macroinvertebrates.

Since Waconda Bay is impacted by munitions effluents, an intensive survey was conducted in this bay. Two additional bays were selected as reference areas; these were Huss Lowe Slough and the un-named bay immediately east of Waconda Bay (Reference Bay A).

In the selection of the reference bays several factors were considered including the bay's area and shape, depth, physical orientation (north-south axis, etc.) and drainage basin. The land use of the basin, its location relative to munitions discharge, as well as its flushing and sediment characteristics were also considered.

The principal differences in the three bays can be described as follows:

Waconda Bay -- receives munitions wastes plus runoff from residential and industrial areas.

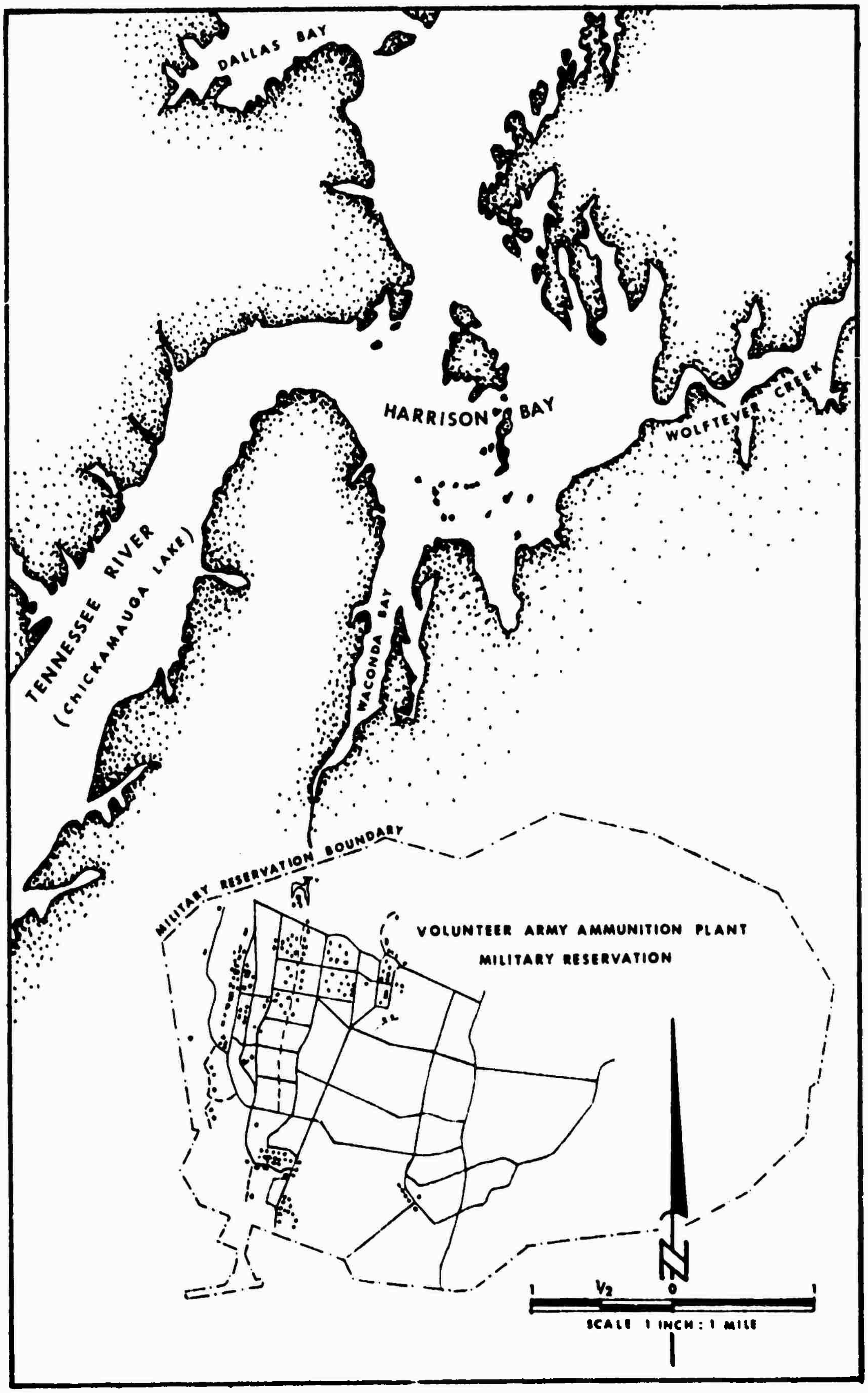


FIGURE 1. VICINITY MAP OF VAAP STUDY AREA.

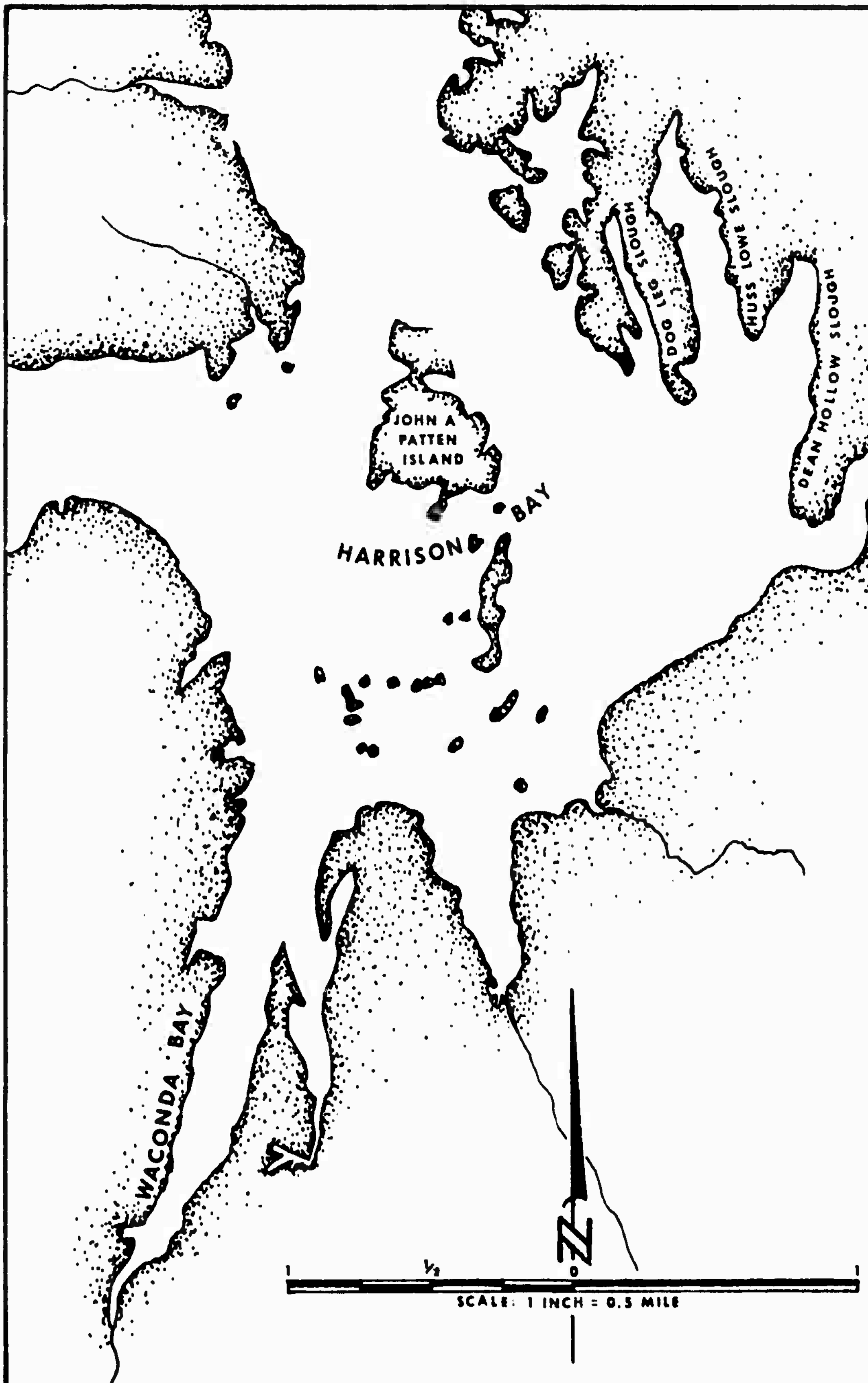


FIGURE 2. LOCALITY MAP OF VAAP STUDY AREA.

Reference Bay A -- receives only runoff from residential areas

Huss Lowe Slough -- receives only runoff from forested plus small residential area

Twenty sampling stations were selected within the three bays (Figures 3 and 4). A brief description of each site is given in Table 1.

The combined June and August surveys, considering as they did effluent discharge, distribution, mixing characteristics, changes and/or alterations in the chemical, biological or sediment characteristics of the three bays provide a data base for the recommendation of effluent guidelines for munitions wastes into receiving bodies.

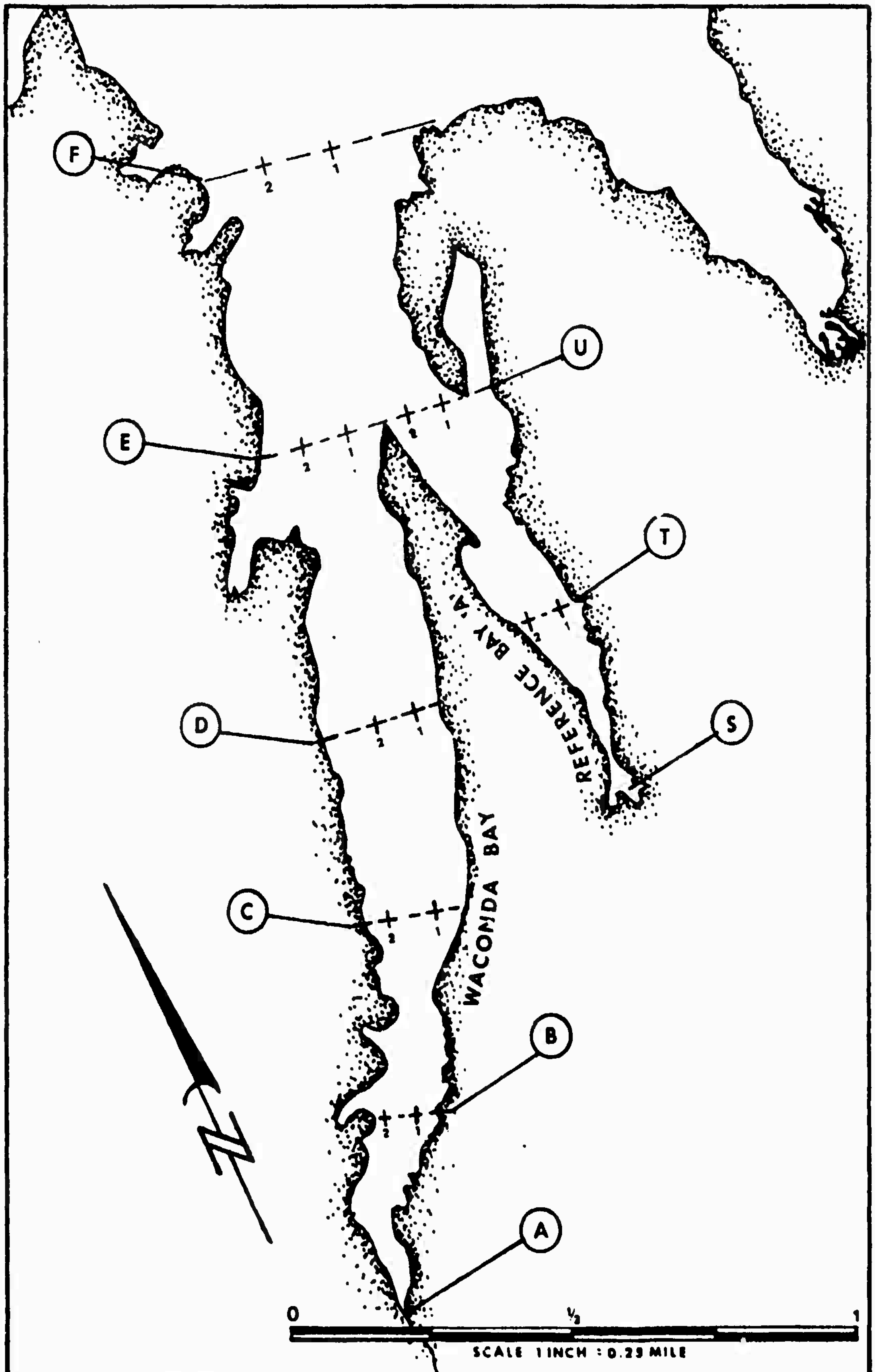


FIGURE 3. SAMPLING STATIONS IN WACONDA BAY AND ADJACENT REFERENCE BAY 'A.'

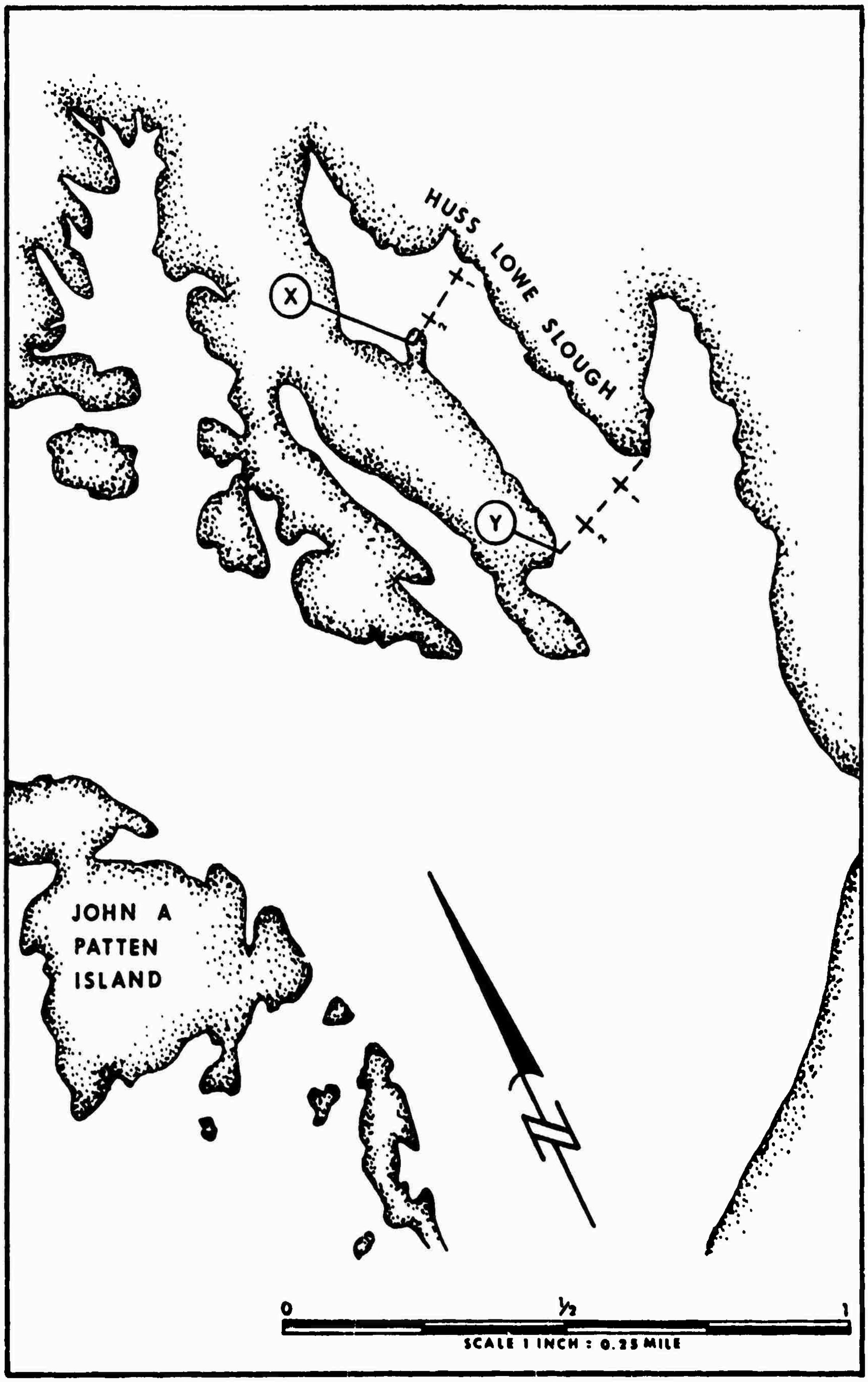


FIGURE 4. SAMPLING STATIONS IN HUSS LOWE SLOUGH (REFERENCE BAY 'B').

TABLE 1

SAMPLING SITE DESCRIPTION

Station Number	Approximate Depth (Feet)	Bottom Type
A	10	Black mud, leaf litter
B-1	2	Clay and sand
B-2	11	Clay and small pebbles
C-1	5	Soft clay and silt, Some leaf litter
C-2	6	Soft clay and silt
D-1	7	Pebbles, leaf litter, twigs, some clay
D-2	12	Soft clay and silt
E-1	19	Rock, pebbles, coarse sand, some clay
E-2	11	Clay, pebbles, and sand
F-1	26	Leaf litter
F-2	18	Sand and shell, little clay
S	5	Pebbles, coarse sand, and clay
T-1	6	Leaf litter, clay
T-2	3	Leaf litter, gravel, clay
U-1	7	Gravel, sand, leaf litter, pine needles, rocks
U-2	12	Gravel, sand, some clay
X-1	6	Clay, pebbles, sand, some twigs and leaf litter
X-2	8	Clay and pebbles
Y-1	7	Very hard clay
Y-2	15	Clay and pebbles

WATER QUALITY

Introduction

A considerable data base is being developed through contract research by the Army Medical Research and Development Command to characterize the environmental effects of TNT discharges. Major impact effects from a water quality standpoint are increased color, "pink water," resulting from photochemical action on nitrobodies; large increases in dissolved solids, mostly chlorides and sulfates; nitrogen enrichment; as well as munitions release. Failure of waste neutralization processes can result in significant pH changes. Effects on sediments include nitrogen, organic carbon, and salt enrichment, as well as accumulation of munitions compounds and their degradation products.

The Wapora study (1975) characterized water quality and biologic conditions in Waconda Bay and concluded that discharges from VAAP containing high levels of color, sulfate, solids, nitrates, nitrites, and organic material caused fish avoidance of upper Waconda Bay and destructuring of zooplankton and invertebrate communities.

Methods

During two 5-day survey periods, June 9 - 13 and August 11 - 15, 1975, samples and field measurements were taken at 20 stations located on nine transects of the three study bays, at the head of Waconda Bay, and Reference Bay A. Locations and descriptions of the stations are contained in the Introduction. The samples were preserved in accordance with EPA (1974) methods and shipped to WAR, Inc., in Gainesville, Florida, for processing.

Field Parameters. Dissolved oxygen (D.O.). temperature, pH, and specific conductance were monitored at various times throughout the day. Dissolved oxygen was measured with a YSI Model 51B D.O. meter. Specific conductance and temperature were measured with a YSI Model 33 Salinity-Conductivity-Temperature meter. Measurement of pH was made with a Photovolt Model 126A portable battery-operated pH meter.

Laboratory Analyses. Samples were collected as described and shipped refrigerated to WAR, Inc. The water quality parameters monitored included the following:

Major Ions	Oxygen Demand
Total Alkalinity	Chemical Oxygen Demand (COD)
Chloride	Total Organic Carbon (TOC)
Total Hardness	
Sulfate	
Total Dissolved Solids (TDS)	

Suspended Materials	Trace Metals
Suspended Solids (SS)	Cadmium (Cd)
Total Solids	Copper (Cu)
	Chromium, Hexavalent (Cr^{+6})
	Iron (Fe)
	Lead (Pb)
	Mercury (Hg)
	Nickel (Ni)
	Zinc (Zn)

Plant Nutrients	Munitions Compounds
Ammonia Nitrogen (NH_3-N)	2,4-Dinitrotoluene (2,4-DNT)
Total Kjeldahl Nitrogen (TKN)	2,6-Dinitrotoluene (2,6-DNT)
Nitrite Nitrogen (NO_2-N)	α-Trinitrotoluene (TNT)
Nitrate Nitrogen (NO_3-N)	
Total Phosphorus (Total P)	

The sediments were characterized by analyzing the following parameters:

Nutrients	Trace Metals
Chemical Oxygen Demand (COD)	Cadmium (Cd)
Total Kjeldahl Nitrogen (TKN)	Copper (Cu)
Nitrate Nitrogen (NO_3-N)	Iron (Fe)
Nitrite Nitrogen (NO_2-N)	Lead (Pb)
Total Phosphorus (Total P)	Manganese (Mn)
Total Solids	Mercury (Hg)
Total Volatile Solids	Nickel (Ni)
	Zinc (Zn)

Munitions Compounds

2,4-Dinitrotoluene (2,4-DNT)
2,6-Dinitrotoluene (2,6-DNT)
α-Trinitrotoluene (TNT)

The methods employed for collecting, preserving, and analyzing the routine water quality parameters followed accepted Standard Methods (APHA, 1971) or EPA (1974) procedures. Chemistry Laboratory Manual Bottom Sediments (EPA, 1969) was the source of the routine methods utilized for collection, preservation, and analysis of the sediment samples. Where existing methods, particularly for trace metals and munitions were insufficient to provide the desired levels of detection, alternate analytical procedures were employed after accuracy and precision had been verified. Details on analytical procedures are presented in Appendix A-1.

Waste Loading and VAAP Permitted Discharge

Table 2 tabulates the permitted discharges of wastes from VAAP. A labor strike, shutting down operations one week before the June survey, lasted through the summer. Therefore, no effluent was being discharged during either the June or August surveys. During the month of May, however, plant production was 1.3 million pounds of TNT. Significant water quality changes resulted in upper Waconda Bay. Comparison of the permitted discharges with plant records for the period October, 1974 (when the permit came into effect) to December, 1974 showed a number of parameters exceeding the set limits. During 1972, an EPA study summarized in STORET examined the characteristics of VAAP wastes. The parameters exceeding NPDES specifications during the two periods are listed below:

NPDES Monitoring (1974)		EPA Study (1972)	
Ammonia	Chromium	BOD	Chromium
BOD	Copper	Ammonia	Copper
COD	Manganese	Suspended Solids	Lead
Nitrite		Phosphate	Manganese
Nitrate		Iron	

Table 3 shows ranges of receiving water parameters monitored during early spring (1974) in conjunction with NPDES requirements.

Water Exchange Characteristics

The relative size of Waconda Bay, Reference Bay A, and Huss Lowe Slough (235, 52, and 71 acres, respectively) can be seen in Figures 3 and 4. Mean depth is about 10 feet for all three bays. Runoff from residential areas and VAAP enter Waconda Bay. The watershed of Reference Bay A is largely residential and that of Huss Lowe Slough forested.

Flushing of the bays will be caused by runoff, by stage fluctuations, and in the case of Waconda Bay by effluent imput. Drainage areas for Waconda Bay and Huss Lowe Slough are each about 9 times the area of the bay. For Reference A, the drainage area is about 21 times the bay area. Assuming typical runoff coefficients, flushing by rainfall will be roughly 10 percent of bay volume per month in Waconda Bay and Huss Lowe Slough and about 20 percent per month for Reference Bay A. At an effluent flow of 5 MGD, Waconda Bay will be about 20 percent flushed in one month. The relative effectiveness of flushing by stage variations is not known. However, Huss Lowe Slough because of morphometric differences, probably would be more affected by stage variations than the other two bays. Given the possible error in these estimates, it seems reasonable to conclude that there are no apparent major differences in potential flushing ability of the three bays. Wind velocity and direction would have only local temporary effects on mixing and flushing rather than creating a consistent pattern. This would be unimportant compared to rainfall and stage variation. In all three the time for complete flushing probably is on the order of months.

Characterization of Water Quality

The monitoring data presented in the previous section and the results of the 1975 survey by Wapora suggest that the impact from nitrobodies,

TABLE 2

NPDES PERMITTED DISCHARGE AND TYPICAL EFFLUENT DISCHARGE DATA AT VAAP

Parameter	NPDES Discharge Limitations Oct. 1, 1974 - April 30, 1979 (lbs/day) mg/l		NPDES Monitoring Data Oct. - Dec. 1974 Quantity lbs/day		NPDES Monitoring Data Oct. - Dec. 1974 Concentration mg/l		EPA Survey June, 1972 Concentration mg/l	
	Daily Average	Daily Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
NH_3-N	0.1	0.5	6.9	140	0.21	3.5	0.39	0.92
BOD_5	(66)	10	45	2890	1.6	12.0	5.0	11.0
COD	-	20	297	713	7.1	25.7	Not Reported	
Cr	(0.33)	0.05	0	4.32	0	0.10	50.0	50.0
Cu	(0.13)	0.02	0	3.0	0	0.06	50.0	50.0
Dissolved Solids	750	1000	4670	36,000	130	1000	10.0	519
Fe	-	0.3	3.2	3.7	0.09	0.1	0.9	4.5
Pb	(0.33)	0.05	0	0	0	0	0.10	0.10
Mn	-	0.05	1.4	13.3	0.01	0.34	0.13	0.25
Hg	(0.013) 0.002	0.005	0	0	0	0	Not Reported	
NO_2-NO_3-N	-	10	76	1050	2.4	22.2	6.2	9.9
Oil and Grease	99 (10)	15	Not Reported		Not Reported		Not Reported	
Phenol	(0.0066)	0.001	Not Reported		Not Reported		Not Reported	
Phosphate	-	0.1	Not Reported		Not Reported		Not Reported	
Settleable Solids	-	0.5	Not Reported		<0.1	0.1	Not Reported	
SO_4	-	250	2020	15,000	40	300	Not Reported	
Suspended Solids	30	-	159	1450	2.0	29.0	10.0	88.0
TNT + Nitrobodies	0.3	0.5	0	104	0	3.2	Not Reported	
Temperature	-	32.2°C	Not Reported		Not Reported		Not Reported	
Flow Rate			3.02 MGD	6.4 MGD			23.6 MGD	36.9 MGD

TABLE 3

CONCENTRATION RANGES DERIVED FROM NPDES MONITORING REPORTS OF SELECTED MUNITIONS MANUFACTURE GENERATED COMPOUNDS IN WACONDA BAY JANUARY - APRIL 1974

PARAMETER (mg/l)	STATION LOCATION				
	Dredge	Wilson Dock	Rod and Gun Club	Harbor Entrance	Main Channel
Ammonia-N	0.5-4.5	0.5-5.0	0.3-2.0	Nil-1.5	Nil-0.2
COD	Nil-52.42	Nil-29.95	Nil-29.95	Nil-37.7	Nil-44.5
Nitrate-N	6.1-9.8	5.4-8.6	1.9-5.5	1.8-3.5	0.03-2.4
Sulfate	80-360	113-326	26.0-196	13.1-240	10.0-27.5
TNT & Nitrobody	Nil-1.6	Nil-1.0	Nil-0.2	Nil	Nil-0.1
Total Sus. Solids	7-22	4-17	2-19	Nil-13.0	Nil-26.0
Chromium	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00
Copper	0.00-0.04	0.00-0.03	0.00=0.03	0.00-0.03	0.00-0.03
Iron	0.03-0.21	0.05-0.18	0.06-0.47	0.10-0.73	0.21-0.66
Lead	Nil	Nil	Nil	Nil	Nil

STATION LOCATIONS:

Dredge - Holding pond outlet prior to discharge into Waconda Bay

Wilson Dock - Approximately 500 meters down bay from the head of Waconda Bay (approximately at transect B)

Rod and Gun Club - Approximately 1200 meters down bay from the head at approximately transect D

Harbor Entrance - Off-shore at approximately location of transect F

Main Channel - Main Channel of Tennessee River nitrogen compounds, carbon, and dissolved solids discharged in the VAAP waste maintain a chemical environment in upper Waconda Bay significantly different from the rest of Harrison Bay. The results of the June - August, 1975 survey further document these water quality changes and offer a unique opportunity to examine the recovery rate of a lacustrine ecosystem from such effects.

Water quality data for selected major inorganic ions, plant nutrients, trace metals, and munitions, as well as associated field measurements, are tabulated in appendices A-2 to A-5. Transect and station locations are shown in Figures 3 and 4. Mean values of selected parameters are graphically illustrated in the text. The impact of TNT wastes on Waconda Bay may be placed in perspective by comparison with two reference bays and background data (STORET) on Chickamauga Lake for summer (1972). Baseline data from 1960 - 1961 gathered by Tennessee Valley Authority also exist for the lower part of Chickamauga Lake. These latter background data were considered by Tennessee Valley Authority to still be relevant to 1974 conditions (Tennessee Valley Authority, 1974). These background materials are appended in Appendix A-6. In general, these data correspond closely to data taken in the reference bays during the June and August, 1975, study in terms of hardness, alkalinity, conductance, and iron. During the 1960 survey, chlorides dropped from 13 - 15 mg/l in 1960 to 4 - 7 mg/l in 1961. These latter levels agree with more recent data. Plant nutrient concentrations, nitrogen and phosphorus, are sufficient to support well developed phytoplankton populations but are not indicative of excessively eutrophic conditions. The background data also suggest that biotoxic metals exist in Lake Chickamauga, but at insignificant levels.

Field Measurements. During the June and August, 1975 surveys, field measurements of dissolved oxygen, temperature, pH, and conductivity were made at all sampling locations. These data are presented in Appendix A-2, Tables A-3 through A-10.

For the week prior to the June sampling rainfall was only 0.19 inches. However, on the second and third sampling days (June 10-11) 1.39 inches were recorded, primarily between 0700 and 1100 hours. Consequently, some runoff was entering the reservoir during the sampling period. Sunshine, expressed as percent of possible, for the five-day sampling period was 50, 4, 2, 65, and 95 percent.

In August, 3.94 inches of rain fell during the week prior to sampling. No rainfall occurred during the five-day sampling period. Sunshine, expressed as percent of possible, for the five-day sampling period was 53, 86, 75, 73, and 15 percent.

In June, surface dissolved oxygen varied from a low of 4.9 mg/l at Station S on day 4 to a high of 9.75 mg/l at Station T-1 on day 1. Dissolved oxygen within one foot of the bottom varied from a low of 0.2 mg/l measured in a localized hole at Station Y-2 to a high of 8.5 mg/l at Station Y-1. Bottom D.O. was normally in the range of 3.5 - 8.0 mg/l. As might be expected, diurnal variations were evidenced by generally lower values in the early morning hours with a late afternoon maximum.

Surface dissolved oxygen values in August were generally higher than in June with concentrations as high as 10.6 mg/l. Bottom concentrations were similar to June observations. The higher surface levels probably are due to the increased amount of sunlight available in August which stimulated algal activity.

June water temperatures averaged 24.4°C with extremes of 20.9 and 27.0°C. In August, the average was 27.6°C with extremes during the photoperiod of 24.0 and 32.0°C.

Conductivity averaged 226 μmhos/cm in both June and August. A distinct gradient was noted from Station A (VAAP effluent input) to Stations F-1 and F-2 (approximately 500 μmhos/cm down to about 180 μmhos/cm). During both surveys a surface to bottom conductivity gradient was observed at Station A. Surface values ranged from 330 to 480. A variation of 465 to 1,350 was noted in bottom water. The highest conductivity was measured within a few inches of the bottom.

For both trips pH was in the range of 7.1 to 8.8. The higher values were measured in the afternoons during the peak algal activity. A slightly higher pH was observed during August probably because of the increased amount of sunlight available for photosynthetic activity.

Major Ions. The mean hardness, sulfate, and chloride levels in Waconda Bay are plotted in Figures 5, 6, and 7, respectively. Hardness shows a steep gradient, dropping from 125 mg/l as $CaCO_3$ at the head of the bay to about 65 mg/l offshore of transect D, a distance of 0.8 miles. An east (side 1) - west (side 2) gradient is also apparent with higher concentrations in the latter portion of the bay. This is a consistent trend throughout the data and reflects the morphometry of the upper bay -- deep water to the west, shallow water to the east. The steepness of the north - south gradient had decreased by the August survey viz maximum concentration 105 mg/l as $CaCO_3$. This suggests that the discharges from the plant create major changes in hardness in the upper bay during operation. A slight gradient existed in Reference Bay A. Huss Lowe Slough showed very stable hardness concentrations and no down-bay gradient. Hardness at Station S was slightly elevated (75 mg/l in June, 73 mg/l in August) as compared to background values of about 60 mg/l. These correspond to TVA (1974) data which ranged from 54 to 78 mg/l as $CaCO_3$. Nearly four inches of rain occurred the week prior to the August sampling trip. This may have caused some suppression of concentrations in Waconda Bay. However, flushing characteristics and data on the reference bay hardness do not support a hypothesis of major dilution effects.

Alkalinity was unaffected by discharges from VAAP and showed no down bay changes. Concentrations were about the same in all three bays and corresponded with historic data on Lake Chickamauga. Alkalinity was slightly higher during August.

Sulfate ions are also a major discharge from VAAP as shown in Figure 6. The shape of the gradient is identical to hardness, dropping to ambient reservoir levels between transects C and D. Maximum values at A were 108 mg/l in June, 55 mg/l in August. The maximum sulfate concentration found at the bay head by Wapora, Inc. (1974) was 72 mg/l. NPDES monitoring

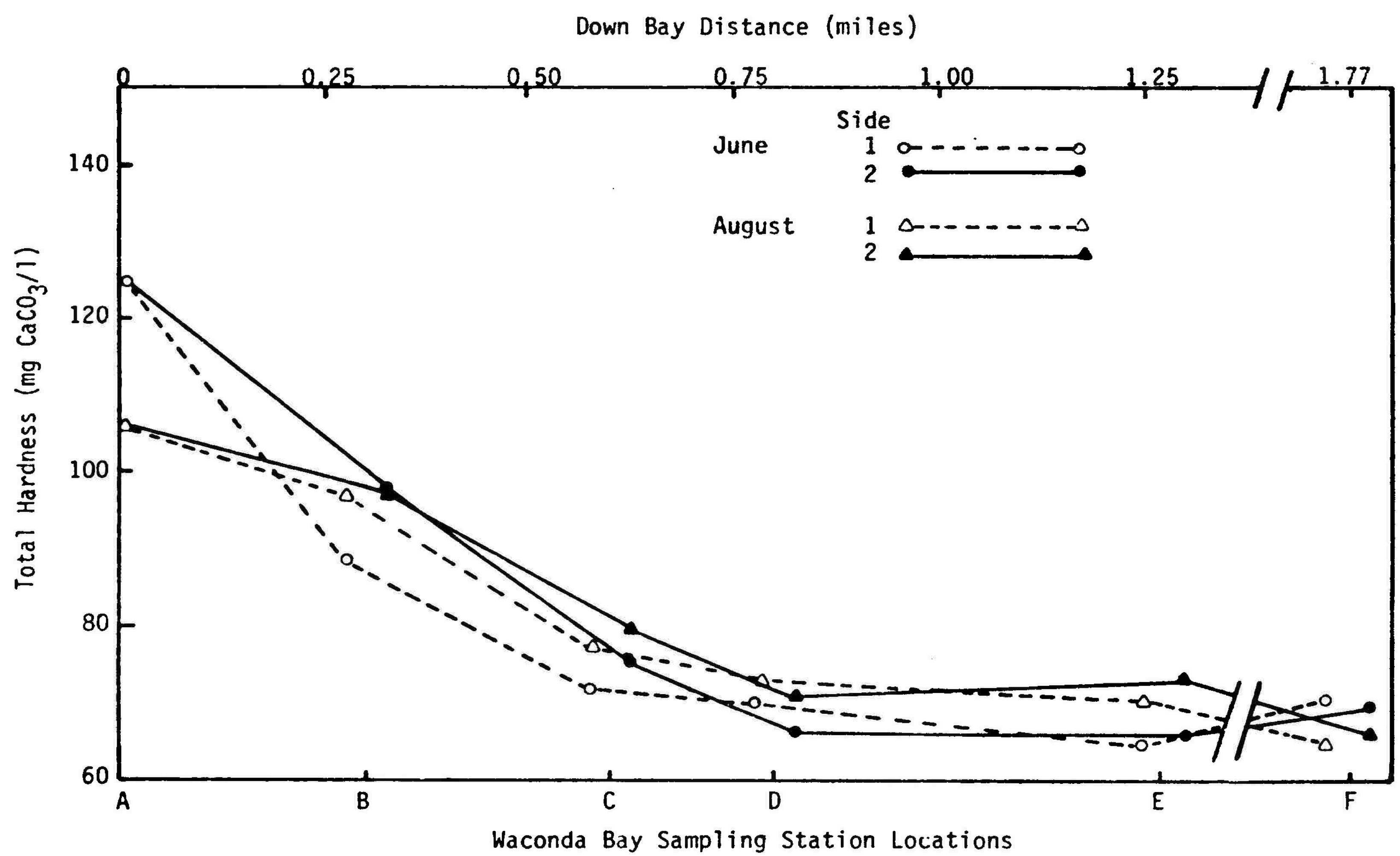


FIGURE 5. MEAN TOTAL HARDNESS CONCENTRATION GRADIENTS IN WACONDA BAY.

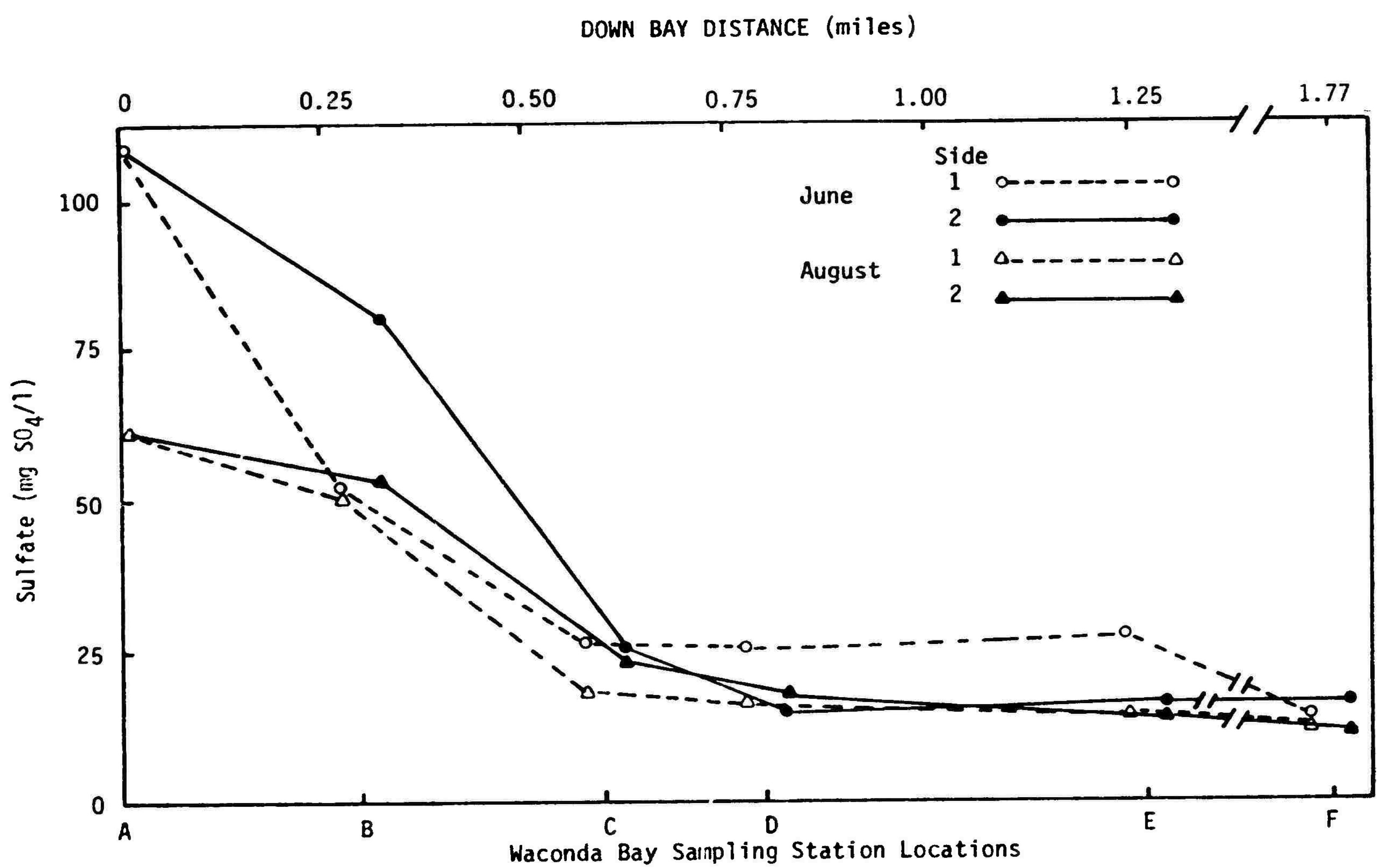


FIGURE 6. MEAN SULFATE CONCENTRATION GRADIENTS IN WACONDA BAY.

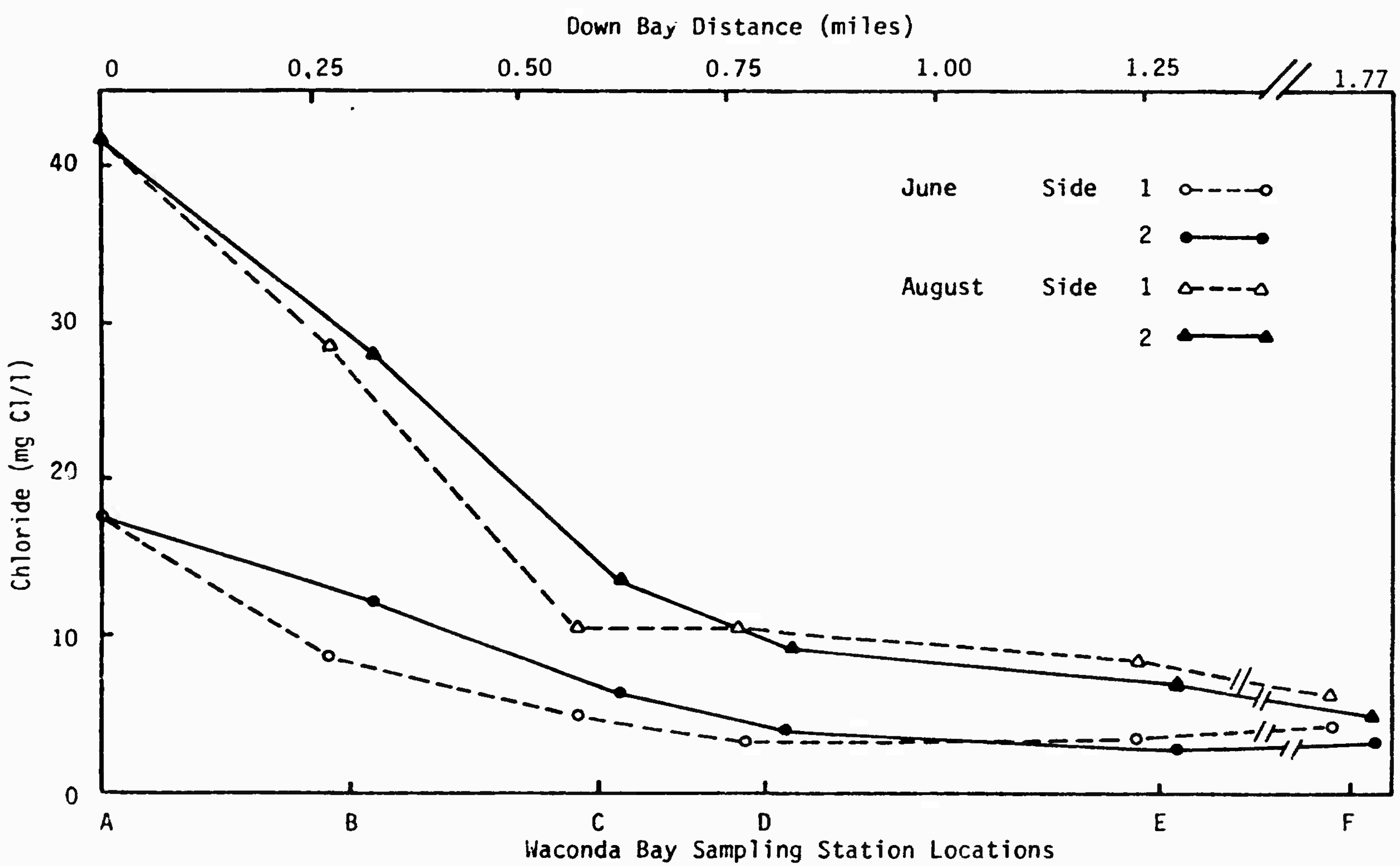


FIGURE 7. MEAN CHLORIDE CONCENTRATION GRADIENTS IN WACONDA BAY.

data indicate a range of 80 - 360 mg SO_4/l for the discharge into the bay. Station S again showed a slightly higher SO_4 concentration (27.3 mg/l) in June than the offshore stations in the reference bays. The background ranges for this ion agree with TVA data from 1960 - 1961.

The background chloride concentration corresponds to the historical Tennessee Valley Authority data. However, the concentration gradients in Waconda Bay differed significantly from those for sulfate and hardness in that the maximum was found during August rather than in June. Maximum June concentrations were only slightly higher than ambient (17.4 mg Cl/l) while the August concentration at A was over 40 mg Cl/l. None of the other major ions measured show a retrograde pattern between June and August levels.

Total dissolved solids ranged from 275 mg/l at A to approximately 100 mg/l at transect F in June. TDS data agree generally with the historical background for dissolved materials in Chickamauga Lake.

The overall ranges for several parameters for the reference bays are tabulated below:

	Concentration Range			
	Reference Bay A		Huss Lowe Slough	
	June	August	June	August
Total Hardness (mg $CaCO_3$/l)	59-79	64-81	59-65	60-67
Alkalinity (mg $CaCO_3$/l)	44-54	53-70	46-54	55-60
Sulfate (mg SO_4/l)	12-28	12-14	10-11	10-11
Chloride (mg Cl/l	2-5	2-4	6-8	5-6
Total Dissolved Solids (mg/l)	76-141	70-227	64-105	61-243

Except for samples taken on August 15, 1975, suspended materials were fairly low <2 - 15 mg/l. A slight gradient appeared to exist in Reference Bay A and in Waconda Bay. In Reference Bay A a general decrease in values offshore from S through U occurred probably due to runoff and dilution effects. In Waconda Bay a pattern existed with transects B and C showing consistently higher values than Station A or the offshore transects. The increase may be due to the higher plankton populations found at these two stations. Levels of suspended solids were relatively the same for both surveys. The gradient (for both the June and August surveys) is shown in Figure 8.

Carbon. The VAAP facility is permitted to discharge 20 mg/l chemical oxygen demand (COD) and up to 66 pounds per day biochemical oxygen demand (BOD) into Waconda Bay. Table 2 shows that up to 25 mg/l COD is likely to be discharged during plant operation. This carbonaceous material would include munitions residues, solvents, process impurities, and wasted starting materials. Apparently, these compounds degrade rapidly as only a slight COD gradient was apparent in Waconda Bay in June (Figure 9). During August the COD has the same pattern as suspended solids, i.e. low at A with highest concentrations at transect B. This suggests the suspended solids pulse in mid-bay is organic, possibly from increased algal populations.

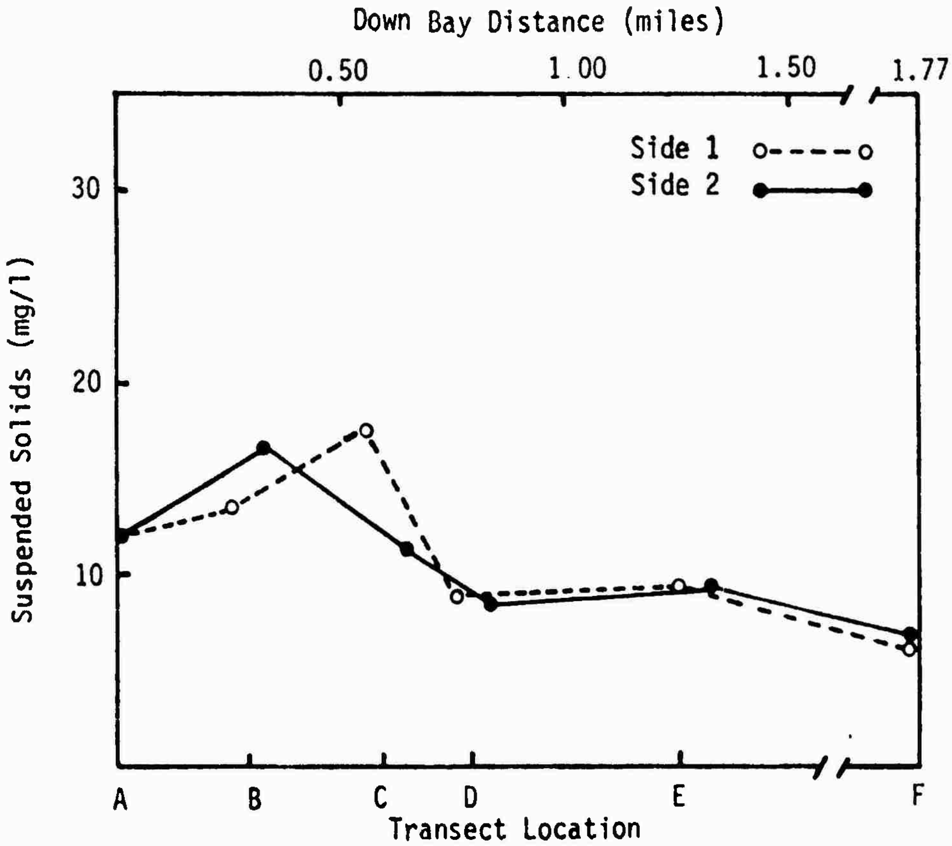


FIGURE 8. MEAN SUSPENDED SOLIDS CONCENTRATIONS IN WACONDA BAY.

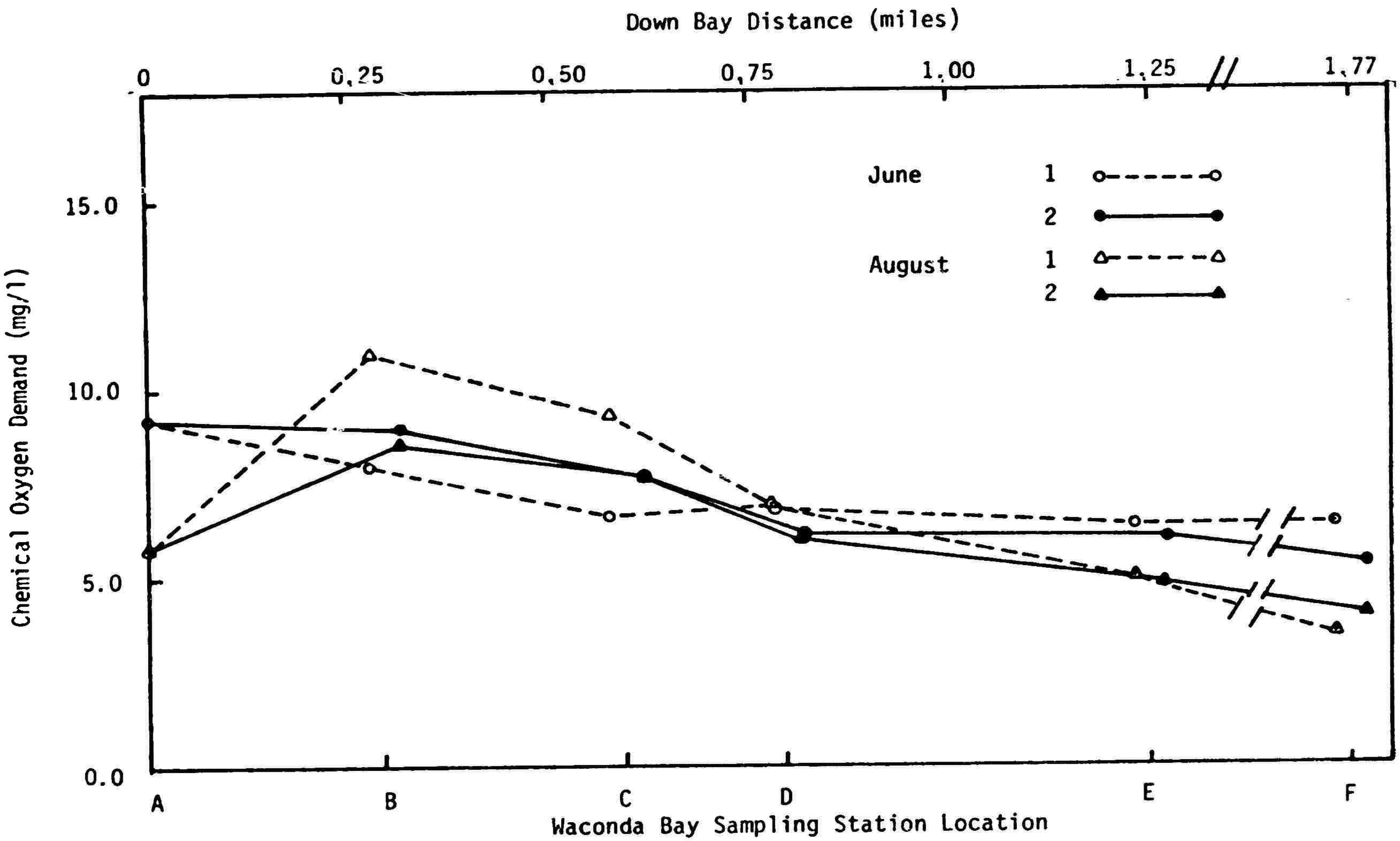


FIGURE 9. MEAN CHEMICAL OXYGEN DEMAND IN WACONDA BAY.

Background COD for transects E and F and the reference bays was 2.3 to 8.7 mg/l in June and <0.5 to 8.2 in August. Station S at the head of Reference Bay A contained slightly elevated COD levels, 6.1 - 10 mg/l in June and 4.2 - 8.5 mg/l in August. At the low carbon levels encountered, both the COD and TOC test lack resolving ability.

The TOC and COD results of Wapora, Inc. (1975) reveal inconsistencies. These data show high COD without a corresponding high TOC value at the bay head and high TOC without similar COD at their transect E located offshore. The upper ranges of COD reported in Table 4 (NPDES monitoring) are high for lake waters (30 - 45 mg/l).

Nitrogen and Phosphorus. Total Kjeldahl nitrogen (TKN) and ammonia levels were similar in Waconda Bay during the two surveys. Ammonia nitrogen discharge is permitted to 0.1 mg N/l. The discharge monitored under operation in 1974 ranged from 0.21 to 3.5 mg N/l. This resulted in concentrations above 1 mg N/l in the bay (Table 3). During the June survey (WAR, Inc.) ammonia averaged 0.32 mg N/l at Station A, but decreased to <0.1 mg N/l by transect C. Background ammonia concentrations in Reference Bay A and Huss Lowe Slough were generally less than 0.1 mg N/l. Ammonia values observed in these bays correspond quite closely to similar low levels reported in STORET for other areas of Lake Chickamauga. During the August sampling period, similar levels of NH_3-N were observed except for very high values encountered on August 15, the last sampling date. Decreasing lake stage may have caused water containing large amounts of NH_3-N from the shallow outfall ditch to enter the upper end of Waconda Bay.

	Ammonia N mg N/l	
Station	Range August 11 - 14	August 15
A	0.07 - 0.33	4.99
B-1	0.04 - 0.25	1.22
B-2	0.06 - 0.26	1.02

Increased levels were also observed on August 15 for total Kjeldahl nitrogen, munitions, and total dissolved solids. Most of the increase in Kjeldahl nitrogen was as ammonia.

The concentration profile of reduced nitrogen species is illustrated for Waconda Bay as TKN in Figure 10. No significant differences occur between June - August and concentrations are at ambient for Harrison Bay at transect D. In contrast, Wapora, Inc. (1975) found TKN considerably elevated only at transect B while the plant was operating. The background values (0.2 to 0.6 mg/l) suggest mesotrophic lake conditions for the Harrison Bay segment of the lake. No gradient was observed in the reference bays. The data suggest that reduced nitrogen is principally in the form of biomass as NH_3/TKN ratios ranged 0.1 - 0.3.

NPDES monitoring data suggest high NO_3-N values in Waconda Bay (Table 3) although discharge concentrations were below the permitting requirements of 10 mg NO_3-N/l. Historically, NO_3-N varies from a negligible amount to ~0.5 mg N/l (Tennessee Valley Authority, 1974, STORET). Reference Bay NO_3-N values fall within this range. Nitrate-nitrogen is higher in Reference Bay A (which receives some urban runoff) than in Huss Lowe Slough which receives only drainage

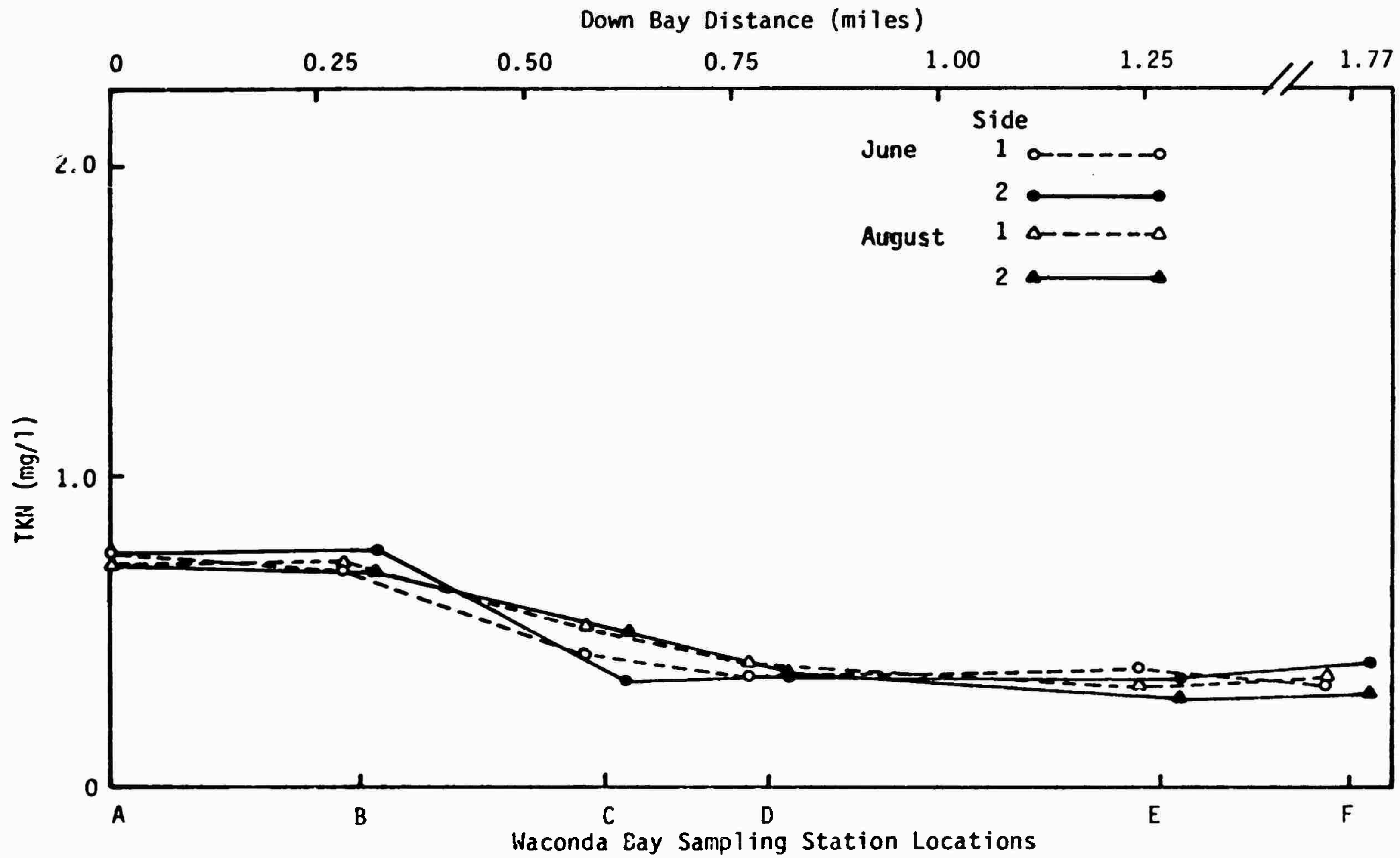


FIGURE 10. MEAN TOTAL KJELDAHL NITROGEN CONCENTRATIONS IN WACONDA BAY.

from a wooded watershed. Station S with an average NO_3-N value of 1.14 mg N/l in June an 0.66 mg N/l in August was nearly 2 times the levels at transects T and U.

Significant gradients and enrichment of the upper end of Waconda Bay by nitrite and nitrate-nitrogen were observed. Figure 11 shows the gradient for NO_3-N. Nitrite distributed in the same pattern. Elevated NO_3 and NO_2 nitrogen concentrations existed down bay to transect C.

Phosphorus showed no apparent differential among the bays or gradations offshore. No differences overall were seen between the June and August surveys. The range of total PO_4-P for both was 0.012 - 0.096 mg/l which agrees with the historical data (STORET).

Trace Metals. Volunteer Army Ammunition Plant is limited to low level discharges of chromium, 50 µg/l; copper, 20 µg/l; lead, 50 µg/l; mercury, 5 µg/l; manganese, 50 µg/l; and iron, 0.3 mg/l. VAAP discharges during 1972 exceeded these limits (STORET). The data extracted from the NPDES reports showed some manganese concentrations in excess of the permitted limits. The receiving water data showed no environmentally significant concentrations of the metals studied (Table 3).

Selected heavy metal analyses sufficient to characterize the burden in Waconda Bay and the reference bays are tabulated in Appendix A-4. These showed no heavy metals in potentially biotoxic concentrations. Ranges of metal concentrations are recorded below:

Metals	Concentration (µg/l)
Iron	82 - 310
Lead	<5 - 21
Cadmium	>5
Hexavalent Chromium	>5
Copper	<5 - 7
Nickel	<5 - 20
Zinc	<2 - 85

Most analyses showed undetectable heavy metals. Mercury was undetectable at all stations in June and was not sampled in August. Wapora, Inc. (1974) reported similar metal concentrations in Waconda Bay confirming that VAAP metal discharges do not significantly affect the bay ecosystem.

Munitions Residues. Periodic discharges of TNT and nitrobodies exceeded the 0.3 mg/l permit limit in fall and winter, 1974 (Table 2). However, during the study by Wapora, Inc., in September, 1974, no residues of greater than 100 µg/l were observed. NPDES monitoring of Waconda Bay (Table 3) showed TNT concentrations ranging above 1 mg/l in the upper bay during spring 1974. These were virtually undetectable beyond 0.5 miles down bay.

Munitions residues were detected during both June and August, 1975 surveys at concentrations below 400 ppb. These ranged to 345 ppb at A in June to near zero between transects C and D. Most upper Waconda Bay concentrations were below 200 ppb. Occasional residues ranging from traces to 15 ppb

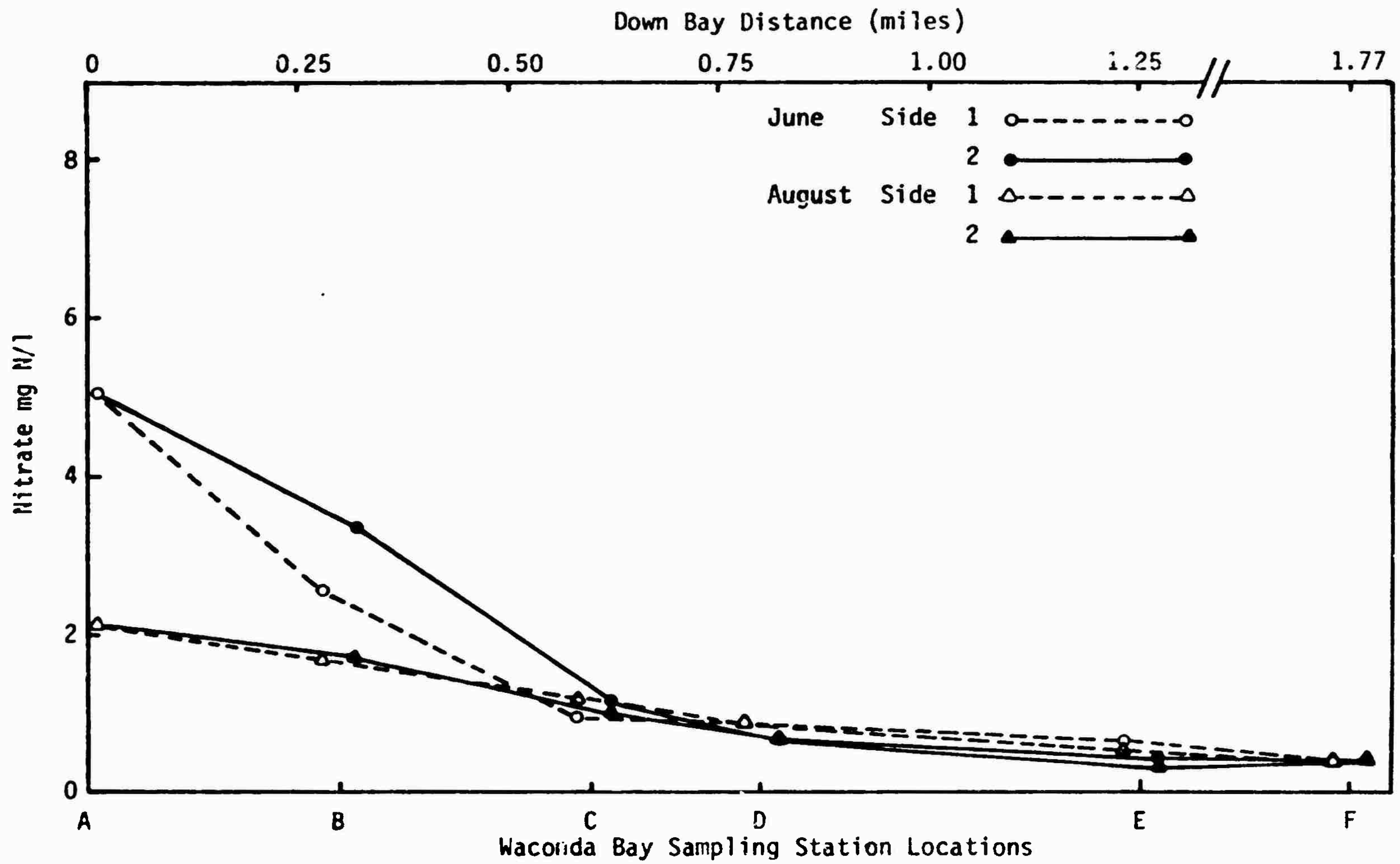


FIGURE 11. MEAN NITRATE CONCENTRATION GRADIENTS IN WACONDA BAY.

were detected as far down bay as transect F, 1.77 miles from the point of discharge. No munitions residues were detected in either reference bays. Figures 12 and 13 depict gradients of munitions residues in Waconda Bay for the June and August trips, respectively. These data are reported as the median and concentration ranges for 2,4-DNT+2,6-DNT+α-TNT. There were no consistent patterns in any of the three compounds related to distance from the outfall. Dinitrotoluene compounds, however, made up the largest proportion of the total residues concentrations. Median munitions concentrations were maximum at B-2 for both studies.

Cluster Analysis. Six parameters were chosen to represent the major facets of water quality. They were total Kjeldahl nitrogen, nitrite-nitrate, chloride, sulfate, total hardness, and the sum of nitrated toluenes. They were clustered as described in "Computational Methods" using the average distance formula, in order to determine water quality relationships and impacted areas. Figures 14 and 15 present the phenograms for June and August, respectively. The phenograms show that the upper 0.3 to 0.5 mile of Waconda Bay (Transect B and Station A) contains water quality characteristics which cause it to be unrelated to the remainder of Waconda Bay and Harrison Bay. Conditions were very similar among the other transects and the reference bays; they group very closely. All of the parameters examined are different for transects A and B. Station S contains some values slightly higher for the parameters considered but not sufficient to significantly alter the cluster pattern. Among the non-impact transects no consistent relationships were observable.

Characterization of Sediments

Except in the upper reaches of Waconda Bay the sediments consisted of a reddish clay matrix mixed with gravel and sand. Overall, the clay is covered with a mixture of detritus in the form of leaves and sticks. The lack of deep organic sediment in Harrison Bay is probably a result of the relatively short time that Lake Chickamauga has been in existence (construction began in 1936). Sediment chemical characteristics, nutrients, percent solids, and metal concentrations are tabulated in Appendix A-47.

Sediment Nutrients. Table 4 compares the June and August means for the first 0.6 miles of Waconda Bay versus the offshore sediments and the reference bays' sediments. The sediments taken in June and August, 1975 were found to be richer in phosphorus than reported by Wapora, Inc. (1975). Upper Waconda Bay contains more organic material, nitrogen, and phosphorus than the down bay area or the reference bays. Reference Bay A was found to have an average NO_3-N content nearly as high as upper Waconda Bay, primarily as a result of two elevated values from the August survey at Station U-2 and T-2. These samples may not be representative of the bay in terms of NO_3-N. If these are ignored, the average drops to about half that for upper Waconda Bay. Essentially the same situation exists for Huss Lowe Slough.

Trace Metals. The trace materials from urban runoff normally are deposited into aquatic sediments. Certain of these are metal ions which may express toxic effects through bioaccumulation. Little is known about the fate and distribution of such materials although several in-depth studies have been conducted. Iskandar and Keeney (1974), and Holmes,

TABLE 4

SUMMARIZED MEAN VALUES FOR SEDIMENTS

Parameter	Upper Waconda Bay*	Lower Waconda Bay**	Reference Bay "A"	Huss Lowe Slough
Volatile Solids (%)	7.9	4.4	4.6	4.0
Chemical Oxygen Demand (gm/kg dry wt.)	8.9	5.5	4.1	3.2
Total Kjeldahl Nitrogen (gm N/kg dry wt.)	1.6	1.0	0.7	0.4
Nitrate Nitrogen (mg N/kg dry wt.)	62	33	54(29)***	49(27)***
Total Phosphorus (gm P/kg dry wt.)	1.07	0.49	0.34	0.17

*Upper Waconda Bay - A, Transects B & C

**Lower Waconda Bay - Transects D, E, F

***Excludes two values that appear to be unreasonably high.

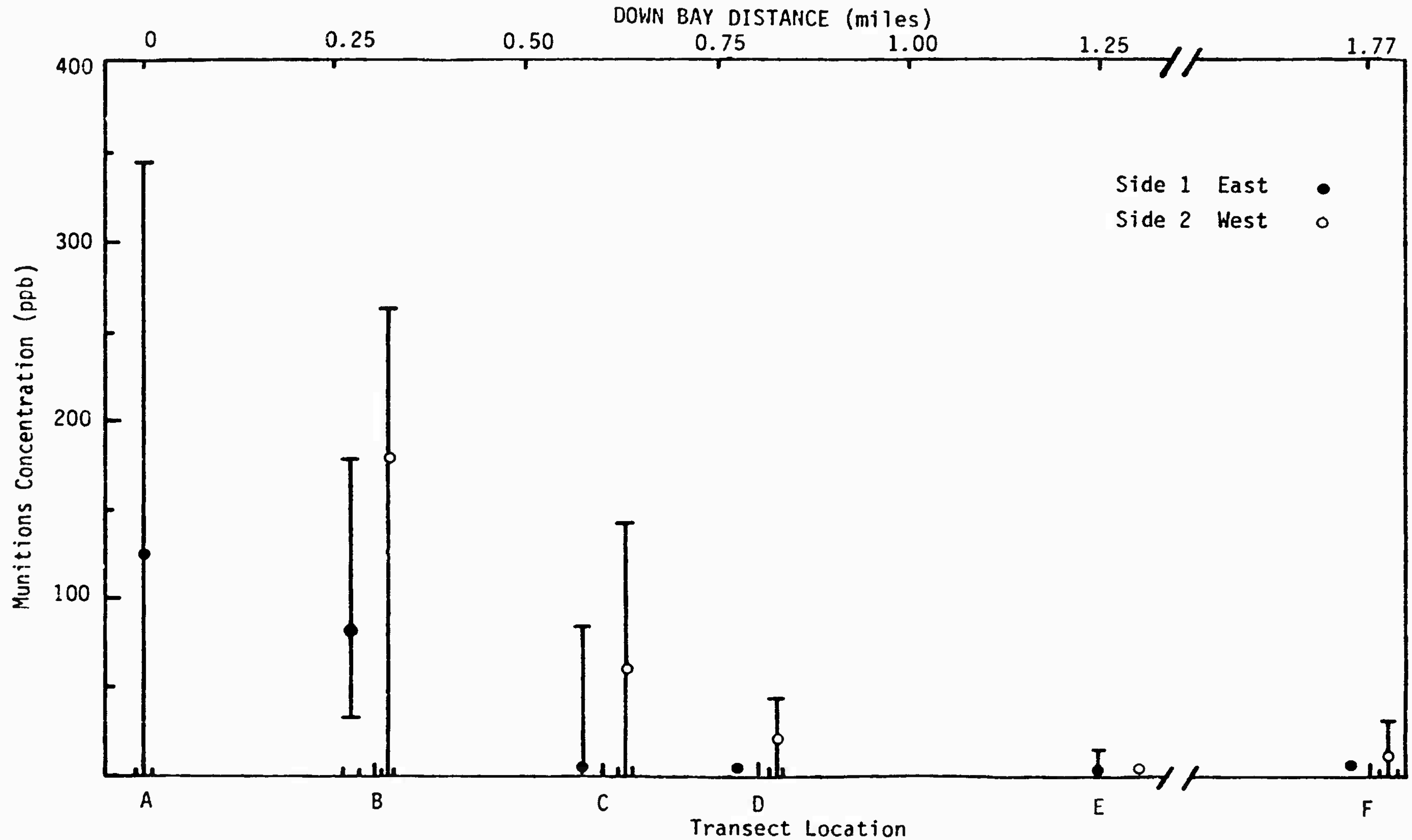


FIGURE 12. MEDIAN VALUES AND CONCENTRATION RANGES FOR MUNITIONS RESIDUES IN WACONDA BAY, JUNE 1975.

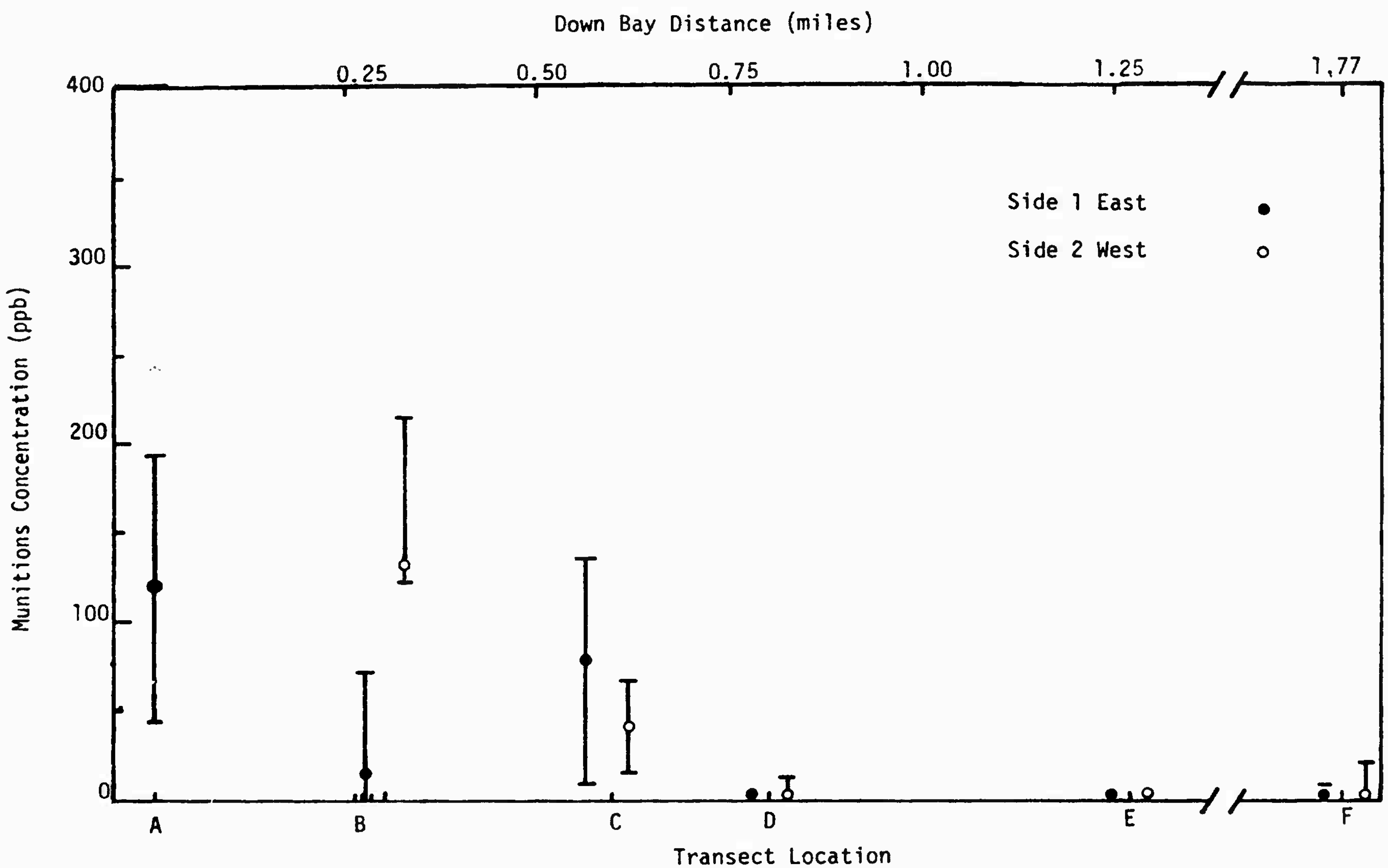
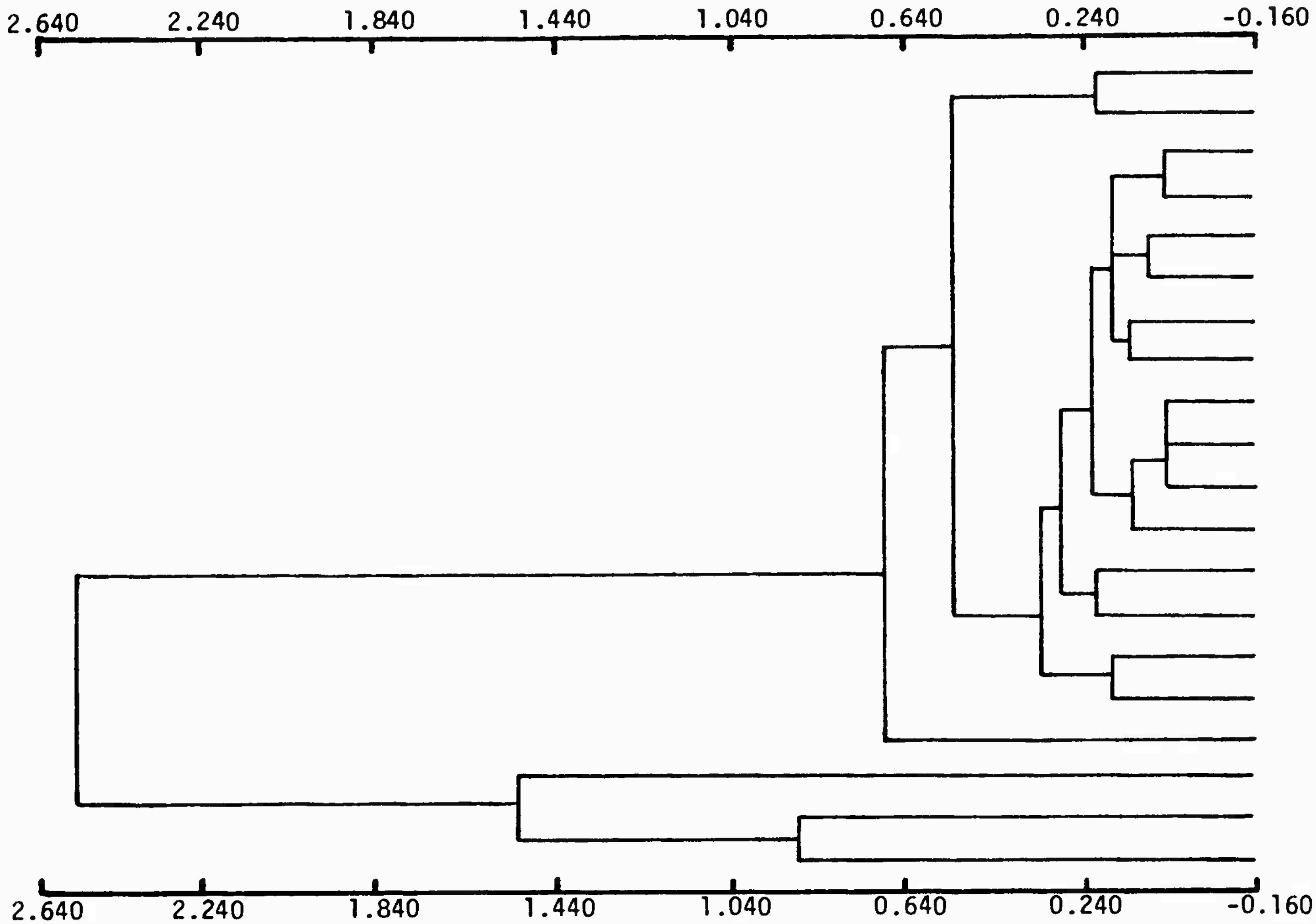


FIGURE 13. MEDIAN VALUES AND CONCENTRATION RANGES FOR MUNITIONS RESIDUES IN WACONDA BAY, AUGUST, 1975



Station	Level
S	0.2105
C-1	0.5218
T-1	0.0471
E-2	0.1424
U-1	0.0664
F-1	0.1674
T-2	0.1093
U-2	0.1972
X-1	0.0345
X-2	0.0290
Y-1	0.1240
Y-2	0.2979
D-2	0.2068
F-2	0.3063
D-1	0.1636
E-1	0.8961
C-2	2.5275
A	1.5076
B-1	0.8793
B-2	

FIGURE 14. PHENOGRAM OF WACONDA BAY AND REFERENCE BAYS, WATER QUALITY RELATIONSHIPS, JUNE SURVEY, TKN, $NO_2 + NO_3$, SO_4, Cl, TNT, AND TOTAL HARDNESS CONSIDERED. COPHENETIC CORRELATION COEFFICIENT, 0.931.

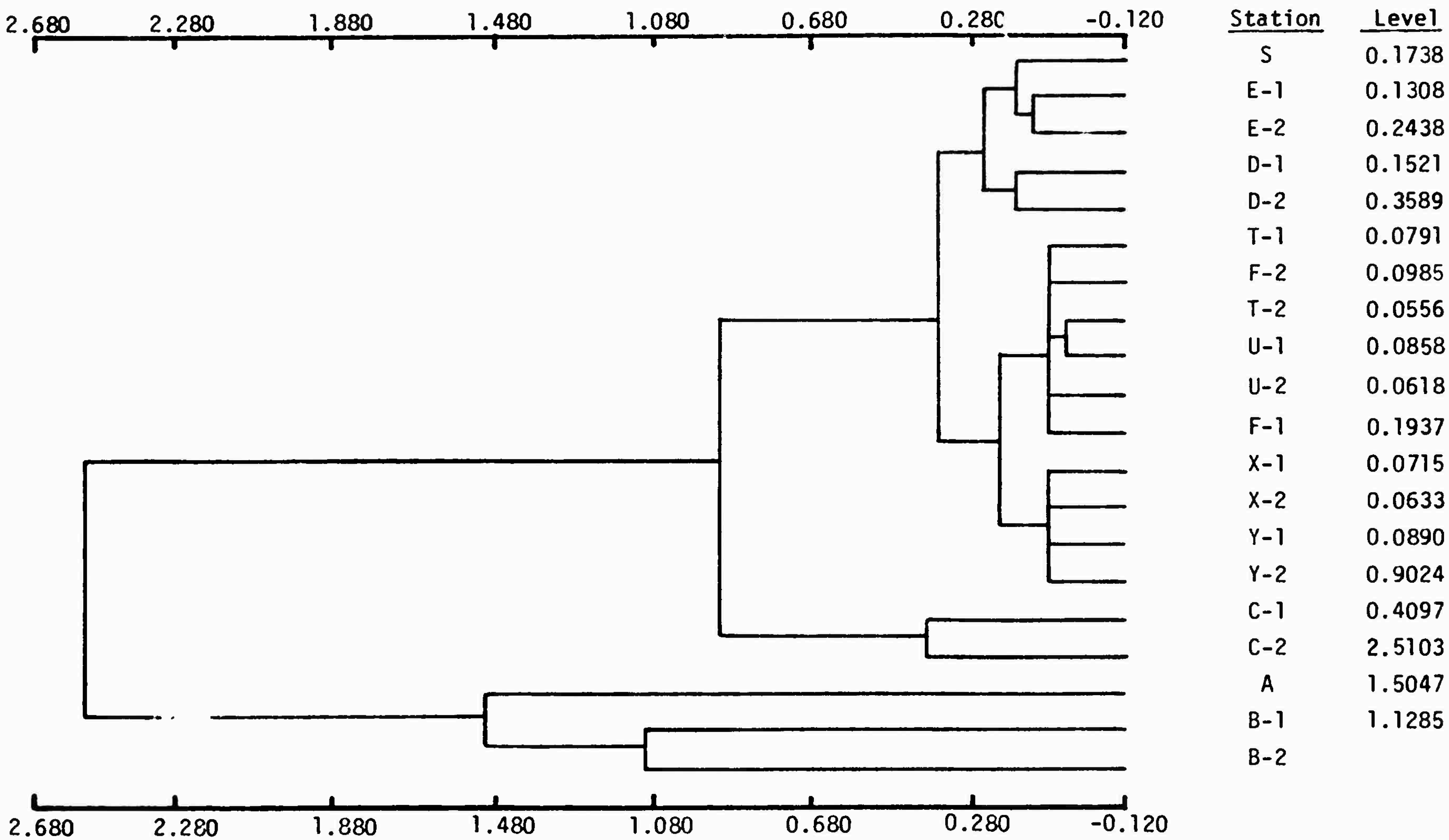


FIGURE 15. PHENOGRAM OF WACONDA BAY AND REFERENCE BAYS, WATER QUALITY RELATIONSHIPS, AUGUST SURVEY, TKN, NO_2 + NO_3, SO_4, Cl, TNT, AND TOTAL HARDNESS CONSIDERED. COPHENETIC CORRELATION COEFFICIENT, 0.947.

et al. (1974) found that redistribution of metals between sediments and overlying waters in lakes and estuaries occurs seasonally, paralleling variations in pH, D.O., temperature, etc. Precipitation of insoluble species and scavenging of metals by sorption to suspended particulates are two main pathways for sediment enrichment. Appendix A-7 tabulates the concentrations found in selected Harrison Bay sediments in June and August, 1975. As expected, iron and manganese ranged an order of magnitude higher than the other metals. Concentration ranges for the various species are tabulated below:

Element	Concentration Range mg/Kg Dry Weight
Fe	1,400 - 140,000
Mn	30 - 10,000
Cd	<1 - 3.5
Cr^{+6}	23 - 740
Cu	<1 - 130
Hg	<0.1 - 1.90
Ni	2 - 110
Pb	5 - 860
Zn	4 - 690

Iskandar and Keeney (1974) were able to show distribution of copper, lead, and zinc in Wisconsin lake sediments related to cultural activities on the watersheds. Ranges for copper were 0 - 400 mg/kg; lead 5 - 160; and zinc 10 - 200, roughly similar to those found in the Harrison Bay sediments. The upper bound of the ranges for Fe, Mn, Cr^{+6}, Cu, Pb, and Zn, were found at A. Table 2 shows that occasional discharges of Mn, Fe, Cr, and Cu at levels above permit specifications may occur. Overall, the data agree with levels found by Wapora, Inc. (1975), except for higher values at A observed during the present study.

The environmental significance of metal concentrations measured by destructive analysis is unclear. Elutriation (Keeley and Engler, 1974) and ammonia acetate extraction measure the amounts leachable from the sediment interstitial water. The relative amounts of the various fractions available or which can act on benthic organisms are undefined. Little evidence exists (WAR, 1975, Keeney and Iskandar, 1974) for biotic effects at the levels reported in this study.

Munitions. Table 5 presents the distribution of munitions residues in selected Bay sediment samples. Single sediment samples were extracted and analyzed for the presence of munitions residues. The distribution of TNT parallels the concentration gradient of munitions in the water column. Wapora, Inc. (1975) were unable to detect residues in sediment samples. (However, their detection limit was 10 mg/kg). Selected samples from offshore transects D to F and the reference bays showed no detectable concentrations.

The TNT concentrations reported may considerable underestimate the actual munitions related biotoxic residues present. Microbial breakdown occurs stepwise, giving rise to dinitrated amines and hydroxyl amines such as 4-Amino-2, 6-dinitrotoluene. Resistance of aromatic rings to attack is measured by increased numbers of nitro-radicals (McCormick, 1974) and toxicity of intermediate breakdown products may be as great or greater than

TABLE 5

MUNITIONS RESIDUES IN HARRISON BAY SEDIMENTS
LAKE CHICKAMAUGA, 1975

Station	TNT (mg/kg Dry Weight) June	TNT (mg/kg Dry Weight) August
Waconda Bay		
A	3.1	2.4
B-1	0.3	0.2
B-2	0.5	<0.1
C-1	0.32	--
C-2	<0.1	0.2
D-2	<0.1	<0.1
E-2	<0.1	<0.1
F-2	<0.1	<0.1
Reference Bays		
S	<0.1	<0.1
X-1	<0.1	--

the parent compound. Weitzel, et al. (1975) were able to characterize a major TNT breakdown in sediment at IAAP as a monohydroxylamino-dinitrotoluene which exhibited comparable biotoxic properties with TNT and further found concentrations of this daughter in sediments equal to or greater than corresponding TNT concentrations.

PERIPHYTON

Introduction

The periphyton or "Aufwuchs" community is an assemblage of attached microorganisms (primarily algae) growing on the free surfaces of submerged substrates forming a slimy green or brown coating. The attached periphyton community consists of an assemblage of both autotrophic (i.e. diatoms and filamentous algae) and heterotrophic (bacteria, protozoa, rotifers, etc.) organisms.

Odum (1956) reports that under clear, clean water conditions, the algal component of the periphyton community can develop a large standing crop (e.g. 100 gm dry wt/m^2, Silver Springs, Florida) and, therefore, represents an important food source for a wide variety of aquatic organisms. As levels of organic pollution increase, the algae are replaced by filamentous bacteria and other non-chlorophyll "consumer-type" organisms (such as Sphaerotilus) resulting in significant increases in biomass-chlorophyll ratios and the establishment of a heterotrophic periphyton community (Weber and McFarland, 1969).

Major factors which limit or control periphyton growth are light, turbidity levels, temperature, current, and nutrient and substrate availability. Current provides a constant nutrient supply and carries away dead organic matter. Adequate light penetration is essential for growth of periphytic algae. Turbid waters strongly affect periphyton development by limiting the light necessary for their photosynthetic development.

The periphyton community lends itself well to biological investigations of water pollution. These organisms remain at fixed locations and are sensitive to changing environmental conditions. Their populations and biomass are relatively easy to quantify using standard laboratory procedures and are adaptable to a variety of statistical analyses.

A detailed study of the Lake Chickamauga periphyton community was conducted during the summer of 1975 in the vicinity of the Volunteer Army Ammunition Plant, Chattanooga, Tennessee. The purpose of this investigation was to investigate and report the effects of TNT residues and other munitions related waste compounds upon lacustrine periphyton flora.

Munitions wastes from the VAAP TNT manufacturing process enter the head of Waconda Bay producing impacts on both water quality and biological communities. Principal components of the discharge consist of TNT residues, organic nitrogen, nitrate and nitrite, chloride, hardness, ammonia, and sulfates. Although the plant had ceased discharge one week before the June sampling, elevated concentrations of nitrate, sulfate, chloride, and hardness existed from transect A to transect c. Average nitrate concentrations at transect A were 5 mg N/l during the June survey. "Pink-water" conditions characteristic of nitrobody discharges were observed at the head of Waconda Bay. TNT and DNT were recorded from transects A through F. Reference bays contained no

TNT or DNT residues. Reference Bay A receives urban runoff at Station S, while Huss Lowe Slough drains forested land. The reference bays exhibited little difference in water quality except that ambient nitrate levels are generally higher on the west side of Harrison Bay (i.e. in Reference Bay A and the offshore transect F).

Previous studies of the effects of munitions related compounds upon natural periphyton communities have varied widely. For example, Wapora, Inc. (1975) surveying New River, Virginia and the Obion River in Tennessee was unable to correlate periphyton community structure with pollutant loading. Field studies by Water and Air Research, Inc. (1975) at the Longhorn, Texas and Louisiana Army Ammunition Plants indicated no significant effects on stream periphyton due to munitions waste effluents. However, results of Battelle Columbus Laboratories (1975) on three munitions facilities (Badger Army Ammunition Plant, Baraboo, Wisconsin; Joliet Army Ammunition Plant, Joliet, Illinois; and Lake City Ammunition Plant, near Kansas City, Missouri) reported observable effects of munitions waste discharges on the periphyton community. Weitzel, et al. (1975) observed shifts in periphyton species diversity corresponding to variations in nutrient levels and TNT concentrations in the streams adjacent to the Iowa Army Ammunition Plant. Periphyton studies conducted on the Holston River in the area of the Holston Army Ammunition Plant have indicated various degrees of environmental stress due to the discharge of ammunition wastes. Wapora (1975) indicated diatom populations percentages to be considerably lower on the north bank as opposed to the far shore. Periphyton distribution patterns also differed in respect to the two banks of the river.

Recent studies on the Holston River (Water and Air Research, Inc. 1976)* noted effects of munitions waste on the periphyton in the vicinity of the HAAP waste outfalls. Significant increases in heterotrophic biomass and reductions in chlorophyll bearing species were noted. Reduction in diatom cell densities, species diversity, and shifts in diatom associations indicated toxic impacts from RDX and associated residues. Effects on periphyton were observed in waters containing RDX concentrations in a range of 20-100 μg/l.

Wapora, Inc.'s (1975) study of Lake Chickamauga, Chattanooga, Tennessee, reported differences in periphyton community structure in the area of Waconda Bay in the vicinity of Volunteer Army Ammunition Plant waste discharge.

Methods

Both natural and artificial substrate periphyton communities were studied during June-July and August-September, 1975. Due to a lack of comparable

*Draft in preparation for Army Medical Research and Development Command.

natural substrates from which to sample, periphyton collections from artificial substrates probably give a more reliable station to station comparison. Standard microscope glass slides were placed in periphyton samplers one inch below the water surface at 20 selected VAAP station locations (Figures 3 and 4) according to the methods outlined in Standard Methods for the Examination of Water and Wastewater 13th Edition (APHA, 1971) and Biological Field and Laboratory Methods for Measuring the Quality of Surface Water and Effluents (Weber, 1973). Table 1 gives the depth and bottom type for each biological station. Due to heavy boat traffic and vandalism, a number of periphyton samples were lost or pulled out of the water at Stations E-1, E-2, F-1, and Y-1 throughout the study period. As a result, periphyton data from these stations were not available during certain sampling periods. As a backup to lost or vandalized stations, two additional periphyton sampling sites were utilized; station "no wake" (a navigation buoy) located midway between transects D and E in Waconda Bay; and Station "F-buoy" located on a channel-marker buoy in the vicinity of Station F-2.

At the end of each incubation period, slides were removed from each sampler for the following laboratory analyses:

(1) diatom community structure (artificial and natural substrates);
(2) filamentous organisms; and
(3) determination of organic biomass (ash-free dry wt.) and chlorophyll a for the determination of an Autotrophic Index and net primary production.

Diatom Community Structure. In terms of cost effectiveness and information content, the diatom (Bacillariophyceae) component of the periphyton community represents the most important group of algae studied in general water quality monitoring surveys. Cairns, et al. (1972) report that other groups of algae (e.g. Cyanophyceae and Chlorophyceae) are sensitive to pollution stresses but the difficulty and high cost of identifying them to the species level (Archibald and Bold, 1970) precludes their use in most field bioassay studies.

Diatom cell density estimates (cells/mm^2) were determined as follows. Replicate samples were analyzed for community structure by first scraping the glass slides into 50 ml of distilled water. The glass slides have an area of 3,871 mm^2. The algal suspension was thoroughly mixed after which a 10 ml aliquot was pipetted into a tall 1 liter beaker and oxidized by 10 ml of hydrogen peroxide and 60 mg of potassium dichromate. The solution was cooled and centrifuged for 15 minutes, decanted, and expanded to a volume of 25 ml (2.5 times the original 10 ml sample volume). The 2.5 fold dilution permitted a distribution of 10-15 organisms per microscope field when magnified 1,250 diameters.

Permanent diatom mounts were prepared by pipetting 0.4 ml of the "cleaned" material onto a 18 x 18 mm coverslip (324 mm^2) and allowing the sample to dry at 65°C (150°F) on a laboratory hot plate. The dried coverslip was placed on a standard microscope slide containing one drop of HYRAX mounting medium (refractive index, 1.71) and the slide was gently heated to drive off the toluene solvent. When cooled, the permanent slide was labeled with station number, date, location, incubation period, and dilution factor. Under an oil immersion lens (Zeiss microscope, 1250X) diatoms were identified and enumerated to the species level where possible utilizing the following standard taxonomic references: Hustedt, 1930, 1962; Cleve-Euler, 1952; Schmidt, et al., 1874-1959; Huber-Pestalozzi, and F. Hustedt, 1942; and Patrick and Reimer, 1966.

All densities were estimated by performing 30 field counts while randomly scanning each slide from left to right (15 field counts) and from top to bottom (15 field counts). At 1,250 magnification each microscope field represented an area of 0.038 mm^2, with a total area examined of 1.14 mm^2 (i.e. 0.038 mm^2 x 30 field counts). Therefore, cell densities were estimated using the following formula:

$$\text{Cells/mm}^2 = \frac{\text{Diatom Counts} \times \dfrac{\text{Total Area of Coverslip } (324\ \text{mm}^2)}{\text{Total Area Examined } (1.14\ \text{mm}^2)} \times \dfrac{\text{Original Volume of Periphyton Suspension } (50\ \text{ml})}{\text{Volume of Sample Dried on Coverslip } (0.4\ \text{ml})} \times \text{Dilution Factor } (2.5)}{\text{Original Surface Area of Slide } (3{,}871\ \text{mm}^2)}$$

The rationale for performing the "short count" 30 field method is supported by the following data. Figure B-1 (Appendix B) shows the effect of increasing sample size (i.e. area examined, mm^2) on diatom species diversity on successive 0.038 mm^2 microscopic field counts. As illustrated in Figure B-1, diatom community structure, as estimated by the Shannon-Weaver Index, was largely established after counting 30 fields. Diatom counts from Stations F-1 and X-1 in Lake Chickamauga indicated that after counting 150 fields the diversity index was approximately the same as a 30 field count (Figure B-1). At Station F-1, after the examination of 150 fields, the index increased 0.065 units; a 3.4 percent increase.

Table B-1 (Appendix B) presents a summary of microscopic field count data from Station T-1, indicating the total numbers of "new" species recorded when counting more than 30 fields. The most important aspect of Table B-1 is the actual densities of these "new" species and their percentage contributions to the total population. These data indicate that after increasing sample size to 150 fields, the number of "new" species only represent 1.0 percent of the total population. As a result these species may be considered rare or "unimportant" in terms of energy flow through the periphyton community.

At Stations X-1 and F-1, the percentage contribution of "new" species to the total population was slightly higher -- 2 to 4 percent. In conclusion, the performance of 30 field "short counts" seemed to describe adequately the primarily dominant or "important" diatom species present at VAAP; i.e. those species which probably account for the largest percentage of energy flow through the periphyton community.

In an effort to compare diatom populations from station to station, cell density estimates were used to calculate community indices such as the Shannon-Weaver Species Diversity Index ($\bar{H}$), (Shannon and Weaver, 1949; Margalef, 1968) to the base e. In addition, stations were compared by measuring the degrees of similarity between species associations at different stations utilizing the Pinkham-Pearson (1974) Index of Biotic Similarity (see Computational Methods for detailed explanations of these indices).

Collections of periphytic algae were also made from natural substrate materials. Periphyton was scraped from the surface areas of rocks into 50 ml of water at six station locations.

Filamentous Organisms. Attempts were made to estimate quantitatively the filamentous algae component of the periphyton community. Artificial substrates (glass slides) were incubated for four weeks during June 11 to July 10, 1975. At the end of the incubation period, the periphyton slides were removed and preserved in 5 percent Formalin in a light excluding sample box. In the laboratory, the slides were scraped and preserved in labeled sample bottles containing 50 ml of a 5 percent Formalin solution. Filamentous algae were identified and enumerated by the Utermohl (1958) sedimentation technique utilizing a 50 ml plankton counting chamber and a Zeiss inverted D microscope. Species identifications were carried to species level where possible, utilizing the following standard references: Drouet (1968); Prescott (1962); and Desikachary (1959).

Organic Biomass and Chlorophyll *a*. Growth of periphyton on artificial substrates was measured as organic biomass (ash-free dry weight) and chlorophyll *a* (corrected for phaeopigments) after 4-week incubation. Standard procedures were used for assessing biomass and chlorophyll *a* levels as outlined below. Primary production estimates were made using chlorophyll *a* as indicated. This estimated the standing crop of both the autotrophic and heterotrophic components of the attached community and characterized summer production levels in the lacustrine system.

Periphyton communities in unpolluted waters tend to be dominated by algae, especially diatoms. The organic weight, or biomass to chlorophyll ratio, in such communities approaches that of an algal culture, i.e. 50-100. Organic pollution, particularly, causes an increase in the ratio due to increase in the heterotrophic component (bacteria such as *Sphaerotilus natans*, fungi, and protozoa) while toxic effects may decrease total mass of either heterotrophic component, autotrophic component, or both.

The levels of periphyton biomass, therefore, serve as an overall index of the level of biological activity in the producer and decomposer compartments as influenced by environmental conditions. Weber and McFarland (1969) have examined artificial substrate data from a number of environments, both polluted and unpolluted, and arrived at an "Autotrophic Ratio" of 100 or less as being indicative of clean-water conditions.

For organic biomass determinations, each slide was rehydrated for 15 minutes, accumulated material scraped from the slide into a graduated cylinder, then resuspended in a total volume of 50 ml of distilled water. An aliquot of the suspension was filtered on a tared, fired-glass filter (Gelman, GFA), the ash-free dry weight determined (APHA, 1971), and converted to grams of organic matter per square meter as ash-free dry weight.

Net production based on biomass accumulation was calculated by converting organic biomass to equivalent carbon* then dividing by the incubation period.

Slides collected for chlorophyll a were placed in 50 ml of a 90 percent acetone v/v, and 10 percent of a saturated $MgCO_3$ solution in the field and immediately stored in the dark in dry ice. Prior to analysis, chlorophyll was extracted for 24 hours in the dark at 4°C. To facilitate extraction, slides were scraped and the acetone suspension ground 30 seconds at 500 rpm in a Potter-type tissue homogenizer.

Following extraction, chlorophyll a, corrected for phaeophytin, was determined fluorometrically after the methods of Yentsch and Menzel (1963), Holm-Hansen, et al. (1965), Lorenzen (1967), and Moss (1968), using a Turner Design Model 10 fluorometer. Fluorometric determination of chlorophyll depends on red fluoroscence emitted by the chlorophyll a molecule when excited by ultrabiolet light and is 100 times more sensitive than spectrophotometric analysis. The method is limited to chlorophyll a only; chlorophyll b and c cannot be determined.

The chlorophyll a reference solution was a purified spinach chlorophyll standard (Product No. C5753, Sigma Chemicals, St. Louis, MO) calibrated by spectrophotometric chlorophyll analysis.

Acidification of chlorophyll a converts it quantitatively to phaeophytin. Reading the fluorescence before and after adding one drop of 1N HCl to the sample cuvette allows calculation of an acid factor related to the interference. Periphytic chlorophyll a was calculated as follows:

$$\text{Chlorophyll } \underline{a} \ (\text{mg/m}^2) = \frac{(F)(r)(Ca)(\text{ml extract})}{(r-1)\ [\text{substrate area (mm) } 10^{-3}]}$$

where: Ca = fluorometer reading before - fluorometer reading after acidification)

$$r = \frac{\text{standard before acidification}}{\text{standard after acidification}}$$

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*Gram organic matter = (2) (grams carbon), Odum, 1971.

$$F = \left[\frac{Ca}{\text{Fluorometer reading}}\right]\left[\frac{\text{dilution ratio fluorometer}}{\text{dilution ratio spectrophotometer}}\right]$$

Net primary productivity based on chlorophyll a accumulation on slides was computed for the 2- and 4-week incubation in terms of grams carbon/square meter based on a chlorophyll to plant carbon ratio of 60 (Strickland and Parson, 1960).

$$\frac{[\text{Chlorophyll } \underline{a}\ (gm/m^2)]\ [60]}{\text{days incubated}} = \text{Net Primary Production } (gm\ C/m^2\ day^{-1}$$

Autotrophic Index. The autotrophic index (Weber, 1973a) indicates the relative composition of the developing periphyton community. this ratio is expressed as:

$$\frac{\text{Organic Biomass } (gm/m^2)}{\text{Chlorophyll } \underline{a}\ (gm/m^2)}$$

and has been used to indicate organic pollution and effluent toxicities. The numerical value of this index increases with an increase in non-algal or heterotrophic biomass and decreases with increasing algal biomass. Systems receiving inputs of organic materials will be likely to show elevated heterotrophic biomass and thus a higher index due to proliferation of attached bacteria and protozoa. Nutrient enriched or autotrophic dominated systems on the other hand will approach autotrophic indices of 100-500 (Weber, 1973a) reflecting the ratio of chlorophyll to plant carbon. An autotrophic index greater than 100 indicates organic pollution, less than 100 "clean water" conditions (Weber, 1973b).

Presentation of Data

A total of 18 filamentous green and blue-green algae species and 100 species of diatoms representing 23 genera were recorded from the VAAP artificial substrate sampling stations. Tables B-2 through B-7, Appendix B, provide an alphabetical listing of these species including cell densities and distribution patterns among stations.

In addition to artificial substrates, a selected number of natural substrates were also analyzed for diatom community structure. Table B-8 presents a list of the diatom species recorded from Lake Chickamauga natural substrates. To quantify further the periphyton community, biomass and chlorophyll a were monitored for the determination of an autotrophic index and net primary production (Tables B-19 through B-31).

Artificial Substrate Colonization Studies. One of the first effects of pollution on periphyton community structure is a change in the reproduction rates of diatom populations (Patrick, 1967). As a result, certain species are unable to reproduce and may become extinct, while tolerant species become more common because of less competition for nutrients and space associated with a reduction in predator pressure.

To ascertain the effects of munitions waste dicharges on the Waconda Bay periphyton communities, diatom artificial substrate cell densities (ceels/mm^2) were plotted for the 2- and 4-week surveys conducted during June through July and August through September, 1975. Tables B-13 and B-14 (Appendix B) present mean diatom cell densities for VAAP artificial substrates incubated for the June through July, and August through September 2- and 4-week incubation periods. Means and ranges for diatom cell densities are shown in Figures B-2 through B-5 (Appendix B) for these periods.

Diatom cell densities in Waconda Bay during the June 11-25, 1975, survey averaged 1.06×10^4 cells/mm^2, while stations located in Reference Bay A and Huss Lowe Slough averaged 1.56×10^4 and 1.10×10^4 cells/mm^2, respectively. Overall, diatom cell density was 1.19×10^4 cells/mm^2. Analysis of variance was utilized to test the hypothesis that all the results belong to populations with a common mean. The calculated F value is significant at the 1 percent level indicating statistically significant differences in the results ($F_{[15,39]} = 14.8$, $F_{0.01\ [15,39]} = 2.54$). Ranking of the results shows the lowest cell density at Station A (708 cells/mm^2) and two of the three highest densities at Stations B-1 and B-2 (27,902 and 18,531 cells/mm^2).

Similar trends were noted during June- July 4-week incubation period (Figure B-3). Analysis of variance gives an F value which is significant at the 1 percent level ($F_{[10,12]} = 5.05$, $F_{0.01\ [10,12]} = 4.30$). Again Station A had the lowest cell density (6,328 cells/mm^2). In both the 2-week and 4-week June data, Tukey's w-procedure (Steel and Torrie, 1960) shows the densities at Stations B-1 and B-2 to be significantly different from the density observed at Station A at the 5 percent level.

Somewhat similar trends were seen in the August data. These results suggest toxicity at Station A and biostimulation at Stations B-1 and B-2.

Cairns, Scheier, and Hess (1963) have suggested that a 50 percent reduction in the growth rates of diatoms compares favorably with a 50 percent survival (or TLm) for fish and snails. Cairns (1972) states "this idea is based on the assumption that a toxicant concentration producing a 50 percent reduction in division rate for a microbial population under otherwise optimal conditions would be approximately equivalent to lethal effects on a static population of fish or invertebrates." This assumption was adopted by Patrick, et al. (1968) when comparing the sensitivities of diatoms, snails, and fish to the effects of industrial waste materials. Utilizing these criteria, the impact of munitions waste upon Waconda Bay periphyton can be assessed. Chemical data collected from Station A indicated high concentrations of total munitions waste residues throughout the study period. High levels of total munitions waste residues have produced a localized toxic or inhibitory effect upon diatom populations in the vicinity of Station A during the June - July 2-week and 4-week surveys.

The presence of relatively large diatom populations at the downbay stations suggests that concentrations of total munition wastes were below chronic effect levels. Biostimulatory trends noted at Stations B-1 and B-2 may reflect the impact of NO_3-N being discharged into Waconda Bay. This nutrient enrichment effect was also apparent at other trophic levels (see Macroinvertebrates).

Similar trends were noted during the August 2-week incubation period. Diatom populations at Station A were again low: 906 cells/mm^2, 95 percent less than overall mean of Reference Bay A and Huss Lowe Slough (Figure B-4). No significant biostimulation was seen at Stations B-1 or B-2. However, a trend of increasing cell densities was noted at the downbay stations "no wake,"* E-1, and E-2.

During the August-September 4-week incubation period, populations at Station A were lower than at other stations, but not as much as in June. For example, diatom cell densities at Station A in June were reduced 84-95 percent below the mean of reference bay stations, whereas in the August 4-week data this reduction was 70-71 percent.

Artificial Substrate Diatom Community Structure. One hundred species of diatoms representing 23 genera were recorded from the Lake Chickamauga artificial substrate sampling stations. Tables B-2 through B-5 (Appendix B) provide a taxonomic list of all species identified, including cell densities (cells/mm^2) and distribution patterns among stations during the summer surveys. Tables B-9 through B-12 (Appendix B) present percent relative abundances for the common to dominant species present at each station location during the survey periods. With the exception of two stations (A and F-2), *Achnanthes minutissima* comprised 75 - 94 percent of the diatom populations during the initial June 2-week incubation period.

Early studies by Geitler (1927) found that *A. minutissima* and certain species of *Cocconeis* are usually the first colonizers of glass slide communities. This is probably an indication that these species are not selective about their substrate requirements. The literature indicates *A. minutissima* to be "one of the most ubiquitous diatoms known" (Hustedt, 1949). Budde (1930a) and Fjerdinstadt (1950) reported this species from eutrophic (i.e. characteristic of waters containing high nutrient concentrations) river systems; Swift (1972) found it as a dominant species in both artificial and natural substrate communities; Scheele (1952) reports *A. minutissima* to be tolerant of a broad spectrum of environmental conditions. Other common species reported from artificial substrates included:

Fragilaria capucina
Synedra rumpens
Gomphonema parvulum
Achnanthes nollii
Cymbella affinis
Synedra delicatissima
Synedra ulna
Melosira ambigua
Navicula cryptocephala
Nitzschia denticula
Anomoeoneis vitrea

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*Station "no wake" refers to an alternate sampling station located midway between transects D and E in Waconda Bay near the navigational sign entitled "no wake."

June Survey. With the exception of Stations A and F-2, diatom populations during the June 2-week incubation period included the following species associations (Table B-9): Achnanthes minutissima (88 percent); Fragilaria capucina (2.1 percent); Synedra ulna (0.9 percent); and Navicula cryptocephala (0.7 percent). A shift in diatom dominance was observed at Station A where the relative abundance of A. minutissima was reduced to 59 percent and the normal Fragilaria-Synedra-Gomphonema flora was replaced by Nitzschia palea (15 percent), Nitzschia cf. capitellata (8 percent) and Synedra rumpens (4 percent). A number of investigators have reported large populations of N. palea as an indicator of organic or toxic pollution (Butcher, 1947; Schroeder, 1939; and Patrick, 1967). Cholnoky (1968) reports N. palea to be an obligate nitrogen heterotroph; tolerant of a wide range of environmental conditions.

In terms of total numbers of species, Station A had the least, with only 14 taxa present, compared to an average of 36 species for Waconda Bay artificial substrates; 28 species for Reference Bay A; and 37 species for Huss Lowe Slough (Table B-2).

Shifts in diatom species associations -- reduction of total species number -- and the increase of those pollution tolerant, correspond with total munitions residues and NO_3-N being discharged into Waconda Bay at Station A during the June 2-week incubation period.

A shift in diatom dominance was also noted at Station F-2 located at the far end of Waconda Bay. Diatom relative abundance at Station F-2 was dissimilar to the shallow bay stations located in Waconda Bay, Reference Bay A, and Huss Lowe Slough. A. minutissima populations comprised only 57 percent of the diatom flora followed by Navicula cryptocephala (6 percent), Synedra ulna (5 percent), Cymbella prostata (3.7 percent), Fragilaria vaucheriae (3.0 percent) and Gomphonema parvulum (2.9 percent). The distribution of individuals among species present was high and, therefore, the species diversity index (2.07) at Station F-2 was above other shallow bay stations in the study area. The physical and chemical data indicate that Station F-2 was not affected by urban runoff or munitions wastes.

The relative abundance of diatoms (Table B-10) for the June 4-week incubation period was similar to the June 2-week data and included the following species associations: A. minutissima (88 percent); Navicula cryptocephala (1.1 percent); Achnanthes nollii (1.0 percent); Cymbella affinis (0.8 percent); Melosira ambigua (0.7 percent); Gomphonema parvulum (5 percent); Synedra rumpens (0.4 percent); and Nitzschia denticula (0.4 percent).

Station A had a total of 24 species. This represented the lowest number reported and can be compared to an average of 37 species in Waconda Bay; 31 species in Reference Bay A; and 34 species in Huss Lowe Slough (Table B-3).

These data indicated that during the June 2- and 4-week incubation period severe toxicity is manifested at Station A from munitions effluent with the following effects: (1) the elimination of sensitive species; (2) the normal colonizing species (e.g. A. minutissima) are not killed but have had their reproductive rates sharply reduced; (3) tolerant species (i.e. Nitzschia palea) became more common due to reduced competition for nutrients, space, and reduction of predator pressures.

August Survey. Trends established for the June - July period are similar for the August 2-week incubation period. With the exceptions of Station A and "F-Buoy," A. minutissima was again the dominant taxon -- ranging from 70 - 94 percent in relative abundance (Table B-11). Other common species were Fragilaria capucina, Cymbella affinis, Melosira ambigua, Synedra delicatissima, and Achnanthes nollii.

A major shift in diatom dominance was observed at Station A where the relative abundance of A. minutissima was reduced to 48 percent. Nitzschia palea and Nitzschia kutzingiana increased to 11 percent followed by Navicula cf. heufleri v. leptocephala and Melosira granulata at 7 percent. Station A exhibited the lowest total number of species present (14) compared to Waconda Bay, Reference Bay A, and Huss Lowe Slough stations (Table B-4).

Again, shifts in diatom dominance; reduction of total numbers of species; and increases of pollution-tolerant species (N. palea) correspond with munition-waste residues at Station A. The relative abundance of A. minutissima was reduced at Stations D-2, E-1, and F-1. However, population increases of Achnanthes nollii, Synedra delicatissima, Fragilaria capucina, and Synedra ulna were noted (Table B-4). Stations D-2 and E-1 also had higher numbers of species present with corresponding higher diversity indices.

Populations during the August - September 4-week incubation period exhibited similar trends in diatom dominance and relative abundance as noted during the June - July and August surveys (Table B-12). However, at Station A a recovery trend was noted as total numbers of species and individuals showed an increase over populations collected during the previous surveys. The relative abundance of common species present at Station A during the August - September 4-week incubation period were: A. minutissima (83 percent); Cyclotella stelligera (4 percent); Fragilaria capucina (2.0 percent); Nitzschia kutzingiana (1.4 percent), and Achnanthes nollii (1.2 percent). Populations of the pollution "indicator" species, Nitzschia palea, were reduced to 0.6 percent.

The munitions plant halted TNT production near the end of May, 1975. Periphyton recovery from VAAP munitions wastes was not observed until September. These data indicate that toxic conditions persisted at Station A for a period of three months after the cessation of munition waste discharge.

Comparison of Diatom Assemblages. In an effort to compare the various diatom assemblages at each station, the Shannon-Weaver Species Diversity Index (Odum, 1971) and the Pinkham-Pearson (1974) Index of Biotic Similarity were employed. For a review of the indices, the reader is referred to the Computational Methods section. Tables B-16 and B-17 (Appendix B) present a summary of the mean Shannon-Weaver species diversity indices for artificial substrate diatoms during the June - July and August - September 2- and 4-week incubation periods.

Species diversity indices were low throughout the study period with overall mean values ranging from 0.77 to 0.87 for the June - July and August - September sampling periods. Except for Station A, species diversity was generally very low at most bay transects due to the overwhelming dominance of Achnanthes minutissima - comprising 80 - 90 percent of the population. Large populations of A. minutissima produced a low evenness among the species present and therefore a lower Shannon-Weaver index.

Data from this study suggest that the Shannon-Weaver index does not reflect subtle changes in community structure (Tables B-2 - B-5). The diatom population at Station A reflected low numbers of taxa, but each taxa had a relatively even distribution of individuals. This phenomenon is probably a result of the low levels of toxicity reducing the reproduction rates of otherwise dominant forms (i.e. A. minutissima). Therefore, Station A appeared to have a higher diversity although it possessed the lowest number of taxa and total organisms.

These results compare well with those of Patrick (1968) concerning the toxic effects of pH on the structure of diatom communities and those reported by Water and Air Research, Inc. (1977) for munitions waste impact on periphyton populations in the Holston River, Tennessee.

Figures 16 through 19 present biotic similarity expressed in a phenographic display. Each phenogram illustrates the VAAP artificial substrate diatom data with stations clustered on the basis of species occurrence and abundance. In these analyses, it was considered unimportant if a species was mutually absent from two stations and, therefore, 0/0 matches were given a value of zero (mutual absence, unimportant).

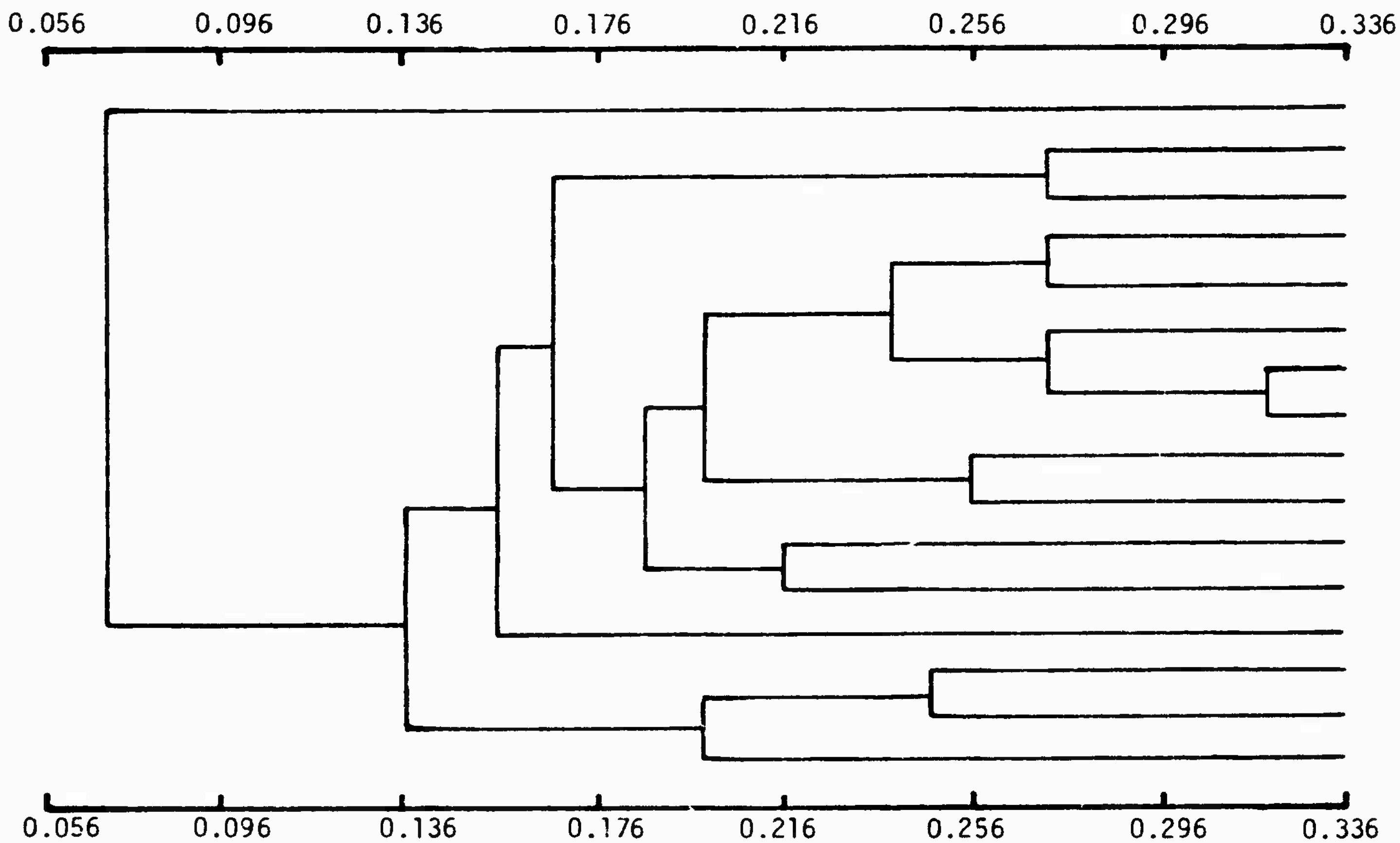
The phenogram (Figure 16) developed from periphyton populations collected during the June 2-week incubation period illustrates the uniqueness of Station A in relation to all others. Diatom populations at Station A exhibited shifts in relative abundance, with significant reductions in cell densities, total numbers of species present, and organic biomass. Total munitions waste residues at Station A during this time ranged to 172 ppb and probably represented the principal stress to the system.

The reference bay stations, T-1, T-2, and U-1, clustered at relatively high levels of similarity whereas stations C-2, X-1, X-2, Y-1, D-2, and F-2 grouped at somewhat lower levels. In the latter group, the X and Y stations were located in Huss Lowe Slough and, therefore, outside the influence of munitions waste.

Stations B-1 and B-2 (Figure 16) illustrate a low correlation to the reference stations. These low similarity coefficients were influenced primarily by significant increases in diatom cell densities at Stations B-1 and B-2. As a result, Figure 16 may indicate a trend of biostimulation corresponding to increased levels of NO_3-N at Stations B-1 and B-2 during the June - July survey.

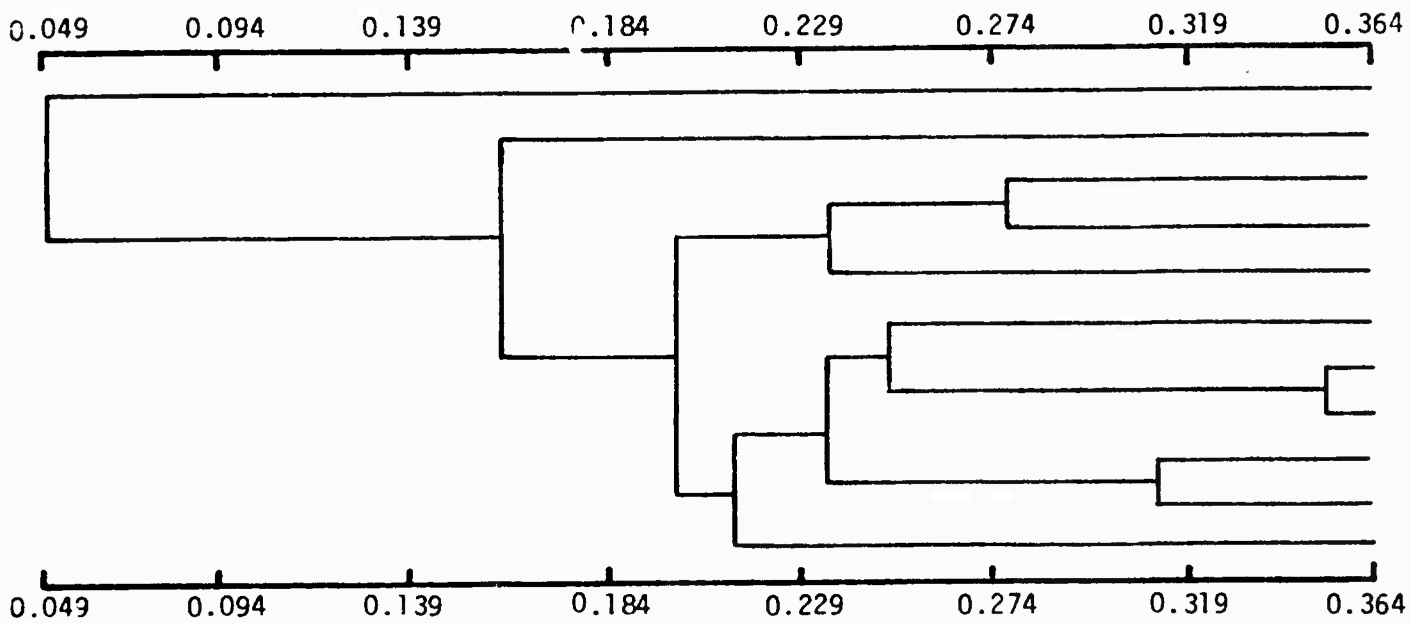
Figure 17 developed from the June - July 4-week incubation period helps to confirm those trends observed during the June 2-week survey. Again, Station A exhibited a unique diatom assemblage, producing the lowest similarity coefficient. Diatom populations at Station B-1 also indicated a low similarity suggesting biostimulation to NO_3-N.

During the August 2-week survey, Station A continued to be markedly dissimilar from all other stations (Figure 18). However, when the incubation period was increased to 4 weeks, the dissimilarity almost completely disappeared (Figure 19). These data suggest that the toxicity at Station A is reduced from June to August.



Station	Level
A	0.0725
B-1	0.2770
B-2	0.1688
C-2	0.2710
X-1	0.2395
T-1	0.2710
T-2	0.3180
U-1	0.2007
X-2	0.2560
Y-1	0.1862
D-2	0.2160
F-2	0.1555
D-1	0.1378
C-1	0.2490
S	0.2015
F-1	

FIGURE 16. PHENOGRAM OF VAAP PERIPHYTON ARTIFICIAL SUBSTRATE, JUNE 11-25, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.812.



Station	Level
A	0.0559
B-1	0.1634
B-2	0.2790
D-2	0.2395
C-1	0.2026
D-1	0.2520
S	0.3560
T-1	0.2393
F-2	0.3160
Y-2	0.2150
X-2	

FIGURE 17. PHENOGRAM OF VAAP PERIPHYTON ARTIFICIAL SUBSTRATE, JUNE 11 - JULY 10, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.897.

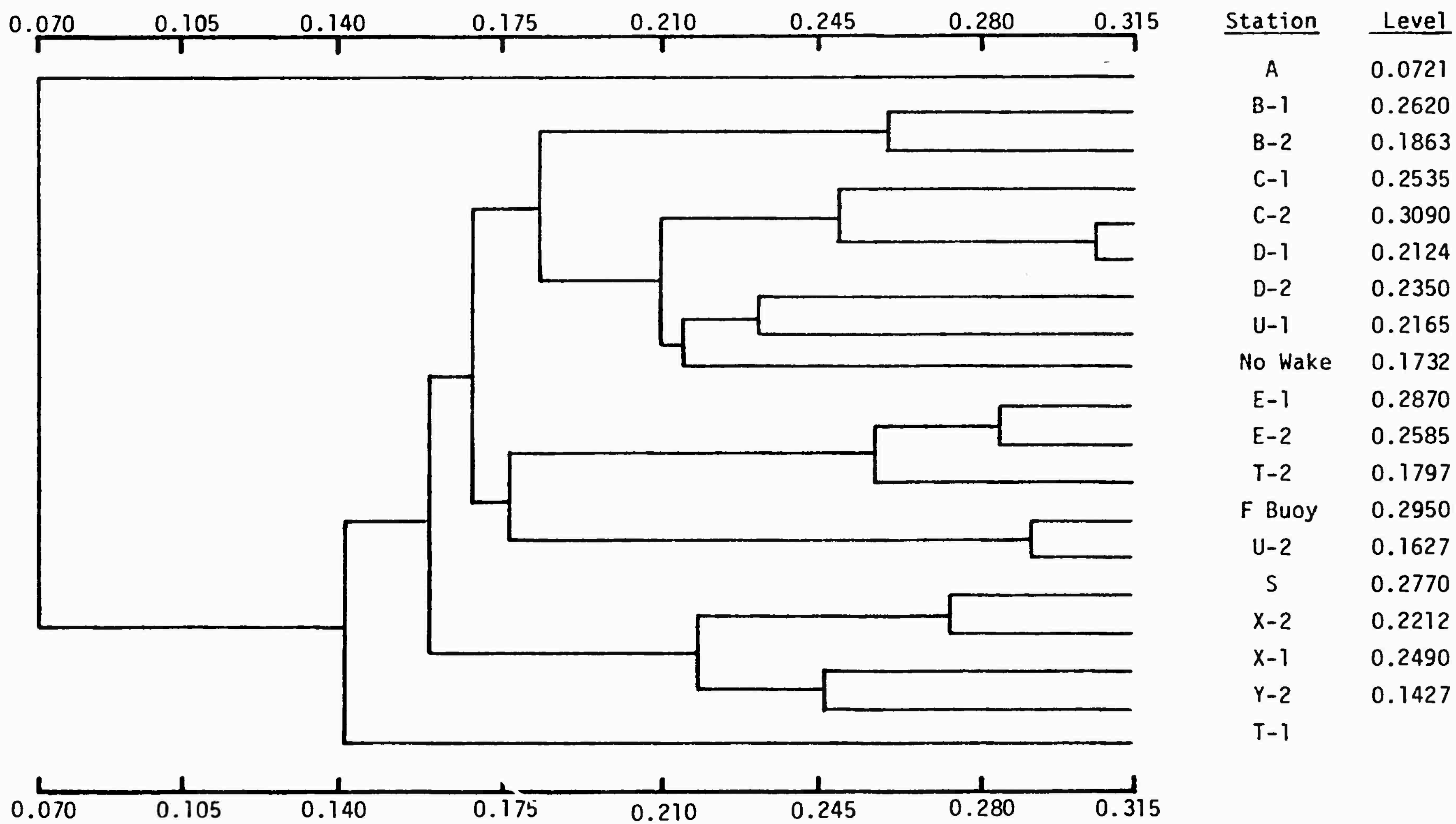
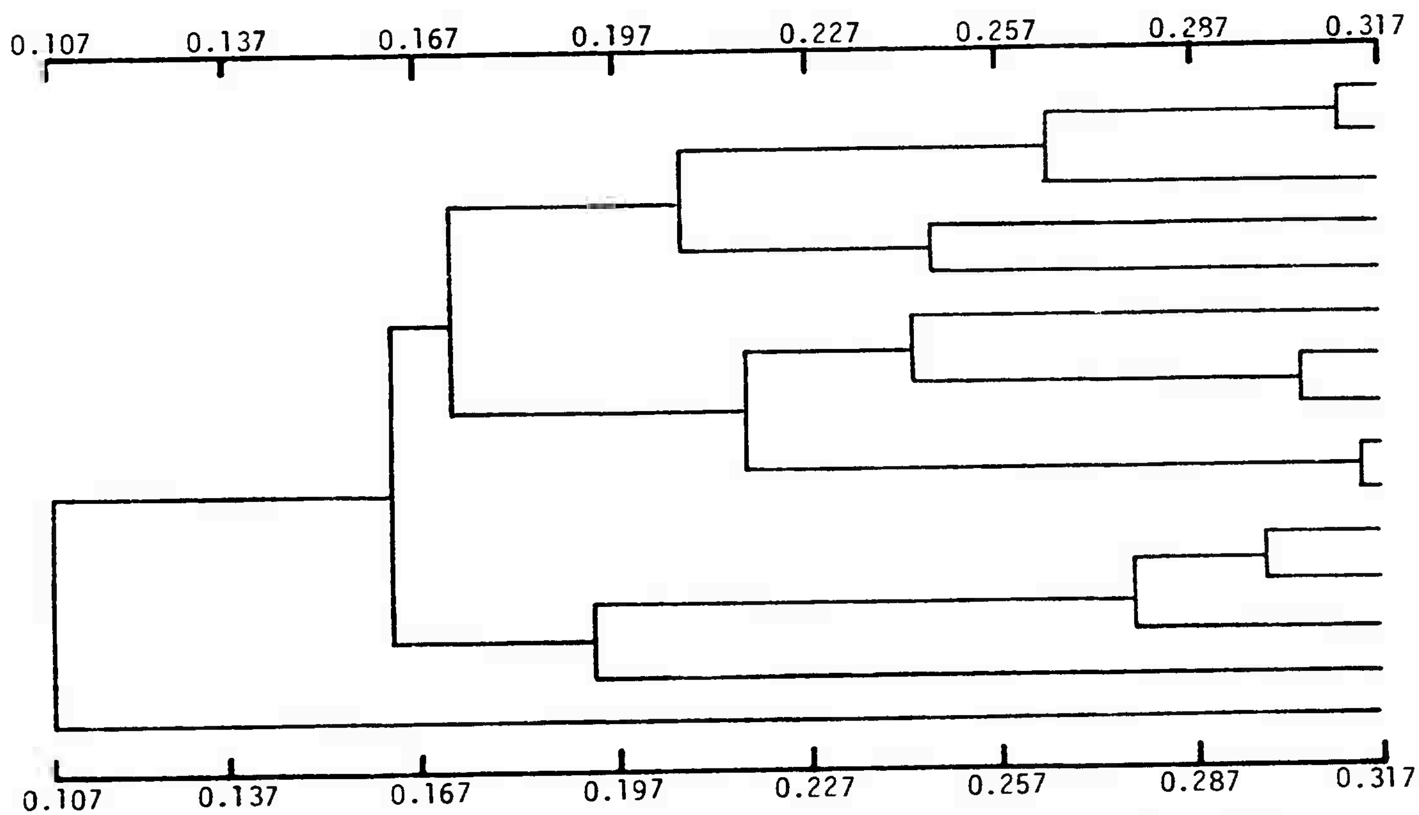


FIGURE 18. PHENOGRAM OF VAAP PERIPHYTON ARTIFICIAL SUBSTRATE, AUGUST 12-26, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.806.



Station	Level
A	0.3100
D-2	0.2665
No Wake	0.2102
E-1	0.2480
C-2	0.1745
E-2	0.2465
U-2	0.3040
X-1	0.2167
X-2	0.3150
Y-2	0.1645
S	0.2990
U-1	0.2790
T-2	0.1947
T-1	0.1071
C-1	

FIGURE 19. PHENOGRAM OF VAAP PERIPHYTON ARTIFICIAL SUBSTRATE, AUGUST 12 - SEPTEMBER 7, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.743.

Natural Substrate Diatom Community Structure. Table B-8 (Appendix B) presents a detailed taxonomic list of diatom species recorded from VAAP natural periphyton substrates (i.e. rock scrapings). Diatom species (65) representing 18 genera were observed on natural substrates collected from Waconda Bay (Stations A, B-1, and F-2), Reference Bay A (Stations S and T-2) and Huss Lowe Slough (Station X-2).

The dominant species were Achnanthes minutissima -- ranging in relative abundance from 49 - 89 percent. Other common species included: Nitzschia sinuata v. tabellaria, Nitzschia denticula, Navicula cincta, and Cymbella microcephala. The natural substrate community exhibited a more even distribution of individuals among species than the glass slide flora As a result, species diversity indices were higher (Table B-16).

The number of species per station were in general agreement to those reported from artificial substrates during June (Table B-18). A species area curve (Figure B-6, Appendix B) was developed to illustrate the effect of increasing sample size (area microscopically examined in mm^2) on total numbers of species. The data graphically illustrated represent the number of species observed per 0.1 mm^2 interval to a total area of 2.0 mm^2 (i.e. 64.5 microscope fields under oil immersion, 1000 X). Total species numbers were highest at Stations F-2 and T-2 where 27 - 30 species/mm^2 were observed (Figure B-6). Lowest values were observed at Station A (10.5 species/mm^2), Station B-1 (13 species/mm^2), and Station S (13.5 species/mm^2).

Diatoms from natural substrates showed a number of similarities to the diatom flora collected from the glass slide communities. Both populations were dominated by A. minutissima; total numbers of species present/station were comparable to the artificial substrates. Quantitatively, however, diatom cell densities/mm^2 were lower for natural substrates. In addition, species diversity indices were generally higher for the natural substrate flora (Table B-18).

Filamentous Organisms. Attempts to quantify periphytic filamentous organisms on a per unit area basis by the use of a number of standard counting techniques (i.e. Sedgewick-Rafter and inverted microscopic counting chambers) were generally unsuccessful. Most filamentous species clumped with the ends of filaments firmly embedded within detrital particles or entangled with filaments of Oedogonium sp. or Stigeoclonium sp. As a result, a qualitative examination was made based on presence-absence criteria at eight selected VAAP station locations (i.e. Stations A, B-1, B-2, C-1, F-2, S, T-1, and X-2) during the June - July and August - September 4-week incubation periods. Tables B-6 and B-7 (Appendix B) lists the most common species present at each of the stations during each survey.

With the exception of Station A, the most common organisms were green algae (Chlorophyceae) comprised of Oedogonium spp., Mougeotia spp., Choleachaetae spp., and Ulothrix spp. Blue-green (Cyanophyceae) algae were represented by Schizothrix calcicola.

Table B-6 shows only one species, Oedogonium spp., at Station A, in comparison to an average 5.3 species per sample from stations located in Waconda Bay and the reference bays, and may indicate toxic effects.

By the end of the August - September 4-week incubation period, some recovery was noted at Station A. Total species increased and a number of heterotrophic organisms (i.e. stalked protozoans) was observed as common components of the periphytic community at Stations A and B-1. These were Vorticella sp., Rhabdostyla sp., and Opisthostyla sp.

Organic Biomass and Chlorophyll. Loss of periphytometers due to vandalism hampered analysis of periphytic biomass in Waconda Bay and the reference bays. Morphometric conditions in Waconda Bay produced unequal mixing of the VAAP waste discharge. Consequently, higher waste ion concentrations were reported on the west side of the impact bay transects. Incomplete data for both sides of the bays required that the periphyton community be analyzed in terms of transects. This is especially true for the August - September trip. Analysis of variance was carried out on all chlorophyll and biomass data. In order to be consistent with the statistical analysis carried out on the diatom cell count data, only individual stations were considered. Replicates consisted of values obtained for separate individual slides located at a station.

Mean chlorophyll and biomass values as well as corresponding autotrophic indices are presented in Tables B-19 to B-22 and B-31 (Appendix B), and Figures 20 through 23. Tables B-22 through B-29 provide the raw chlorophyll a and organic biomass (AFDW) data for each transect replicate.

Table B-19 and Figure 20 illustrate the distribution of chlorophyll a and biomass incubated for two weeks in June. Analysis of variance showed that significant differences existed in the biomass values, but not the chlorophyll (Biomass, $F_{[18,72]} = 10.5$, $F_{0.01\ [18,72]} = 2.23$; Chlorophyll, $F_{[11,9]} = 1.35$, $F_{0.05\ [11,9]} = 3.10$. As with the cell count data, Station A showed uniformly low values while the B stations were uniformly high. Tukey's test (Steel and Torrie, 1960) showed that significant differences existed between Stations A and both B-1 and B-2 at the 1 percent confidence level.

The June 4-week incubation data (Table B-20 and Figure 21) showed significant differences for chlorophyll a, and biomass (Chlorophyll, $F_{[10,27]} = 10.7$, $F_{0.01\ [10,27]} = 3.06$; Biomass, $F_{[10,21]} = 4.08$, $F_{0.01\ [10,21]} = 3.31$) In both cases Station A ranked lowest or next to lowest. Stations B-1 and B-2 were either the two highest or two of the three highest values. These results are consistent with the diatom cell count results. Tukey's test applied to the chlorophyll a data showed Station A to be different from both Stations B-1 and B-2 at the 1 percent level. With the biomass data Station A was different from B-1 at the 5 percent level, but not significantly different from Station B-2.

The August data for 2-week incubation (Table B-21) are less conclusive for chlorophyll a and biomass in that these values were not determined for Station A. Station B-1 had the third highest chlorophyll a value and the second highest biomass value. However, cell count data show Station B-1 to be in the lower third when stations were ranked low to high.

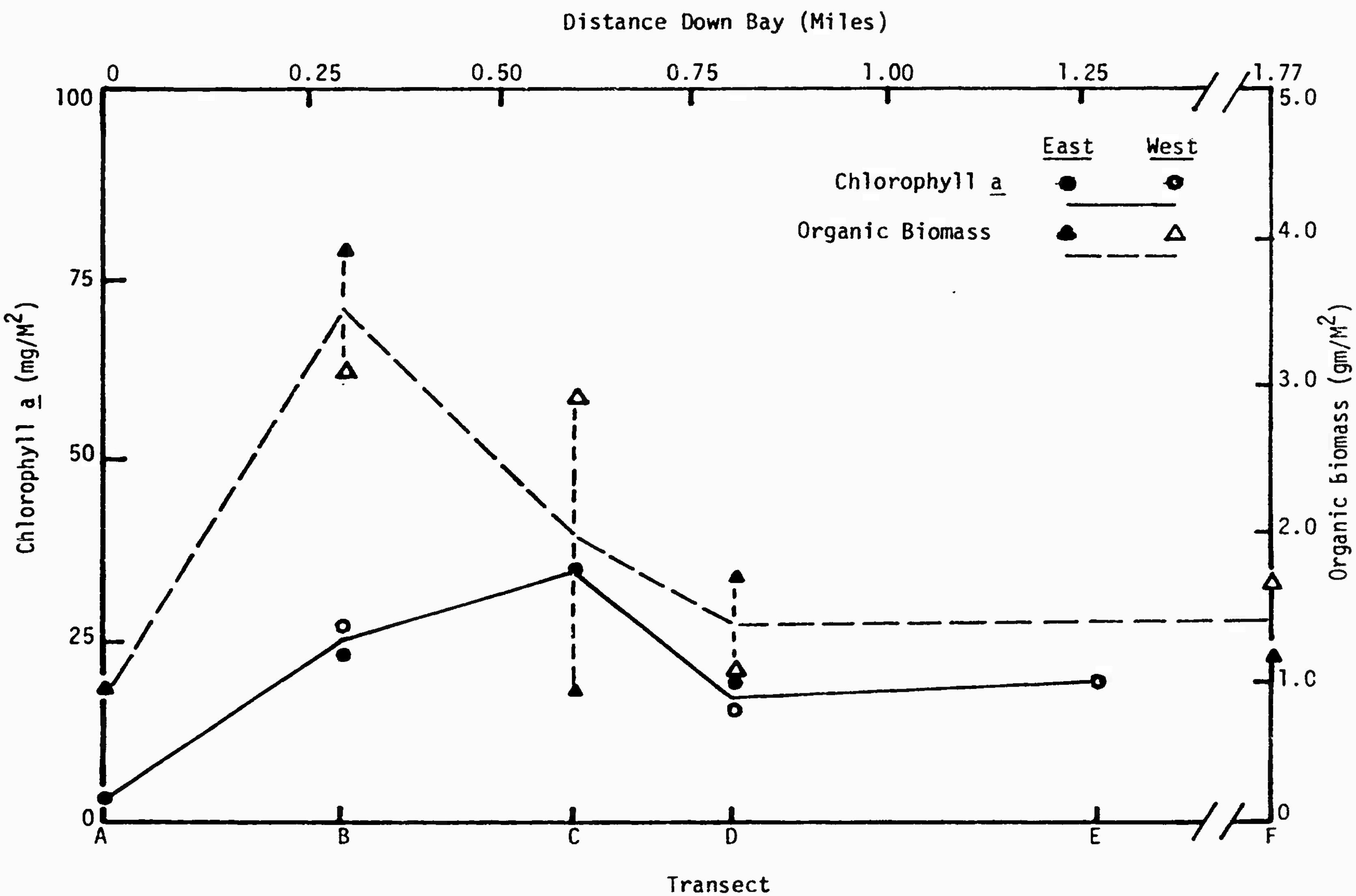


FIGURE 20. MEAN PERIPHYTIC CHLOROPHYLL a AND ORGANIC BIOMASS AS ASH-FREE DRY WEIGHT ON ARTIFICIAL SUBSTRATES (GLASS SLIDES) INCUBATED IN WACONDA BAY, JUNE-JULY, 1975, 2-WEEK INCUBATIONS.

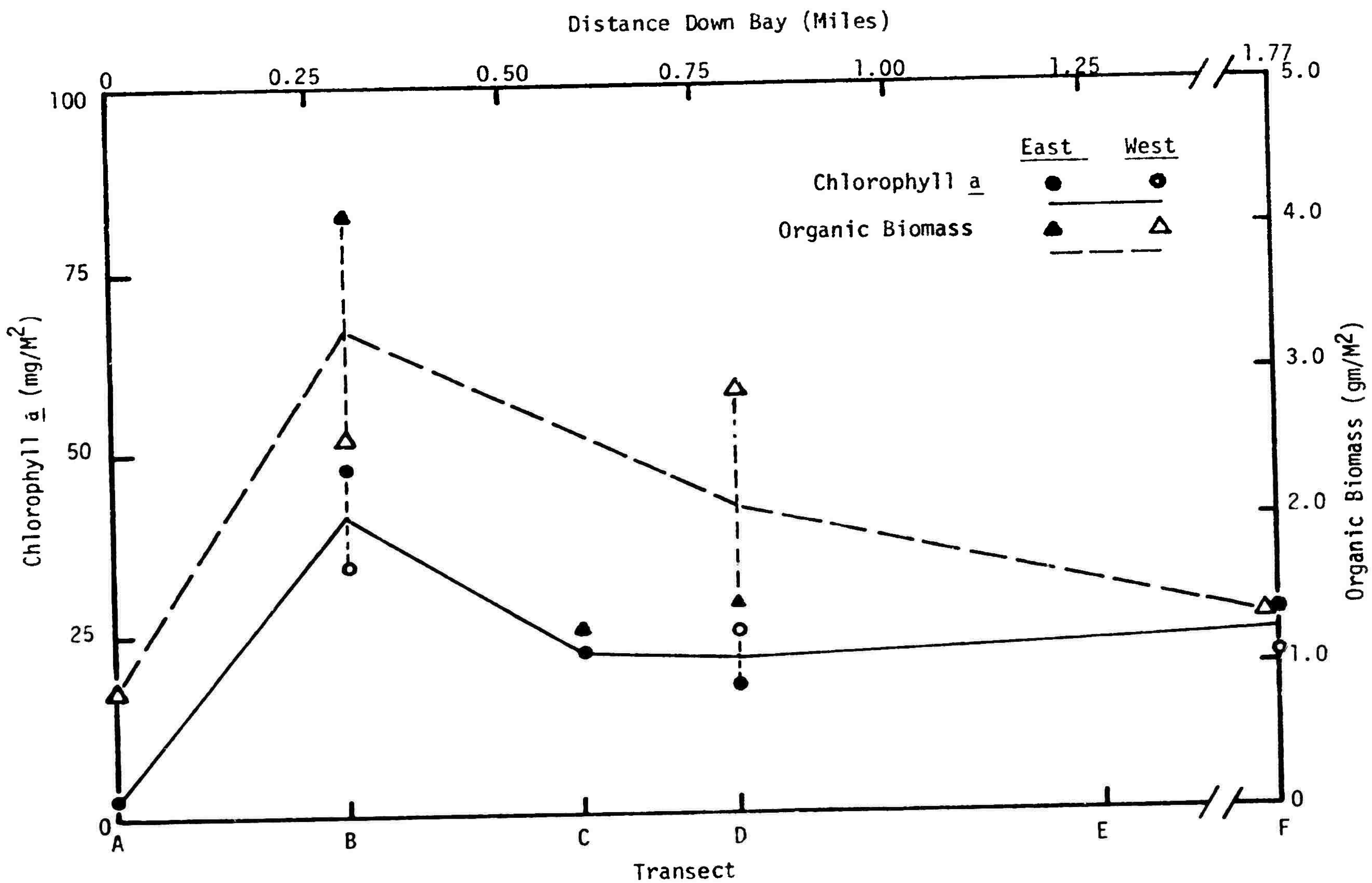


FIGURE 21. MEAN PERIPHYTIC CHLOROPHYLL a AND ORGANIC BIOMASS (AFDW) ON ARTIFICIAL SUBSTRATES (GLASS SLIDES) INCUBATED IN WACONDA BAY, JUNE-JULY, 1975, 4-WEEK INCUBATIONS.

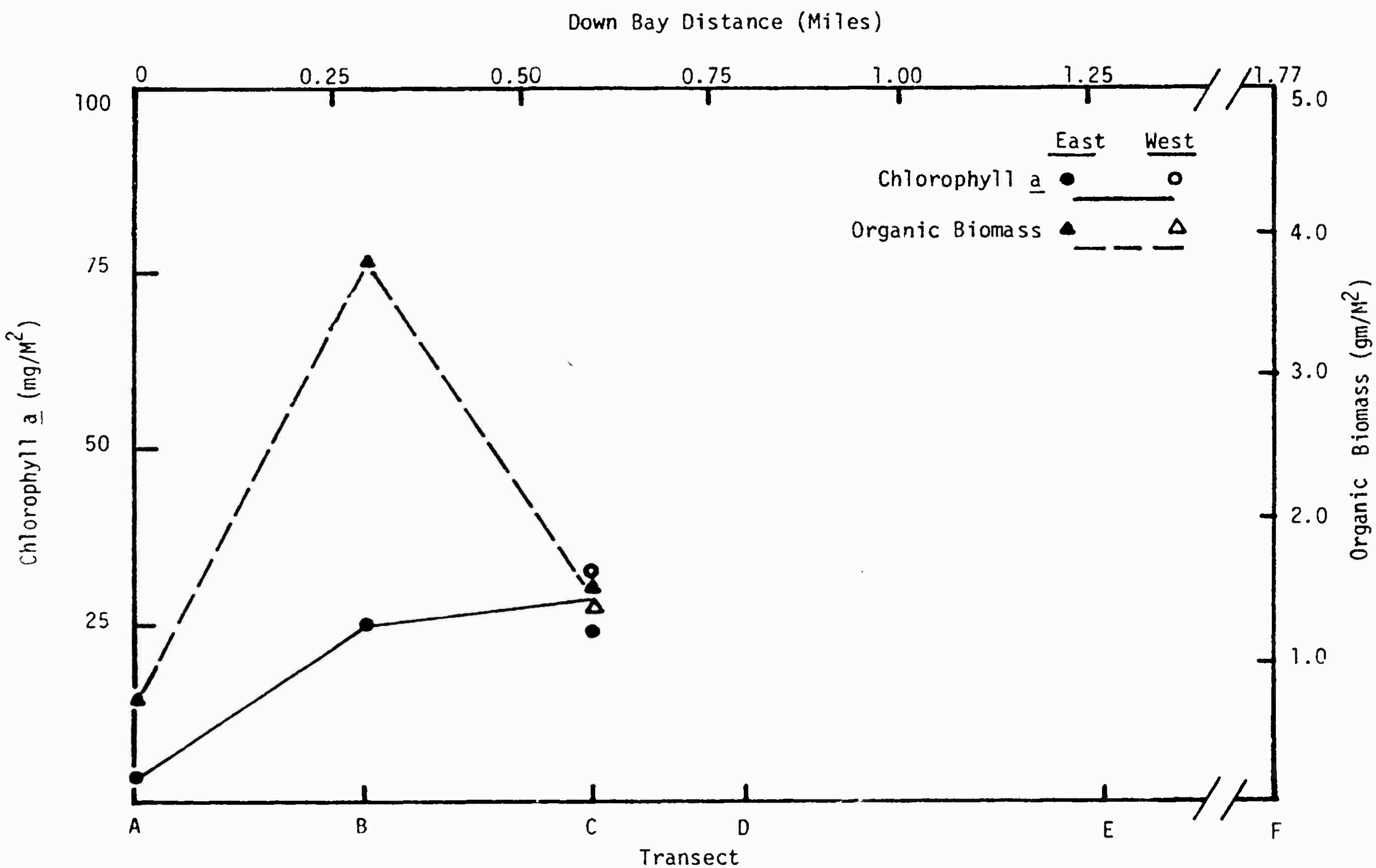


FIGURE 22. MEAN PERIPHYTIC CHLOROPHYLL a AND ORGANIC BIOMASS (AFDW) ON ARTIFICIAL SUBSTRATES (GLASS SLIDES) INCUBATED IN WACONDA BAY, AUGUST-SEPTEMBER, 1975, 4-WEEK INCUBATIONS.

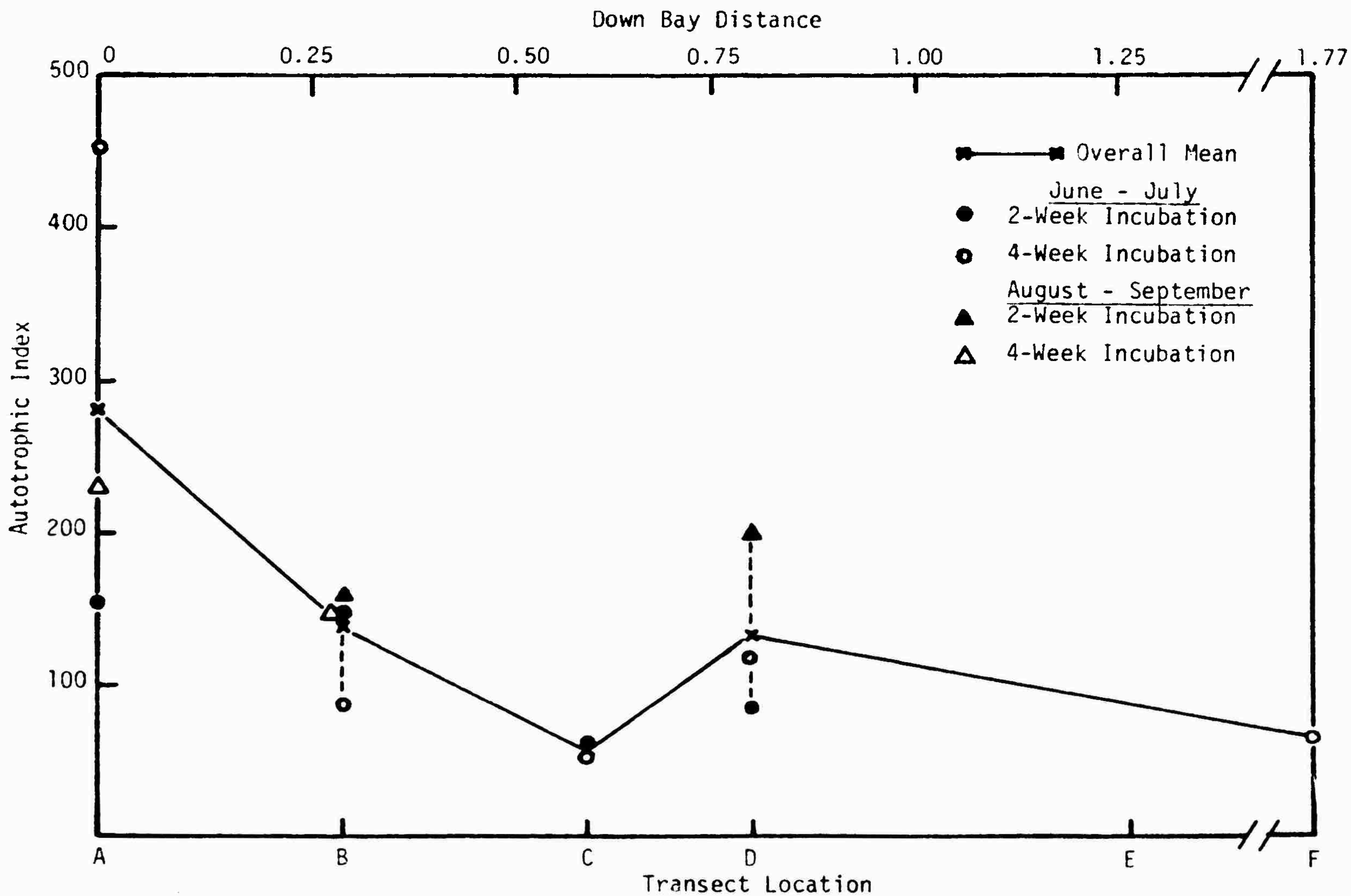


FIGURE 23. MEAN TRANSECT AUTOTROPHIC INDICES FOR WACONDA BAY, JUNE - SEPTEMBER, 1975.

The August data for 4-week incubation (Table B-22 and Figure 22) are similar to results obtained in June. Station A had the lowest values for cell count, biomass, and chlorophyll a. Station B-1 had either the highest or next to the highest values. Analysis of variance showed significant differences in both the chlorophyll a and biomass data (Chlorophyll, $F_{[10,19]} = 13.4$, $F_{0.01\ [10,19]} = 3.43$; Biomass, $F_{[8,11]} = 16.3$, $F_{0.01\ [8,11]} = 4.74$). Tukey's test showed that in both cases Station A was different from Station B-1.

Autotrophic index means for the 1975 summer survey are shown in Figure 23. There is a general downbay trend from stressed conditions at Station A to no stress at transect F. The increase in autotrophic index at transect D may be the result of the marina at the location. Domestic waste from houseboats as well as gasoline engine related wastes could enter the bay at that point. Except at Station A, the mean autotrophic index ratio at 4 weeks generally ranged from 62 to 150, typical of algal-dominated material. Transect X in Huss Lowe Slough was an anomaly, however, in that the autotrophic index in June was 1000. The mean autotrophic index at 2 weeks versus 4 weeks for all stations showed the 4-week data to be lower. These results indicate that the heterotrophic component of the periphyton develops more rapidly than the autotrophic in this environment rather than indicating the presence of pollution stress. Station A indices did not decrease between 2- and 4-week incubation, showing that stress persists.

Productivity Data

Generally, net production based on chlorophyll and biomass accumulation showed that the periphyton component on glass slides was relatively low as compared to studies previously conducted in waters impacted by munitions wastes (Weitzel, 1975, WAR, Inc., 1976). The exception to this was transect B where relatively high productivity was measured. Production rates of organic biomass tended to be lower for the 4-week incubations compared to the two week while chlorophyll a based productivity rates remained more constant. This is further evidence that heterotrophs colonized the slides more rapidly, building stable population sizes by the end of 2 weeks, while autotrophs continued to increase in mass for the entire 4-week incubation period.

The chlorophyll a and biomass data for artificial substrates suggest several conclusions regarding autotrophic and heterotrophic microbial communities in Chickamauga Lake. Primarily inhibition of microbial growth occurs at the impact point, Station A. Biomass of both autotrophs and heterotrophs is reduced, however, autotrophic metabolism seems to be suppressed to the greater degree. Biomass of both components is increased at transect B, 0.3 miles downbay from A and some stimulation is evident at C, 0.6 miles downbay from A. TNT and DNT residues, while found to be highly variable in concentration, decreased from a median value of 123 ppb at A to about 50 ppb beyond transect C in June and 121 to 60 ppb for the same reach in August. Nitrite plus nitrate-nitrogen decreased over the same distance from >5 mg N/l to about 1.0 mg N/l in June and 2.3 to 1.0 mg N/l in August. Total reduced nitrogen, sulfate, and hardness showed similar patterns of concentration. The concentrations of the nitrogen forms, anions, and cations measured, however, are unlikely to be totally responsible for the biological effects. The nitrate-nitrite and Kjeldahl nitrogen concentrations should cause a definite biostimulatory effect. Pink-water conditions at Station A may reduce light, causing a reduction of algal biomass at that station. This does not, however, explain the effect on the heterotrophs. Elevated sulfate concentrations do not likely explain the inhibition as it existed in the August survey when sulfate concentration had dropped at A to the same levels as was found at transect B in both June and August in conjunction with biostimulation. The enrichment at transects B and C is an indication that Harrison Bay may be nitrogen limited overall, however, the enrichment shown may be due to a combination of factors rather than simple nitrogen limitation since slightly elevated nitrogen concentrations at the offshore stations on the west side of Harrison Bay do not increase chlorophyll or biomass over eastern stations.

It is likely that two major munitions related factors interact to produce the patterns of periphytic growth in Waconda Bay. These are illustrated conceptually in Figures 24 and 25. In Figure 24, the pattern of growth rate or production as affected by biostimulatory factors only is illustrated as a decrease downbay to non-impact production levels. Such factors might include nitrogen compounds (TKN, NH_3, and NO_3) from the effluent. Growth rate would parallel nutrient concentrations which would decrease with dilution downbay. Concentrations of toxic factors would also be diluted downbay. The effect on periphyton growth would be the opposite of the biostimulatory effect such that as the toxic factor was diluted the growth rate would increase. Toxic or suppressive effects could result from munitions residues, physical effects of "pink water," or some synergistic effect related to SO_4, NO_3. TKN, and munitions. Figure 25 illustrates the probable effect of both biostimulation and toxicity on primary production. Below a critical level biostimulation or suppression of overall productivity becomes negligible and levels of production are not different from offshore by conditions. The interaction of these two effects is shown as a dotted line in Figure 25, where production level balances between suppressive and biostimulatory effects. Initially, suppression of production occurs in the presence of strong biostimulatory concentrations of nutrients. As the concentration of toxic materials is reduced downbay, biostimulation overrides suppression. Primary production then peaks and decreases with the lower concentrations offshore.

Examination of the decreases in munitions concentration indicates that above 100 to 150 ppb TNT toxic effects may occur, below about 50 ppb there is no effect on overall periphytic community production. Concentrations of munitions at A and B-2 appear to range to similar levels although community response is markedly different. This suggests that other factors than just the strict TNT, DNT concentrations may be active, for example a synergism between nitrate-nitrite level and munitions, or that the more consistent presence of high levels munitions residues at A than in transect B causes a more integrative effect than intermittent munition levels above 100 ppb at B.

Shading due to "pink water" and turbidity is also a likely suppressive factor at A which has been reduced at B, allowing biostimulation due to nutrients to be expressed.

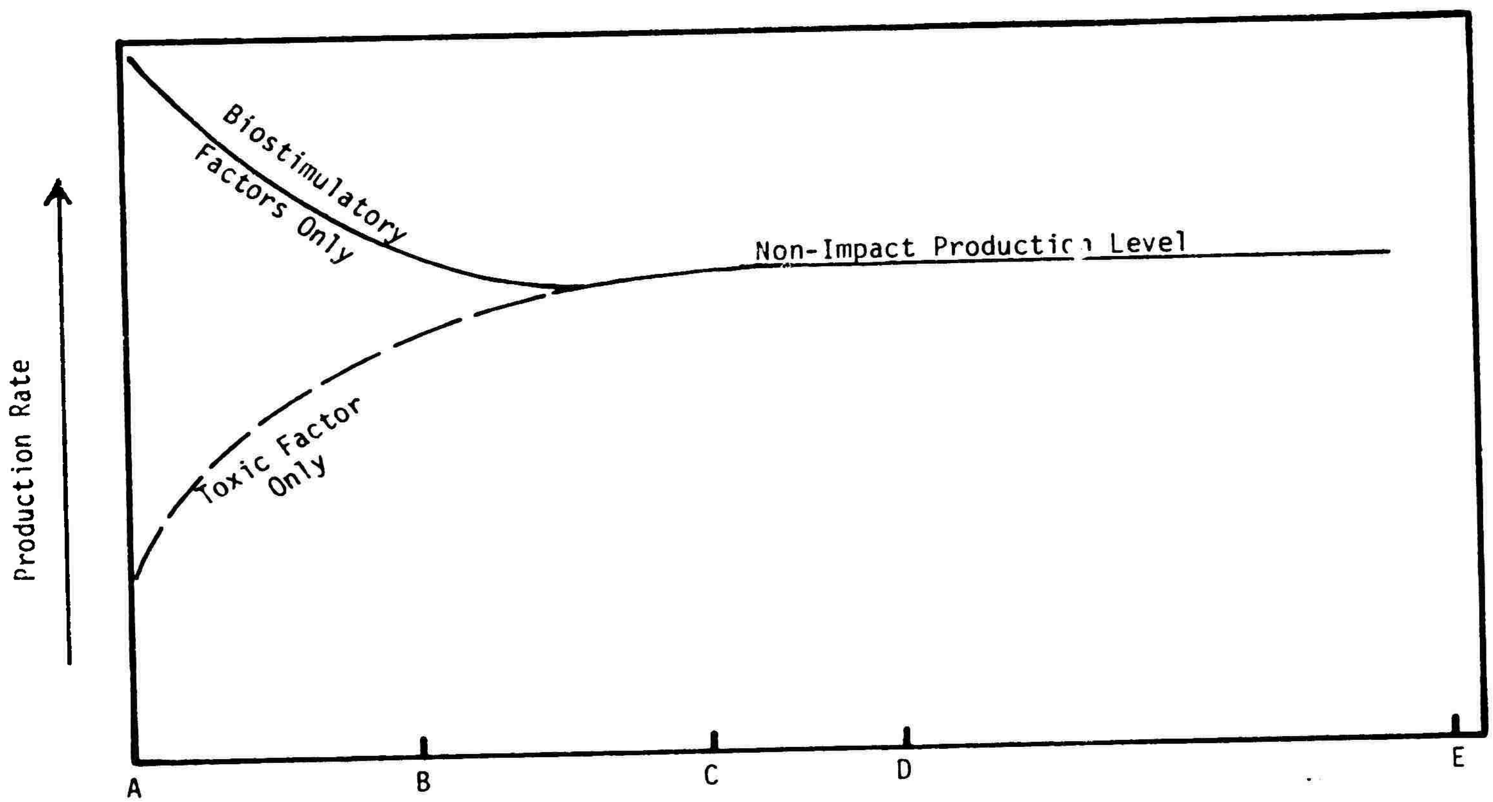


FIGURE 24. THEORETICAL BIOLOGICAL PRODUCTION RATES WITH EITHER TOXIC OR BIOSTIMULATORY EFFECTS DUE ONLY TO MUNITIONS DISCHARGES.

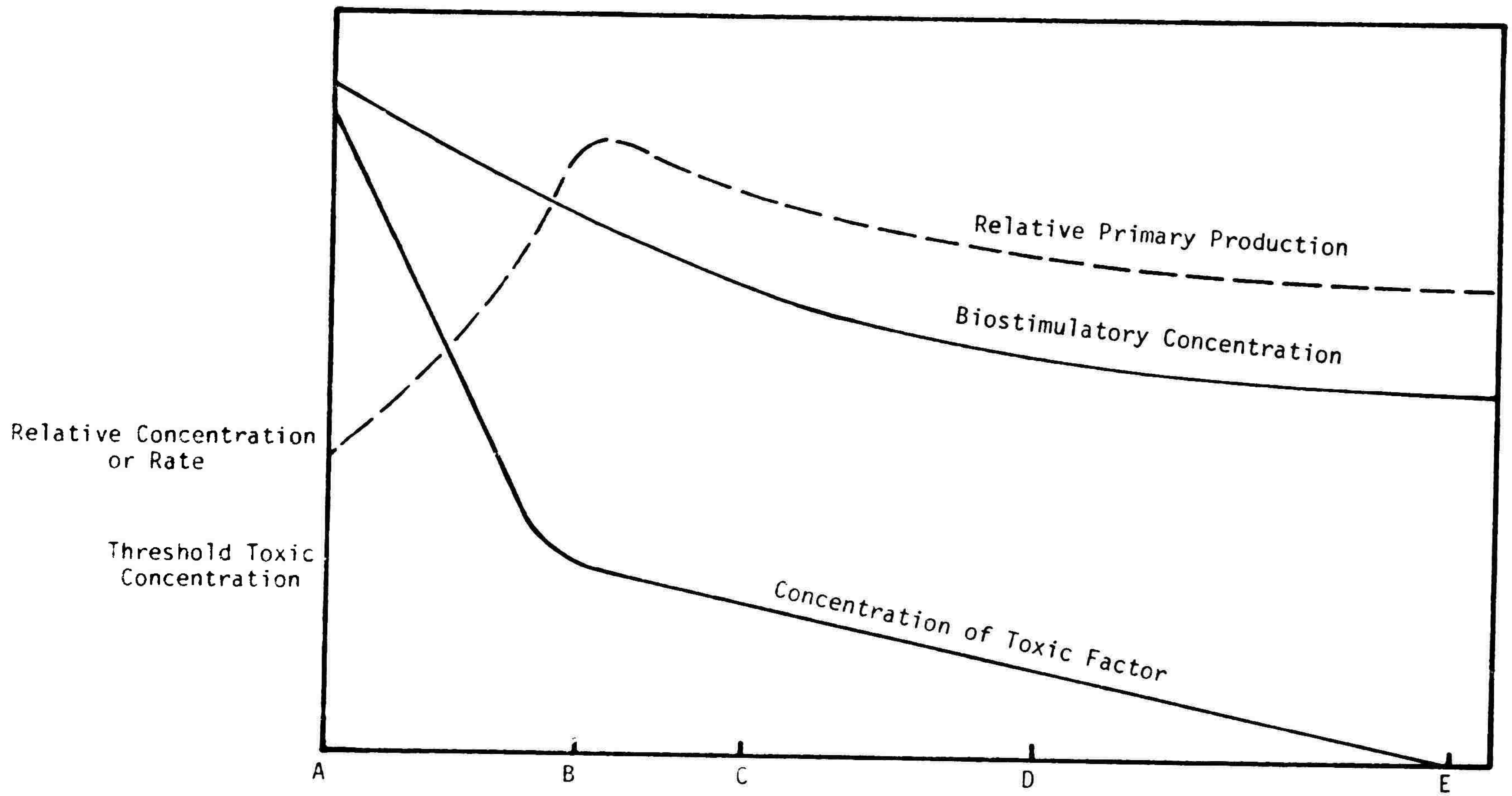


FIGURE 25. THEORETICAL BIOLOGICAL PRODUCTION RESULTING FROM BOTH BIOSTIMULATORY AND TOXIC EFFECTS FROM MUNITIONS DISCHARGES.

There are also some downbay differences in biological production evident in the reference bays; some of the effects in Waconda Bay may be due to runoff factors such as turbidity. These biological effects in the reference bays do not exhibit the consistency or magnitude of the effects in Waconda Bay.

Introduction

Plankton are free floating organisms suspended within the water column of aquatic systems. They span all trophic levels and consist primarily of three components: 1) the phytoplankton -- free floating microscopic plants (algae); 2) the zooplankton -- free living microscopic animals (protista, rotatoria, mollusca and crustacea); and 3) the meroplankton -- free floating eggs and/or larvae of certain invertebrates and fishes. Chlorophyll-bearing plants such as algae usually constitute the greatest portion of plankton biomass. Phytoplankton use the energy of sunlight to metabolize inorganic nutrients and convert them to complex organic materials. Zooplankton and other herbivores graze upon the phytoplankton and, in turn, are preyed upon by other organisms -- thus transferring stored energy to larger, more complex organisms. In this manner, nutrients become available to large organisms such as macroinvertebrates and fish (Weber, 1973).

The phytoplankton community response to pollution stress is similar to that of other microbial populations. In waters severely affected by organic pollution, heterotrophs may be extremely abundant; sometimes with a biomass exceeding that of algae. As a result of heterotrophic metabolism, high concentrations of inorganic nutrients become available and massive algal blooms may develop. Plankton blooms can cause extreme fluctuations of dissolved oxygen in water, may cause taste and odor problems -- and if present in large numbers, are aesthetically objectionable. In some cases, plankton may be of limited value as indicator organisms as they move with the water currents; thus, the origin of the plankton may be obscure and the duration of exposure to pollutants may be unknown (Weber, 1973.)

The quantity of phytoplankton occurring at a particular station depends upon many factors including sampling depth, time of day, season of year, nutrient content of water, and the presence of toxic materials.

Methods

Phytoplankton samples were collected June 9-13 and August 11-15, 1975, at 20 stations in Lake Chickamauga, (Figures 3 and 4). Surface samples were taken and preserved with five percent neutralized formalin and placed in a cool, light-excluding box for shipment back to the laboratory. Plankton enumeration was made according to the Utermohl (1958) sedimentation technique. Phytoplankton counts were performed on the following samples: 6/9, 6/10, 6/13, 8/11, 8/13, and 8/15, 1975. Species identifications were carried to the lowest taxonomic level, utilizing a Zeiss inverted "D" microscope at 400 diameters, while species identifications were carried out utilizingan oil immersion lens (1250 magnification). Four strip counts were made of each settled sample for an estimate of numbers of organisms per liter. Phytoplankton species occurring commonly as groups, clumps, or filaments were considered as one unit (e.g. Micractinium, Gomphosphaeria, and Chroococcus). The diatom Melosira, however, was a noted exception as filaments were usually shorter than 6 cells and were therefore counted as individual units. Major taxonomic references used were Drouet and Daily (1956); Drouet (1968);

Prescott (1954, 1962); Witford and Schumacher (1969); and Patrick and Reimer (1966).

Shannon-Weaver Species Diversity Index ($\bar{H}$) (Shannon and Weaver, 1949; Margalef, 1968) and the Pearson-Pinkham (1974) Index of Biotic Similarity were used to make station to station comparisons. These indices are explained in detail in the Computational Methods section of this report.

Presentation of Data

A total of 71 phytoplankton species representing at least 70 genera were present from Lake Chickamauga during the two 5-day sampling periods. Tables C-1 through C-4 present taxonomic lists of species occurrence and distribution patterns between stations for four typical sampling trips. Figures 26 through 31 illustrate the percent relative abundance of the various phytoplankton groups at each station during the two surveys. The remainder of the abundance data is illustrated in Appendix C. Means, standard deviations, and coefficients of variation for phytoplankton cell densities (cells/ml); total numbers of species per station; as well as Shannon-Weaver species diversity estimates* are also tabulated in Appendix C.

Diatoms (Bacillariophyceae) were the predominant organisms at Stations A through D (Waconda Bay) during the June survey -- accounting for 38 - 68 percent of the phytoplankton population. The dominant to common diatom species during the period were approximately: Melosira ambigua (15 percent), Melosira distans (14 percent) and Fragilaria crotonensis (5 percent).

Other important groups were: the Chlorophyceae (green algae) represented by Ankistrodesmus falcatus, Scenedesmus bijuga, S. quadricauda, Tetraedron minum, and Chlamydomonas sp.; the Chrysophyceae, including Dinobryon divergens, and D. bavaricum; the Cryptophyceae, with Cryptomonas sp. and Rhodomonas sp.; and the Dinophyceae represented by Peridinium pusillum.

Diatom dominance decreased from Station A to D (Waconda Bay) with equal numbers of diatoms and Chlorophyceae present at transects E and F. The relative abundances of diatom populations were generally lower at the offshore transects E-F and higher in Waconda Bay and Huss Lowe Slough. The relative abundance of Chlorophyceae populations increased at transects E - F and X - Y (Figures 26 and 27).

With the exception of the June 9 sampling period (Figure 27), similar population trends of diatom-chlorophycean dominance were observed in Reference Bay A and Huss Lowe Slough.

During the August 5-day survey, the phytoplankton was dominated by the Cyanophyceae (blue-green algae), (Figures 30-31) comprising 36-43 percent of population followed by the diatoms and Chlorophyceae representing about 21-20 percent.

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*Based on two replicates.

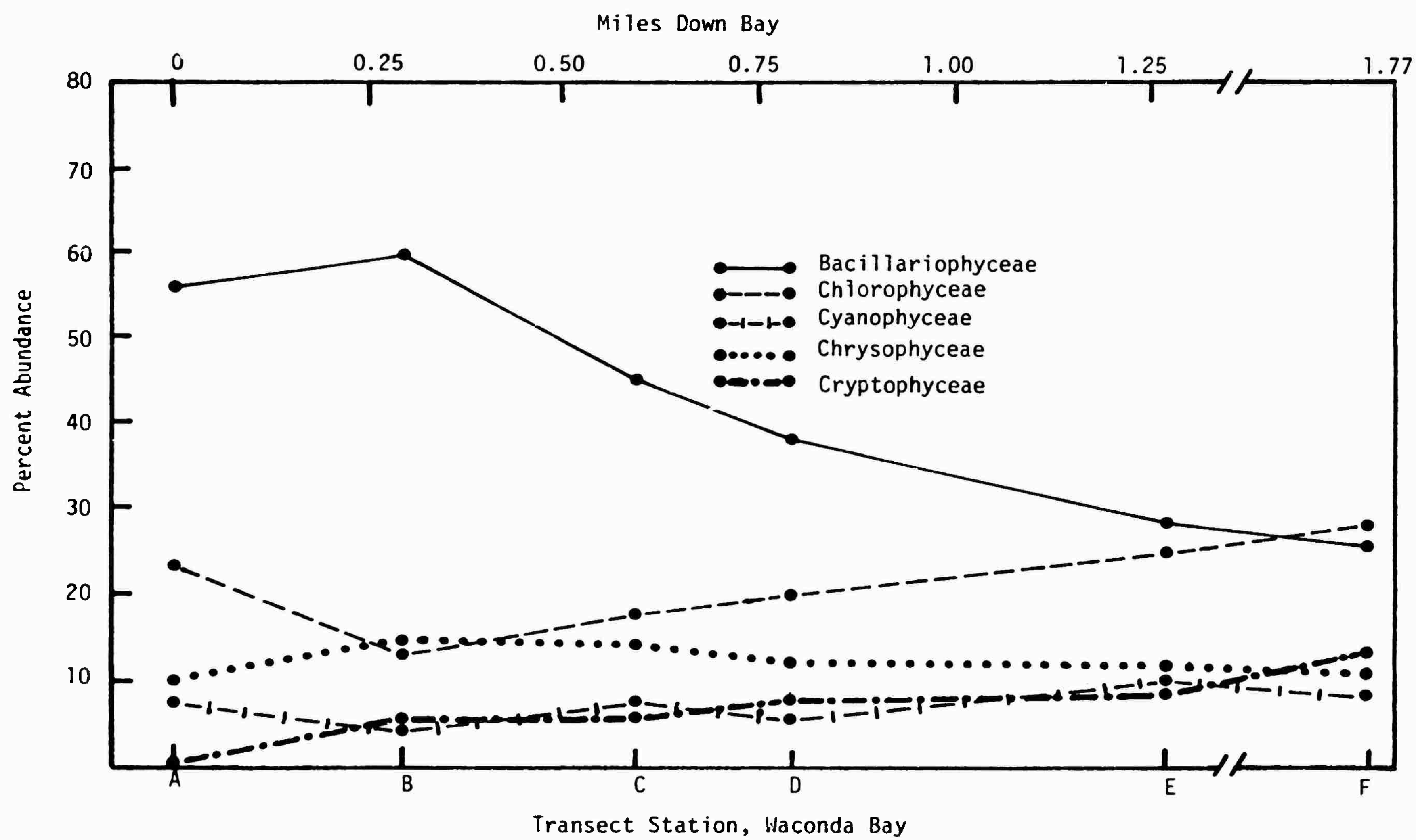

FIGURE 26. DISTRIBUTION OF MAJOR GROUPS OF PHYTOPLANKTON IN WACONDA BAY, JUNE 9, 1975

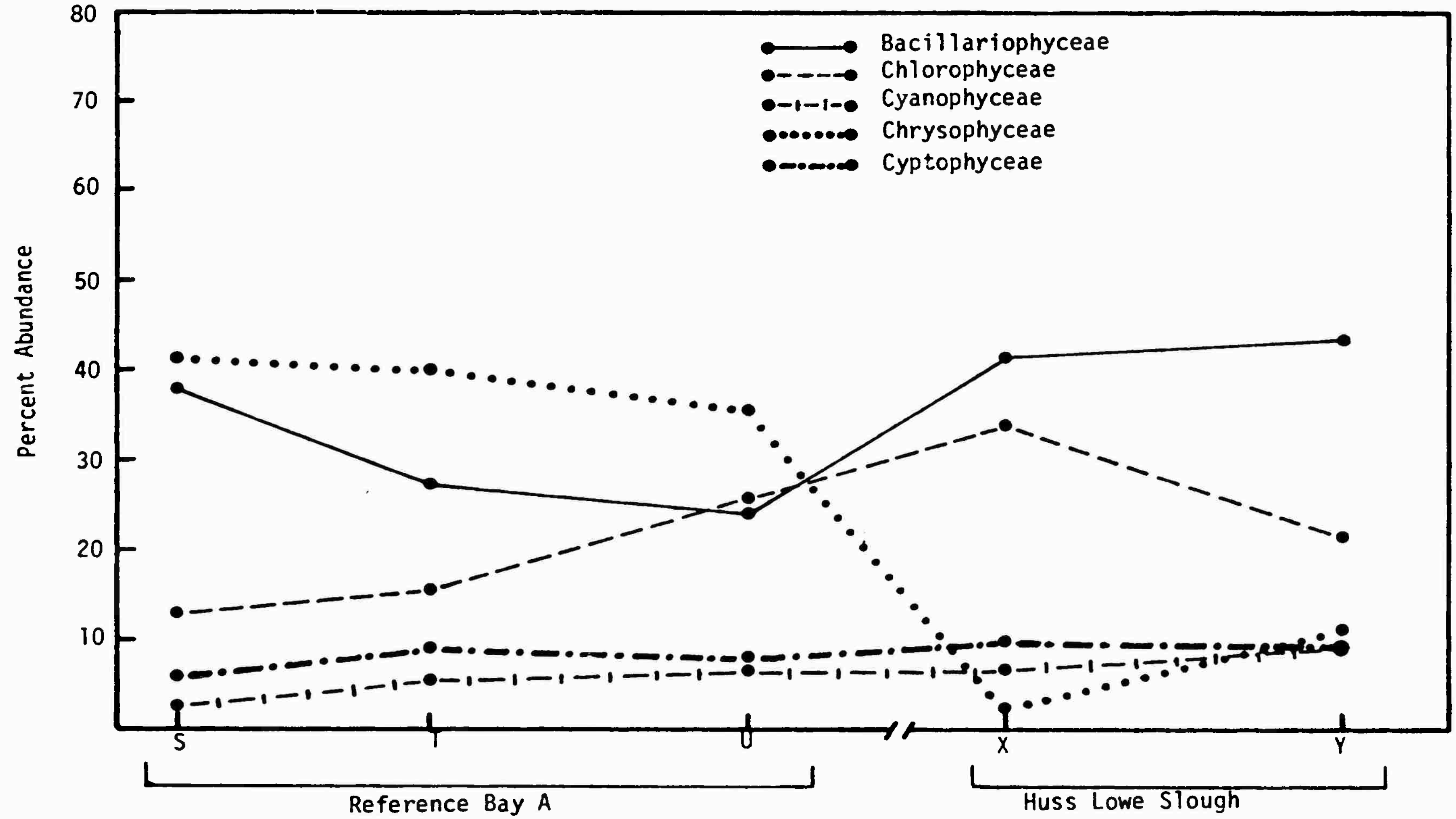

FIGURE 27. DISTRIBUTION OF MAJOR GROUPS OF PHYTOPLANKTON IN THE REFERENCE BAYS, JUNE 9, 1975.

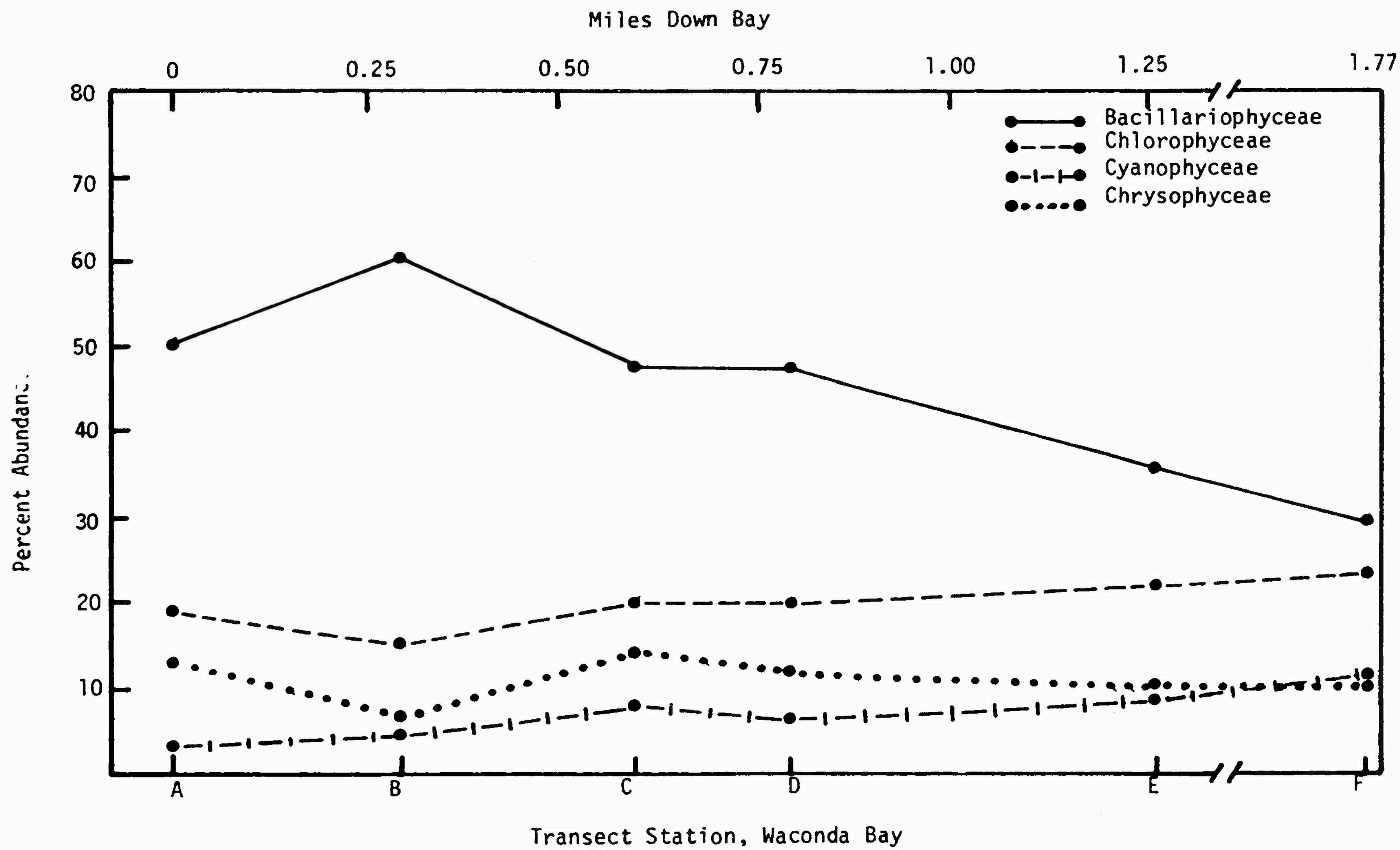

FIGURE 28. DISTRIBUTION OF MAJOR GROUPS OF PHYTOPLANKTON IN WACONDA BAY, JUNE 10, 1975.

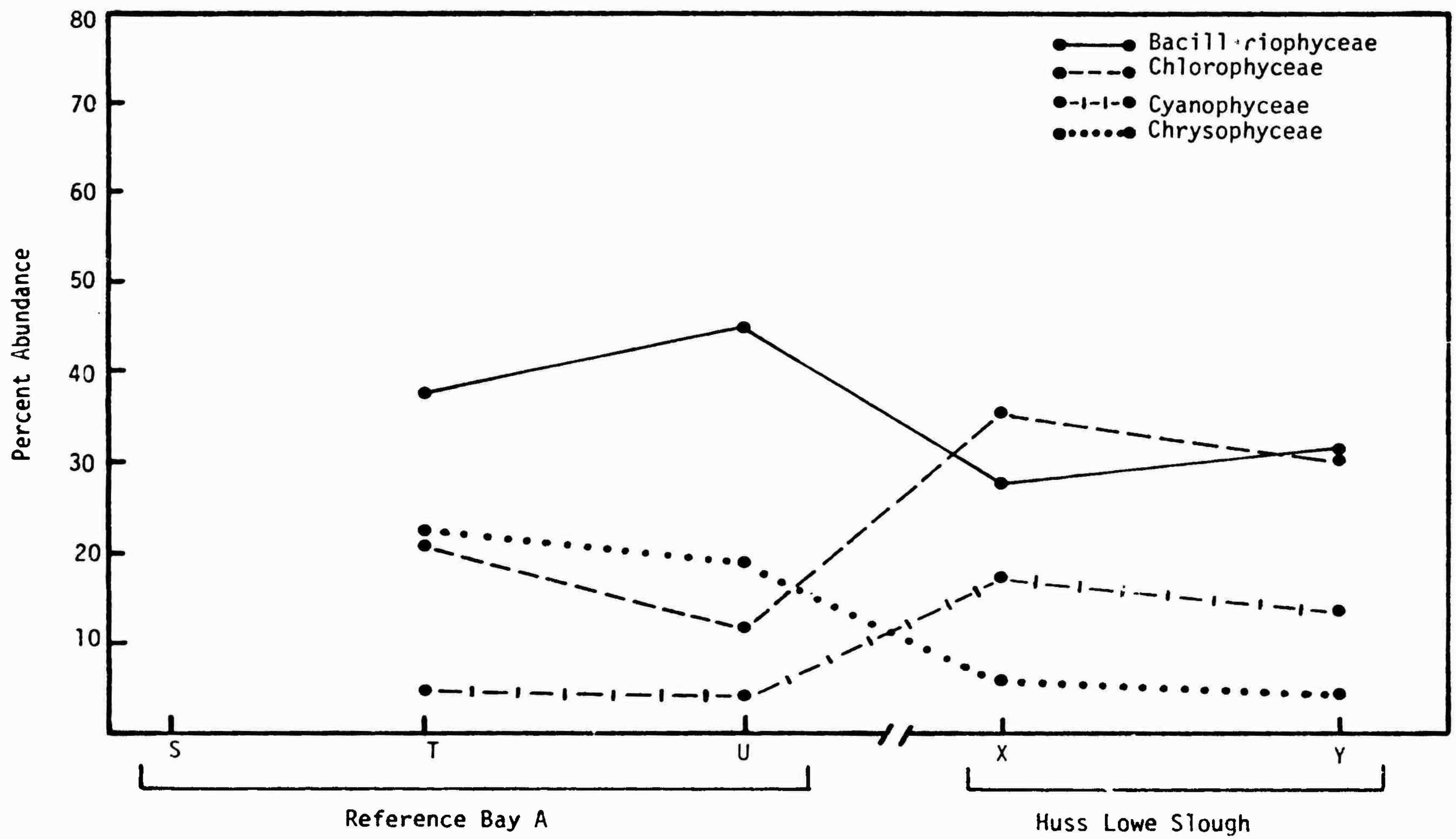

FIGURE 29. DISTRIBUTION OF MAJOR GROUPS OF PHYTOPLANKTON IN THE REFERENCE BAYS, JUNE 10, 1975.

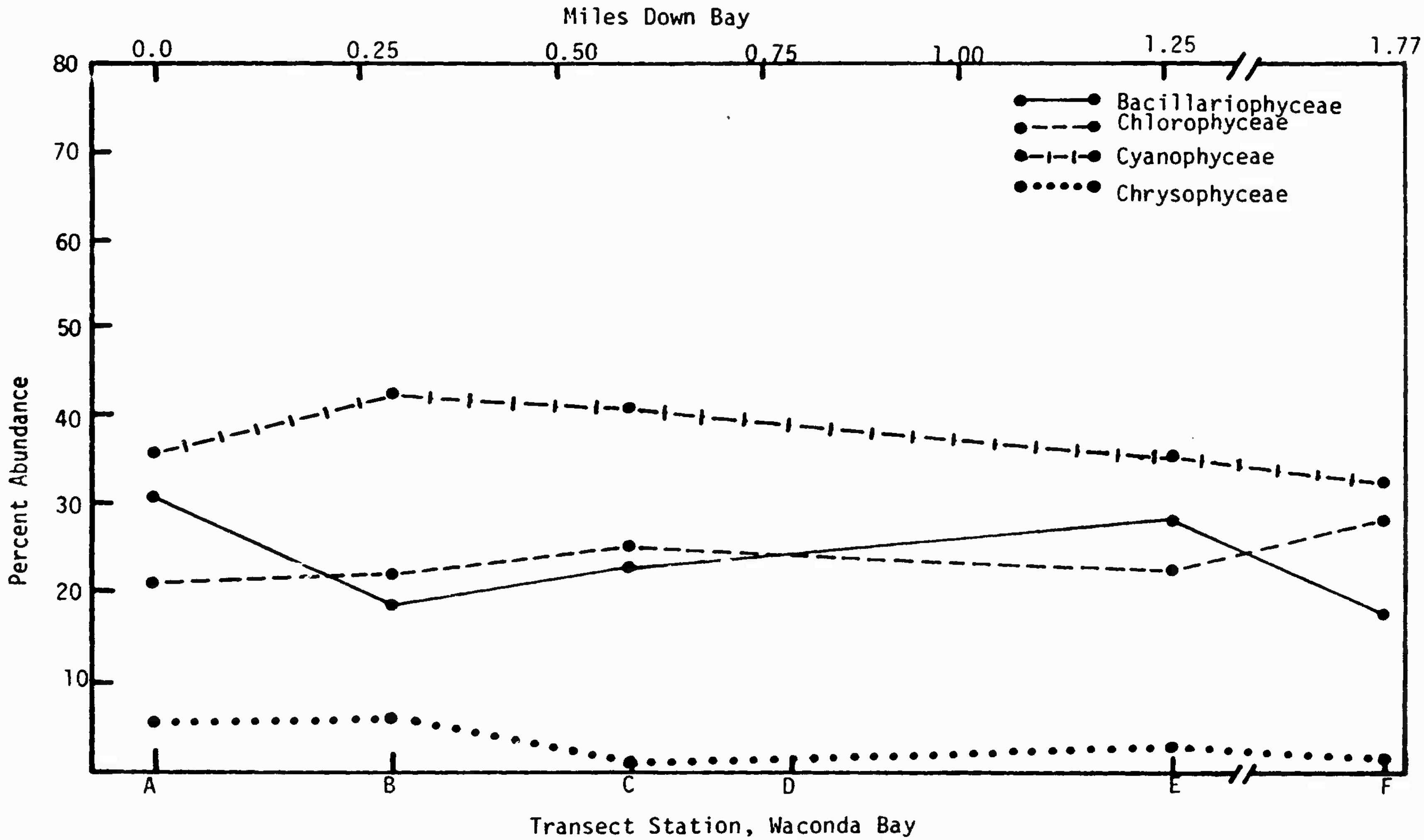

FIGURE 30. DISTRIBUTION OF MAJOR GROUPS OF PHYTOPLANKTON IN WACONDA BAY, AUGUST 11, 1975.

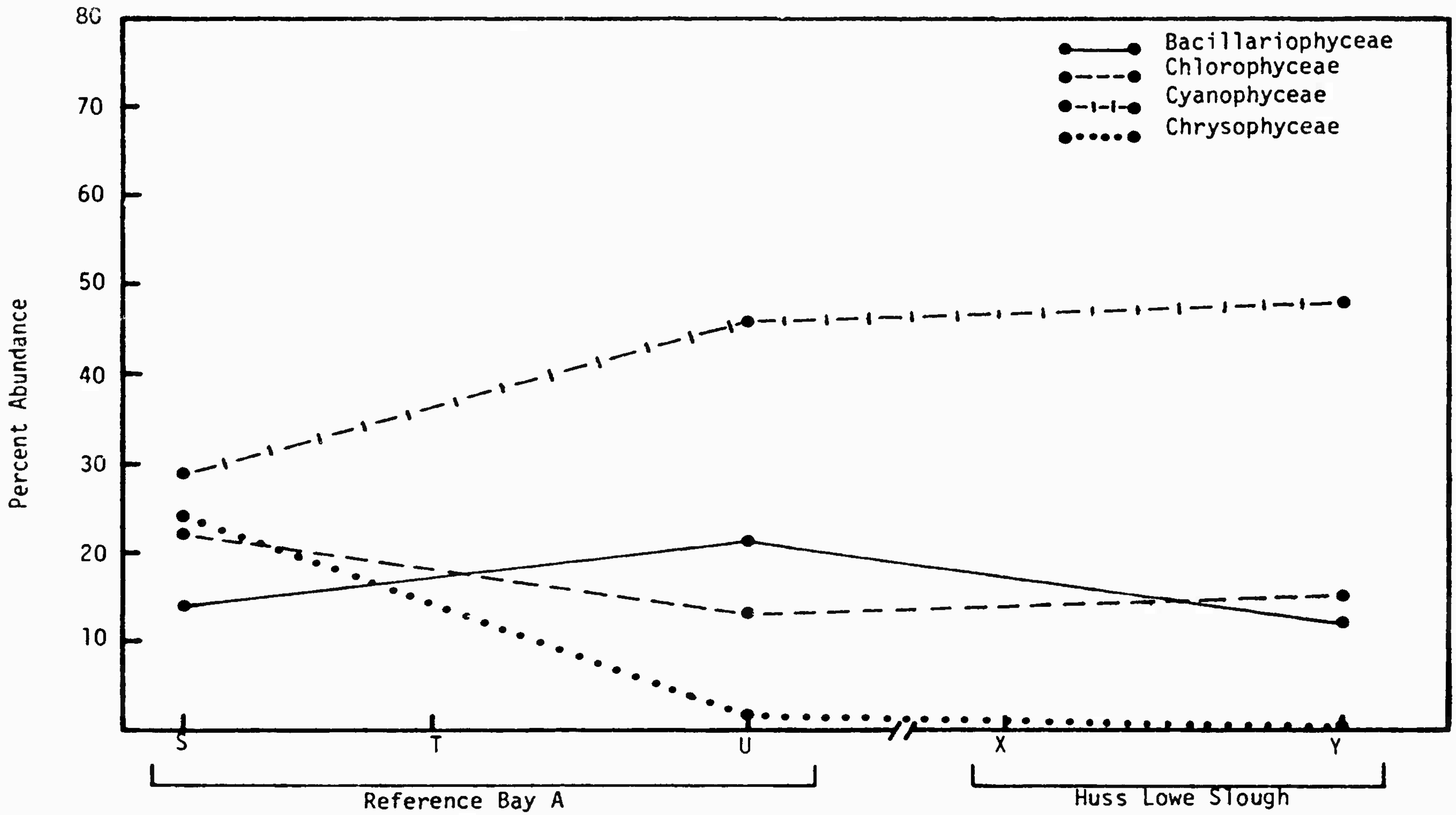

FIGURE 31. DISTRIBUTION OF MAJOR GROUPS OF PHYTOPLANKTON IN THE REFERENCE BAYS, AUGUST 11, 1975.

Bloom conditions (i.e. >500 cells/ml) were reported for the blue-green species, Spirulina laxissima and Gomphosphaeria lacustris at Stations A, B-1, C, and Y-1. Other important blue-green species were: Oscillatoria geminata (Schizothrix calcicola)* and Aphanocapsa delicatissima (Anacystis incerta). Prominent non-Cyanophytes were: the diatoms Melosira distans, M. ambigua, Chamydomonas sp. (Chlorophyceae), Rhodomonas sp. and Cryptomonas sp. (Cryptophyceae).

Phytoplankton populations (cells/ml) were generally higher during the second survey. Mean cell densities ranged from approximately 1300 to 2600 in June as compared to 2100 to 5400 in August. Analysis of variance on the June data showed no significant differences among station mean values at the 5 percent level ($F_{[19,38]} = 1.48$, $F_{0.05\ [19,38]} = 1.87$). However, the three highest cell densities were at Stations B-1, B-2 and C-1. Station A had a density slightly below the overall mean. The elevated populations at Stations B-1, B-2 and C-1 suggest possible biostimulation in the upper end of Waconda Bay. In August greater differences existed between stations. Analysis of variance indicated that significant differences did exist at the 1 percent level ($F_{[10,27]} = 4.62$, $F_{0.01\ [10,27]} = 3.06$). The three highest densities were found at Stations B-1, C-1, and A, respectively. If any plankton toxicity ever existed at Station A, it was not evident in August, some three months after plant shut-down. However, biostimulation in the upper end of Waconda Bay was indicated. This trend was also reflected in the other biological compartments examined.

The response is more subtle in the phytoplankton, and, in terms of the number of plankton species recorded per station, no significant trends were observed that could be attributable to munitions waste. Mean values for numbers of species/station ranged from 44 to 53 during the June survey and from 52 to 55 species/station for the August survey. The highest value recorded through the study was 71 species at Station B-1 (August 11, 1975); the lowest, 35 species at Station U-2 (June 9, 1975).

Phytoplankton populations were compared on a station-to-station basis by employing the Pearson-Pinkham Biotic Similarity Index (1974). Each phenogram illustrates the VAAP phytoplankton with stations clustered on the basis of species occurrence and abundance. In these analyses, it was considered unimportant if a particular species was mutually absent at two stations (i.e. mutual absence, unimportant).

With the exception of phytoplankton data collected on June 9, no significant trends were observed as a result of biotic similarity cluster analysis during June and August. The phenograms plotted in Appendix C depict impact stations readily clustering with control stations in both Reference Bay A and Huss Lowe Slough. On June 9, Stations A, B-1, and B-2 exhibited relatively low levels of biotic similarity to all other stations, and indicated a

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*Drouet (1968) classification.

possible impact. Using this technique of data analysis, the trend was not observed on the following day's analyses (June 10) -- nor during other sampling periods. Based on these results, it appears that the phytoplankton is a marginal biological compartment to discriminate waste impact in Waconda Bay from VAAP during plant operation. There is limited evidence, however, that limnoplankton may be useful to delineate areas of biostimulation associated with TNT decomposition in aquatic systems.

MACROINVERTEBRATES

Introduction

Aquatic macroinvertebrates are a diverse group of small aquatic animals too large to pass through a U. S. Standard No. 30 mesh screen. They are comprised of snails, clams, arthropods, annelids (segmented worms and leeches), planarians, and coelenterates. Of these, oligochaetes and chironomid (midge fly) larvae account for the majority of the organisms in this study.

Aquatic macroinvertebrates are a major biological component of aquatic systems and form an important part of the food chain. They feed on detritus and microscopic plants and animals. They are in turn eaten by small fish which support the larger recreationally and economically important species. They are of special importance in stream environments because of their role in recycling large amounts of organic detritus introduced from uplands.

Macroinvertebrate species composition (density, number of taxa, and diversity) is primarily dependent on three factors -- water quantity, water quality, and substrate composition.

Water quantity limits species within a site. For example, some organisms prefer large, deep lakes while others are found in smaller, shallower lakes.

Water quality is a significant factor in determining the assemblage of macroinvertebrates. Principal parameters include oxygen, temperature, hardness, and dissolved solids. The most important of these is oxygen. While many species require oxygen-saturated water in order to thrive, others can tolerate reduced oxygen tensions. Aquatic macroinvertebrates are also affected by temperature extremes. The Aquatic Life Advisory Committee (1956) indicates that benthic communities in temperature zones are adapted to seasonal fluctuations of temperature between 0 and 32°C (32 - 90°F).

Substrate is the most important determinant in species composition (Hynes, 1960). There is a direct relationship between amounts of available surface area and species abundance and diversity. That is to say, there are more hiding and foraging places in a rock or pebble bottom than in a sand or mud bottom. The amount of organic matter, particularly from plants, is also important. Aquatic plants increase the abundance and diversity of benthic organisms viz. there is more surface area, periphytic food organisms, food from the plants themselves, and detritus on which to feed. Beck (1954) states, "...after careful examination of many streams, diversity of fauna was primarily the result of one factor -- the diversity of habitat."

Aquatic macroinvertebrates were chosen as a parameter for this study because they are sensitive to environmental changes and thus are important indicators of water quality. Natural or man-induced fluctuations in the physical-chemical characteristics of a lentic system are reflected by shifts in benthic community structure. They are useful as an integrated monitor of the environment. They tend to remain at fixed locations and they have a relatively short life span -- usually a year or less -- therefore, reflecting both the present and recent past environmental conditions.

Methods

Aquatic macroinvertebrates were collected from natural and artificial substrates during June - September, 1975. Sampling information is tabulated in Appendix F. Natural substrates were sampled with a petite Ponar dredge. Hester-Dendy artificial substrates were suspended approximately 1.5 - 3.0 feet below the surface. Five replicates of the natural substrate and three Hester-Dendy units were collected to minimize natural variability. The number of replicates were determined utilizing the information presented in Appendix E.

In the field, dredge samples of the natural substrate were washed in a bucket sieve (U.S. Standard No. 30 mesh) and bottled. Rose Bengal dye was then added to facilitate laboratory sorting. Samples were preserved in 10 percent formalin. Natural substrate samples were rewashed in the laboratory and picked in a white enamel pan partially filled with water. After sorting, organisms were placed in vials containing 95 percent ethanol. Chironomid larvae were mounted in polyvinyl-lactophenol for microscopic identifications. Identifications were made to the lowest practical taxonomic level. Verification of chironomid identifications were made by Mr. W.C. Beck of Florida A & M University. Key taxonomic references used in this study were Edmondson (1959) and Pennak (1953).

The community structure indices computed for aquatic macroinvertebrates are the Shannon-Weaver Species Diversity Index and Pearson-Pinkham Index of Similarity.

Presentation of Data

Chironomid (midge fly) larvae and oligochaetes (sludgeworms) were the dominant groups in the Chickamauga Reservoir bays.

Midge larvae were more than 50 percent of the population during the survey. They colonized artificial substrates abundantly and accounted for nearly 80 percent of the total number of organisms (Tables 6 through 9).

Of the 54 taxa enumerated, 44 were associated with the surfaces of Hester-Dendy plates. This suggests that chironomids preferentially colonize artificial substrates of this type to graze on periphyton. Lake sediments generally were composed of clay, silt, and detritus, which are also conducive to chironomid colonization. Lower population and taxa (37) in the latter environment probably reflects periphyton enrichment on artificial substrates.

In contrast to the chironomid distribution, oligochaetes reached higher populations in sediments. This is to be expected since these organisms burrow into the substrate and recycle organic materials. This kind of habitat is not available on artificial substrates as used in this study.

Both of these groups exhibit similarities in their response to environmental conditions. The chironomids, which dominate, are adaptable to changes in pH, oxygen concentrations, and turbidity. They prefer moderate-to-high nutrient concentrations and will tolerate some organic enrichment.

TABLE 6

VAAP MACROBENTHOS ARTIFICIAL SUBSTRATE, JUNE, 1975, POPULATION SIZE EXPRESSED PER M^2 BASED ON POOLED REPLICATES

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATIONS							
	A	B1	C1	D1	DP	E1	F	T1
MACROBENTHOS								
OLIGOCHAETA	-	337	-	889	1136	177	877	955
PHYLUM ARTHROPODA - CLASS INSECTA								
ORDER EPHEMEROPTERA								
CAENIS SP	-	10	133	13	-	11	-	-
[illegible] SP	-	-	[illegible]	[illegible]	-	[illegible]	-	-
STENONEMA SP	-	-	44	-	-	-	10	-
ORDER ODONATA								
[illegible] SP	-	-	44	13	-	-	-	-
ORDER PLECOPTERA								
UNIDENTIFIABLE PLECOPTERA	-	10	-	-	-	-	-	-
ORDER TRICHOPTERA								
[illegible] SP	10	-	-	[illegible]	-	-	-	-
[illegible]	[illegible]	-	-	[illegible]	33	293	144	810
[illegible] SP	-	-	-	-	5	-	-	-
[illegible]	-	-	-	44	-	90	77	-
ORDER COLEOPTERA								
[illegible] SP	-	-	-	-	-	-	10	-
UNIDENTIFIABLE COLEOPTERA	-	-	-	-	-	-	-	-
ORDER DIPTERA - FAMILY CHIRONOMIDAE								
[illegible]	-	100	33	-	-	-	[illegible]	[illegible]
[illegible]	-	-	133	813	5	11	18	[illegible]
[illegible]	-	-	-	-	-	-	-	-
[illegible] SP	-	-	-	-	-	-	-	-
[illegible] SP	-	33	-	-	-	-	-	-
[illegible]	-	33	-	81	-	44	-	-
[illegible] SP A	-	55	-	13	-	-	-	-
[illegible]	-	-	-	-	-	-	-	-
[illegible] SP A	-	-	-	-	-	-	-	-
DICROTENDIPES [illegible]	11	700	299	967	95	400	878	813
DICROTENDIPES [illegible]	-	-	-	31	5	-	-	-
DICROTENDIPES [illegible]	-	97	77	39	-	-	18	-
DICROTENDIPES NERVOSUS	-	537	310	1088	162	413	906	317
DICROTENDIPES SP A	-	-	-	-	-	-	-	-
GLYPTOTENDIPES SP	-	8865	12490	9009	15	1179	4051	809
[illegible]	-	92	-	-	-	130	10	60
[illegible]	-	14	-	13	5	34	-	-
[illegible]	-	-	-	118	70	670	40	27
[illegible]	-	-	-	-	-	-	-	-
[illegible] SP	22	-	-	-	-	-	18	-
[illegible] SP A	-	-	-	13	-	-	-	-
[illegible] SP	-	73	-	28	-	-	-	-
[illegible] SP	-	-	-	88	-	77	-	-
[illegible] SP	-	-	77	-	-	-	-	11
[illegible] SP	-	37	44	44	-	187	-	-
[illegible] SP	-	-	-	-	-	63	-	-
[illegible] SP A	-	54	-	70	-	84	-	10
[illegible] SP A	-	-	-	-	-	-	-	-
[illegible] SP B	-	-	-	74	-	-	-	-
[illegible] SP D	-	-	-	-	-	11	-	23
[illegible] SP E	-	-	-	-	-	-	-	-
[illegible] UNIDENTIFIABLE	11	124	-	-	-	11	-	11
ORDER DIPTERA - OTHER								
[illegible] UNIDENTIFIABLE	11	-	-	-	-	-	-	-
PHYLUM MOLLUSCA								
CLASS GASTROPODA								
GASTROPODA UNIDENTIFIABLE	11	-	44	-	-	-	-	-
CLASS PELECYPODA								
[illegible] SP	-	-	77	-	-	-	-	-
PHYLUM TURBELLARIA								
TURBELLARIA SP A	-	-	-	-	-	-	877	-
UNSPECIFIED IN [illegible]								
UNSPECIFIED TAXA	-	-	-	-	-	-	-	-
UNSPECIFIED TAXA	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	100	16059	14006	8737	1801	3700	8390	8730
NUMBER OF TAXA	6	17	10	23	10	19	15	13

TABLE 6 (CONTINUED)

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATIONS VI	XI	VI						
MACROBENTHOS									
OLIGOCHAETA	53	135	190	-----	-----	-----	-----	-----	-----
PHYLUM ARTHROPODA - CLASS INSECTA									
ORDER EPHEMEROPTERA									
CAENIS SP	6	9	87	-----	-----	-----	-----	-----	-----
[illegible] SP	-	-	-	-----	-----	-----	-----	-----	-----
STENONEMA SP	-	-	-	-----	-----	-----	-----	-----	-----
ORDER ODONATA									
NEHALENNIA SP	-	[illegible]	-	-----	-----	-----	-----	-----	-----
ORDER PLECOPTERA									
UNIDENTIFIABLE PLECOPTERA	-	-	-	-----	-----	-----	-----	-----	-----
ORDER TRICHOPTERA									
AGRAYLEA SP	-	-	-	-----	-----	-----	-----	-----	-----
[illegible] CARDINALIS	[illegible]	[illegible]	[illegible]	-----	-----	-----	-----	-----	-----
LEPTOCELLA SP	-	[illegible]	-	-----	-----	-----	-----	-----	-----
OECETIS	-	-	-	-----	-----	-----	-----	-----	-----
ORDER COLEOPTERA									
DINEUTUS SP	-	[illegible]	-	-----	-----	-----	-----	-----	-----
UNIDENTIFIABLE COLEOPTERA	-	[illegible]	-	-----	-----	-----	-----	-----	-----
ORDER DIPTERA - FAMILY CHIRONOMIDAE									
ABLABESMYIA MALLOCHI	[illegible]	-	[illegible]	-----	-----	-----	-----	-----	-----
ABLABESMYIA [illegible]	[illegible]	[illegible]	[illegible]	-----	-----	-----	-----	-----	-----
ABLABESMYIA [illegible]	[illegible]	-	-	-----	-----	-----	-----	-----	-----
CLADOTANYTARSUS SP	-	[illegible]	-	-----	-----	-----	-----	-----	-----
[illegible] SP	-	[illegible]	-	-----	-----	-----	-----	-----	-----
CRICOTOPUS [illegible]	[illegible]	-	[illegible]	-----	-----	-----	-----	-----	-----
CRICOTOPUS SP A	-	[illegible]	-	-----	-----	-----	-----	-----	-----
CRYPTOCHIRONOMUS FULVUS	-	[illegible]	-	-----	-----	-----	-----	-----	-----
CRYPTOCHIRONOMUS SP A	-	[illegible]	-	-----	-----	-----	-----	-----	-----
DICROTENDIPES LEUCOSCELIS	75	81	193	-----	-----	-----	-----	-----	-----
DICROTENDIPES MODESTUS	-	-	-	-----	-----	-----	-----	-----	-----
DICROTENDIPES NEOMODESTUS	78	-	13	-----	-----	-----	-----	-----	-----
DICROTENDIPES NERVOSUS	178	17	176	-----	-----	-----	-----	-----	-----
DICROTENDIPES SP A	-	-	-	-----	-----	-----	-----	-----	-----
GLYPTOTENDIPES SP	[illegible]	[illegible]	[illegible]	-----	-----	-----	-----	-----	-----
PARACHIRONOMUS CARINATUS	-	12	[illegible]	-----	-----	-----	-----	-----	-----
PARACHIRONOMUS MONOCHROMUS	-	-	13	-----	-----	-----	-----	-----	-----
PARACHIRONOMUS PECTINATELLAE	-	-	-	-----	-----	-----	-----	-----	-----
PARALAUTERBORNIELLA NIGROHALTERALE	-	17	-	-----	-----	-----	-----	-----	-----
PROCLADIUS SP	-	-	-	-----	-----	-----	-----	-----	-----
PSECTROCLADIUS SP A	-	-	-	-----	-----	-----	-----	-----	-----
PSECTROCLADIUS SP	[illegible]	-	-	-----	-----	-----	-----	-----	-----
PSEUDOCHIRONOMUS SP	[illegible]	[illegible]	[illegible]	-----	-----	-----	-----	-----	-----
PENTANEURA? SP	[illegible]	-	-	-----	-----	-----	-----	-----	-----
TANYTARSUS SP	[illegible]	34	[illegible]	-----	-----	-----	-----	-----	-----
THIENEMANNIELLA SP	[illegible]	[illegible]	-	-----	-----	-----	-----	-----	-----
TRIBELOS SP 1	[illegible]	[illegible]	-	-----	-----	-----	-----	-----	-----
CHIRONOMID SP A	-	[illegible]	[illegible]	-----	-----	-----	-----	-----	-----
CHIRONOMID SP [illegible]	[illegible]	-	-	-----	-----	-----	-----	-----	-----
CHIRONOMID SP [illegible]	[illegible]	-	13	-----	-----	-----	-----	-----	-----
CHIRONOMID SP F	[illegible]	-	-	-----	-----	-----	-----	-----	-----
CHIRONOMIDAE UNIDENTIFIABLE	[illegible]	[illegible]	-	-----	-----	-----	-----	-----	-----
ORDER DIPTERA - OTHER									
CULICIDAE UNIDENTIFIABLE	-	-	-	-----	-----	-----	-----	-----	-----
PHYLUM MOLLUSCA									
CLASS GASTROPODA									
GASTROPODA UNIDENTIFIABLE	-	-	-	-----	-----	-----	-----	-----	-----
CLASS PELECYPODA									
SPHAERIUM SP	-	-	-	-----	-----	-----	-----	-----	-----
PHYLUM [illegible]									
[illegible] SP A	-	-	-	-----	-----	-----	-----	-----	-----
UNSPECIFIED IN MASTER FILE									
UNSPECIFIED TAXON	-	[illegible]	-	-----	-----	-----	-----	-----	-----
UNSPECIFIED TAXON	-	[illegible]	-	-----	-----	-----	-----	-----	-----
TOTAL NUMBER OF ORGANISMS	[illegible]	[illegible]	[illegible]	------	------	------	------	------	------
NUMBER OF TAXA	[illegible]	[illegible]	19	-----	-----	-----	-----	-----	-----

TABLE 7
VAAP MACROBENTHOS NATURAL SUBSTRATE, JUNE, 1975
POPULATION SIZE EXPRESSED PER M^2 BASED ON POOLED REPLICATES

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATIONS							
	A	B1	B2	C1	C2	D1	[illegible]	E1
MACROBENTHOS								
OLIGOCHAETA	47	25	-	100	[illegible]	[illegible]	[illegible]	[illegible]
PHYLUM ARTHROPODA - CLASS INSECTA								
ORDER EPHEMEROPTERA								
BRACHYCERCUS SP	-	-	-	-	-	-	-	8
CAENIS SP	-	8	-	-	-	-	-	25
HEXAGENIA SP	-	16	-	76	270	987	-	-
ORDER TRICOPTERA								
AGRAYLEA SP	-	-	-	-	-	-	-	-
LEPTOCELLA SP	-	-	-	8	-	-	-	8
OECETIS	-	-	-	-	16	8	-	-
ORDER DIPTERA - FAMILY CHIRONOMIDAE								
ABLABESMYIA ANNULATA	-	-	-	34	-	8	-	-
ABLABESMYIA CINCTIPES	-	-	-	-	-	-	-	-
ABLABESMYIA MALLOCHI	-	8	-	-	-	-	-	-
CHIRONOMUS ATTENUATUS	-	-	16	-	-	-	-	-
CLADOTANYTARSUS SP	-	84	-	-	-	292	-	-
COELOTANYPUS CONCINNUS	-	-	-	26	-	-	16	-
COELOTANYPUS TRICOLOR	-	-	-	8	16	-	-	-
CONCHAPELOPIA SP	-	-	-	-	-	-	-	-
CRICOTOPUS BICINCTUS	-	-	-	-	-	-	-	-
CRICOTOPUS SP 5	16	-	-	-	-	-	-	-
CRYPTOCHIRONOMUS BLARINA	-	87	-	25	16	55	-	-
CRYPTOCHIRONOMUS FULVUS	-	16	-	41	65	8	-	16
CRYPTOCHIRONOMUS SP A	-	-	-	-	-	-	-	-
CRYPTOTENDIPES SP	-	-	-	-	-	-	-	-
DICROTENDIPES LEUCOSCELIS	-	-	-	-	-	8	-	-
DICROTENDIPES MODESTUS	-	-	-	-	-	-	-	-
DICROTENDIPES NEOMODESTUS	-	26	-	-	-	-	-	-
DICROTENDIPES SP A	-	-	-	-	26	-	-	-
EPOICOCLADIUS SP	-	-	-	-	-	-	-	-
GLYPTOTENDIPES SP	-	-	-	-	-	-	-	8
HARNISCHIA SP	-	-	-	-	-	-	-	-
MACROPELOPIA SP	-	-	-	-	-	-	-	-
NANOCLADIUS SP	-	-	-	-	-	-	-	8
PAGASTIELLA SP (TENT.)	-	-	-	-	-	8	-	-
PARACHIRONOMUS ALATUS	-	-	-	-	26	8	-	-
PARACLADOPELMA SP	-	8	-	-	47	31	-	26
PARALAUTERBORNIELLA NIGROHALTERALE	-	-	-	-	-	25	-	-
PARATENDIPES CONNECTENS	-	-	-	-	-	-	-	-
POLYPEDILUM HALTERALE	-	16	-	-	-	-	-	-
PROCLADIUS SP	17	8	-	55	16	8	-	-
PSECTROCLADIUS SP	-	8	-	-	-	-	-	-
PSEUDOCHIRONOMUS SP	-	43	-	-	-	49	-	-
RHEOTANYTARSUS SP	-	-	-	-	-	-	-	-
SMITTIA SP	-	8	-	-	-	-	-	-
STEMPELLINA SP	-	-	-	-	-	-	-	-
TANYPUS SP	8	-	-	-	-	-	-	-
TANYTARSUS SP	-	102	-	16	142	105	-	94
THIENEMANNIELLA SP	-	-	-	-	-	-	-	-
XENOCHIRONOMUS SP	-	-	-	-	-	-	-	-
CHIRONOMID SP A	-	-	-	-	-	-	-	-
CHIRONOMID SP B	-	-	-	-	-	-	-	-
CHIRONOMIDAE UNIDENTIFIABLE	-	8	-	-	-	8	-	-
ORDER DIPTERA - OTHER								
CHAOBORUS SP	110	-	120	-	-	-	101	8
CERATOPOGONIDAE UNIDENTIFIABLE	-	-	-	-	26	25	-	-
CULICIDAE UNIDENTIFIABLE	-	-	-	-	-	-	8	-
PHYLUM COELENTERATA								
HYDRA SP	-	-	-	-	-	-	-	-
PHYLUM MOLLUSCA								
CLASS GASTROPODA								
VIVIPARUS SP	-	-	-	-	-	-	-	-
CLASS PELECYPODA								
CORBICULA MANILENSIS	-	-	-	-	-	16	-	42
SPHAERIUM SP	-	-	-	108	802	292	8	86
PELECYPODA UNIDENTIFIABLE	-	-	-	-	-	-	-	-
PHYLUM NEMATODA								
NEMATODA	-	16	-	17	56	61	-	-
PHYLUM TURBELLARIA								
TURBELLARIA SP A	-	-	-	-	-	-	-	17
TURBELLARIA SP B	-	-	-	-	-	-	-	8
TURBELLARIA SP C	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NUMBER OF TAXA	[illegible]	[illegible]	2	12	16	[illegible]	2	16

TABLE 7 (CONTINUED).

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATION: S2	F1	F8	S	Y1	F2	U1	U8
MACROBENTHOS								
OLIGOCHAETA	[illegible]	150	[illegible]	171	8	[illegible]	1150	118
PHYLUM ARTHROPODA - CLASS INSECTA								
ORDER EPHEMEROPTERA								
BRACHYCERCUS SP	-	-	-	-	-	-	-	-
CAENIS SP	-	8	20	-	-	-	420	84
HEXAGENIA SP	-	403	-	8	33	-	-	-
ORDER TRICOPTERA								
AGRAYLEA SP	-	-	-	-	-	-	8	-
LEPTOCELLA SP	-	-	-	-	-	-	-	-
OECETIS	-	-	-	-	-	-	8	8
ORDER DIPTERA - FAMILY CHIRONOMIDAE								
ABLABESMYIA ANNULATA	-	-	-	-	-	-	-	-
ABLABESMYIA CINCTIPES	-	267	-	-	8	-	-	-
ABLABESMYIA MALLOCHI	-	-	-	-	-	-	-	-
CHIRONOMUS ATTENUATUS	10	20	-	-	-	-	8	11
CLADOTANYTARSUS SP	659	-	373	-	-	415	291	884
COELOTANYPUS CONCINNUS	-	41	-	-	-	-	-	-
COELOTANYPUS TRICOLOR	-	8	-	-	-	-	-	-
CONCHAPELOPIA SP	-	-	-	17	-	-	-	-
CRICOTOPUS BICINCTUS	100	-	-	-	-	-	-	-
CRICOTOPUS SP A	-	-	-	-	-	-	-	-
CRYPTOCHIRONOMUS BLARINA	10	-	-	-	-	42	8	76
CRYPTOCHIRONOMUS FULVUS	42	-	64	-	-	20	33	8
CRYPTOCHIRONOMUS SP A	-	-	-	-	-	10	-	16
CRYPTOTENDIPES SP	-	-	-	-	-	-	8	-
DICROTENDIPES LUCOSCELIS	-	-	76	-	-	-	25	-
DICROTENDIPES MODESTUS	-	-	-	-	-	-	-	-
DICROTENDIPES NEOMODESTUS	-	-	57	-	-	-	59	8
DICROTENDIPES SP A	-	-	-	-	-	-	-	-
EPOICLADIUS SP	-	-	-	-	-	-	-	-
GLYPTOTENDIPES SP	-	-	-	-	-	10	-	-
HARNISCHIA SP	-	-	-	-	-	-	-	-
MACROPELOPIA SP	-	8	-	-	-	-	-	-
NANOCLADIUS SP	-	-	-	-	-	-	-	-
PAGASTIELLA SP [illegible]	-	-	-	-	-	-	-	-
PARACHIRONOMUS [illegible]	-	-	-	-	-	-	-	-
PARACLADOPELMA SP	-	-	-	-	-	42	42	25
PARALAUTERBORNIELLA NIGROHALTERALIS	-	-	-	-	-	-	-	5
PARATENDIPES CONNECTENS	-	-	-	-	-	-	-	-
POLYPEDILUM HALTERALE	29	-	10	-	-	-	8	-
PROCLADIUS SP	-	8	-	8	-	-	-	-
PSECTROCLADIUS SP	-	-	-	-	-	-	-	-
PSEUDOCHIRONOMUS SP	57	-	63	-	-	10	65	42
RHEOTANYTARSUS SP	-	-	-	-	-	-	-	8
SMITTIA SP	-	-	-	-	-	-	-	-
STEMPELLINA SP	-	-	-	-	-	-	-	-
TANYPUS SP	-	-	-	-	-	-	-	-
TANYTARSUS SP	315	-	42	-	-	100	142	170
THIENEMANNIELLA SP	-	-	10	-	-	-	-	-
XENOCHIRONOMUS SP	-	-	-	-	-	-	-	-
CHIRONOMID SP A	-	-	-	-	-	-	-	-
CHIRONOMID SP B	-	-	-	-	-	-	-	-
CHIRONOMIDAE UNIDENTIFIABLE	-	-	-	-	8	-	8	8
ORDER DIPTERA - OTHER								
CHAOBORUS SP	-	25	-	-	8	-	8	-
CERATOPOGONIDAE UNIDENTIFIABLE	-	-	-	-	-	-	-	8
CULICIDAE UNIDENTIFIABLE	-	-	-	-	-	-	-	-
PHYLUM COELENTERATA								
HYDRA SP	-	-	-	-	-	-	10	-
PHYLUM MOLLUSCA								
CLASS GASTROPODA								
VIVIPARUS SP	10	-	-	-	-	-	-	-
CLASS PELECYPODA								
CORBICULA MANILENSIS								10
SPHAERIUM SP	42	260	10	17	-		10	8
PELECYPODA UNIDENTIFIABLE	-	17			-		-	
PHYLUM NEMATODA								
NEMATODA	100		168			71	46	42
PHYLUM PLATYHELMINTHES								
TURBELLARIA SP A								
TURBELLARIA SP B			-		-		-	
TURBELLARIA SP C			-	10	-		-	
[illegible]								
UNSPECIFIED TAXON		17						
TOTAL NUMBER OF ORGANISMS	[illegible]	1250	[illegible]	[illegible]	[illegible]	1677	2864	[illegible]
NUMBER OF TAXA	12	14	12	5	4	6	20	18

TABLE 7 (CONTINUED).

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATION: 41	42	51	*****	*****	*****	*****	*****
MACROBENTHOS								
OLIGOCHAETA	590	220	810	*****	*****	*****	*****	*****
PHYLUM ARTHROPODA - CLASS INSECTA								
ORDER EPHEMEROPTERA								
BRACHYCERCUS SP	50	10	-	*****	*****	*****	*****	*****
CAENIS SP	16	40	16	*****	*****	*****	*****	*****
HEXAGENIA SP	704	157	-	*****	*****	*****	*****	*****
ORDER TRICOPTERA								
AGRAYLEA SP	-	-	-	*****	*****	*****	*****	*****
LEPTOCELLA SP	-	-	16	*****	*****	*****	*****	*****
OECETIS	-	-	8	*****	*****	*****	*****	*****
ORDER DIPTERA - FAMILY CHIRONOMIDAE								
ABLABESMYIA ANNULATA	25	-	-	*****	*****	*****	*****	*****
ABLABESMYIA CINCTIPES	33	63	-	*****	*****	*****	*****	*****
ABLABESMYIA MALLOCHI	-	-	37	*****	*****	*****	*****	*****
CHIRONOMUS ATTENUATUS	-	-	8	*****	*****	*****	*****	*****
CLADOTANYTARSUS SP	100	143	95	*****	*****	*****	*****	*****
COELOTANYPUS CONCINNUS	-	-	-	*****	*****	*****	*****	*****
COELOTANYPUS TRICOLOR	-	-	-	*****	*****	*****	*****	*****
CONCHAPELOPIA SP	-	-	-	*****	*****	*****	*****	*****
CRICOTOPUS BICINCTUS	-	-	-	*****	*****	*****	*****	*****
CRICOTOPUS SP A	-	-	-	*****	*****	*****	*****	*****
CRYPTOCHIRONOMUS BLARINA	33	67	111	*****	*****	*****	*****	*****
CRYPTOCHIRONOMUS FULVUS	70	67	55	*****	*****	*****	*****	*****
CRYPTOCHIRONOMUS SP A	25	-	-	*****	*****	*****	*****	*****
CRYPTOTENDIPES SP	-	-	-	*****	*****	*****	*****	*****
DICROTENDIPES LEUCOSCELIS	15	16	-	*****	*****	*****	*****	*****
DICROTENDIPES MODESTUS	-	-	5	*****	*****	*****	*****	*****
DICROTENDIPES NEOMODESTUS	60	-	25	*****	*****	*****	*****	*****
DICROTENDIPES SP A	-	-	-	*****	*****	*****	*****	*****
EPOICOCLADIUS SP	8	-	-	*****	*****	*****	*****	*****
GLYPTOTENDIPES SP	-	-	-	*****	*****	*****	*****	*****
HARNISCHIA SP	8	-	-	*****	*****	*****	*****	*****
MACROPELOPIA SP	-	-	-	*****	*****	*****	*****	*****
NANOCLADIUS SP	-	-	-	*****	*****	*****	*****	*****
[illegible]TIELLA SP (TENT.)	-	-	-	*****	*****	*****	*****	*****
PARACHIRONOMUS ALATUS	15	-	-	*****	*****	*****	*****	*****
PARACLADOPELMA SP	8	16	16	*****	*****	*****	*****	*****
PARALAUTERBORNIELLA NIGROHALTERALE	-	16	8	*****	*****	*****	*****	*****
PARATENDIPES CONNECTENS	-	20	-	*****	*****	*****	*****	*****
POLYPEDILUM HALTERALE	8	21	33	*****	*****	*****	*****	*****
PROCLADIUS SP	8	-	-	*****	*****	*****	*****	*****
PSECTROCLADIUS SP	-	-	-	*****	*****	*****	*****	*****
PSEUDOCHIRONOMUS SP	17	-	272	*****	*****	*****	*****	*****
RHEOTANYTARSUS SP	-	-	-	*****	*****	*****	*****	*****
SMITTIA SP	-	-	-	*****	*****	*****	*****	*****
STEMPELLINA SP	8	-	-	*****	*****	*****	*****	*****
TANYPUS SP	-	-	-	*****	*****	*****	*****	*****
TANYTARSUS SP	105	160	409	*****	*****	*****	*****	*****
THIENEMANNIELLA SP	-	-	-	*****	*****	*****	*****	*****
XENOCHIRONOMUS SP	-	-	8	*****	*****	*****	*****	*****
CHIRONOMID SP A	5	70	5	*****	*****	*****	*****	*****
CHIRONOMID SP B	5	-	-	*****	*****	*****	*****	*****
CHIRONOMIDAE UNIDENTIFIABLE	16	-	11	*****	*****	*****	*****	*****
ORDER DIPTERA - OTHER								
CHAOBORUS SP	-	-	-	*****	*****	*****	*****	*****
CERATOPOGONIDAE UNIDENTIFIABLE	60	42	46	*****	*****	*****	*****	*****
CULICIDAE UNIDENTIFIABLE	-	-	-	*****	*****	*****	*****	*****
PHYLUM COELENTERATA								
HYDRA SP	-	-	-	*****	*****	*****	*****	*****
PHYLUM MOLLUSCA								
CLASS GASTROPODA								
VIVIPARUS SP	-	-	-	*****	*****	*****	*****	*****
CLASS PELECYPODA								
CORBICULA MANILENSIS	-	20	-	*****	*****	*****	*****	*****
SPHAERIUM SP	440	41	-	*****	*****	*****	*****	*****
PELECYPODA UNIDENTIFIABLE	-	-	-	*****	*****	*****	*****	*****
PHYLUM NEMATODA								
NEMATODA	40	70	42	*****	*****	*****	*****	*****
PHYLUM TURBELLARIA								
TURBELLARIA SP A	-	-	-	*****	*****	*****	*****	*****
TURBELLARIA SP B	-	-	5	*****	*****	*****	*****	*****
TURBELLARIA SP C	-	-	-	*****	*****	*****	*****	*****
TOTAL NUMBER OF ORGANISMS	[illegible]	[illegible]	[illegible]	******	******	******	******	******
NUMBER OF TAXA	[illegible]	18	22	*****	*****	*****	*****	*****

TABLE 8

TAXONOMIC LIST OF VAAP MACROINVERTEBRATES:
ARTIFICIAL SUBSTRATE, AUGUST 1975
POPULATION SIZE EXPRESSED PER M^2 BASED ON POOLED REPLICATES

PHYLUM ANNELIDA	A	B1	C1	D2	E1	F1	S	T1
OLIGOCHAETA	-	-	-	-	-	-	221	-
PHYLUM ARTHROPODA - CLASS INSECTA								
ORDER EPHEMEROPTERA								
BAETUS SP	-	-	-	-	-	-	-	-
CAENIS SP	-	1281	-	-	-	-	-	-
OXYETHIRA SP	-	137	-	-	-	-	-	-
STENONEMA SP	-	-	23	-	11	122	-	-
ORDER ODONATA								
NEHALENNIA SP	11	34	11	-	-	-	-	-
ORDER TRICOPTERA								
CYRNELLUS MARGINALIS	56	114	1186	710	519	190	218	591
ORDER COLEOPTERA								
DINEUTUS SP	-	-	-	-	-	-	-	-
ORDER DIPTERA - FAMILY CHIRONOMIDAE								
ABLABESMYIA AMERICANA	11	-	-	-	-	-	-	-
ABLABESMYIA ANNULATA	-	-	-	-	-	-	-	-
ABLABESMYIA MALLOCHI	34	22	-	-	-	-	-	-
ABLABESMYIA PARAJANTA	34	22	687	44	222	80	136	329
CHIRONOMUS ATTENUATUS	11	11	-	-	-	-	-	-
COELOTANYPUS CONCINNUS	-	-	-	-	-	-	26	-
CRICOTOPUS SP A	-	-	45	-	-	-	-	45
CRYPTOCHIRONOMUS FULVUS	-	-	-	-	-	-	13	-
CRYPTOCHIRONOMUS SP A	-	-	11	-	11	-	-	-
DICROTENDIPES LEUCOSCELIS	150	126	234	90	103	13	26	186
DICROTENDIPES NEOMODESTUS	-	94	-	-	127	27	-	34
DICROTENDIPES NERVOSUS	-	93	437	281	79	66	13	210
DICROTENDIPES SP A	-	-	-	-	-	13	-	-
GLYPTOTENDIPES SP	11	6421	580	-	162	136	275	92
GOELDICHIRONOMUS HOLOPRASINUS	11	-	-	-	-	-	-	-
PARACHIRONOMUS CARINATUS	-	23	-	-	-	-	-	-
PARACHIRONOMUS MONOCHROMUS	-	-	-	-	-	-	-	-
PARACHIRONOMUS PECTINATELLAE	-	-	-	11	-	13	-	-
PARALAUTERBORNIELLA NIGROHALTERALE	-	-	-	-	-	-	40	-
POLYPEDILUM FALLAX	11	-	-	-	-	13	-	58
PSECTROCLADIUS SP	11	-	-	-	-	13	-	11
PSEUDOCHIRONOMUS SP	-	-	80	-	-	40	-	11
RHEOTANYTARSUS SP	-	-	-	-	-	13	-	-
TANYTARSUS SP	-	-	11	-	-	233	26	-
THIENEMANNIELLA SP	-	-	-	-	-	-	-	-
TRIBELOS SP A	-	-	45	68	81	13	53	22
CHIRONOMID SP A	-	-	-	-	-	-	13	-
CHIRONOMIDAE UNIDENTIFIABLE	-	-	11	-	-	13	-	11
ORDER DIPTERA - OTHER								
CERATOPOGONIDAE UNIDENTIFIABLE	-	-	-	-	-	-	13	-

TABLE 8 (CONTINUED)

	A	B1	C1	D2	E1	F1	5	T1
PHYLUM MOLLUSCA								
CLASS GASTROPODA								
PHYSA SP	46	-	-	-	-	-	-	-
CLASS PELECYPODA								
SPHAERIUM SP	-	-	-	-	-	40	13	-
PHYLUM NEMATODA								
NEMATODA	11	366	-	-	-	-	-	-
PHYLUM TURBELLARIA								
TURBELLARIA SP B	-	-	-	-	-	13	-	-
TOTAL NUMBER OF ORGANISMS	408	8744	3361	1204	1315	1051	1086	1600
NUMBER OF TAXA	13	13	13	6	9	18	14	12

TABLE 8 (CONTINUED)

PHYLUM ANNELIDA	U1	X1	Y1
OLIGOCHAETA	-	104	34
PHYLUM ARTHROPODA - CLASS INSECTA			
ORDER EPHEMEROPTERA			
BAETUS SP	925	-	197
CAENIS SP	-	-	-
OXYETHIRA SP	174	-	-
STENONEMA SP	11	-	-
ORDER ODONATA			
NEHALENNIA SP	11	-	-
ORDER TRICOPTERA			
CYRNELLUS MARGINALIS	45	425	102
ORDER COLEOPTERA			
DINEUTUS SP	-	11	-
ORDER DIPTERA - FAMILY CHIRONOMIDAE			
ABLABESMYIA AMERICANA	-	-	-
ABLABESMYIA ANNULATA	11	11	-
ABLABESMYIA MALLOCHI	-	11	-
ABLABESMYIA PARAJANTA	116	269	22
CHIRONOMUS ATTENUATUS	-	-	-
COELOTANYPUS CONCINNUS	-	-	-
CRICOTOPUS SP A	-	-	-
CRYPTOCHIRONOMUS FULVUS	11	11	11
CRYPTOCHIRONOMUS SP A	-	-	11
DICROTENDIPES LEUCOSCELIS	55	23	56
DICROTENDIPES NEOMODESTUS	-	-	-
DICROTENDIPES NERVOSUS	128	46	81
DICROTENDIPES SP A	-	-	-
GLYPTOTENDIPES SP	484	1185	389
GOELDICHIRONOMUS HOLOPRASINUS	-	-	-
PARACHIRONOMUS CARINATUS	22	-	114
PARACHIRONOMUS MONOCHROMUS	-	-	22
PARACHIRONOMUS PECTINATELLAE	-	-	-
PARALAUTERBORNIELLA NIGROHALTERALE	-	-	-
POLYPEDILUM FALLAX	-	-	-
PSECTROCLADIUS SP	11	-	-
PSEUDOCHIRONOMUS SP	23	567	-
RHEOTANYTARSUS SP	11	11	-
TANYTARSUS SP	-	-	-
THIENEMANNIELLA SP	-	11	-
TRIBELOS SP A	-	213	-
CHIRONOMID SP A	-	-	-
CHIRONOMIDAE UNIDENTIFIABLE	11	-	-
ORDER DIPTERA - OTHER			
CERATOPOGONIDAE UNIDENTIFIABLE	-	-	-

TABLE 8 (CONTINUED)

	U1	X1	Y1
PHYLUM MOLLUSCA			
CLASS GASTROPODA			
PHYSA SP	-	-	-
CLASS PELECYPODA			
SPHAERIUM SP	-	-	-
PHYLUM NEMATODA			
NEMATODA	-	-	-
PHYLUM TURBELLARIA			
TURBELLARIA SP B	-	-	-
TOTAL NUMBER OF ORGANISMS	2049	2898	1039
NUMBER OF TAXA	16	14	11

TABLE 9

TAXONOMIC LIST OF VAAP MACROINVERTEBRATES: NATURAL SUBSTRATE, AUGUST SURVEY, 1975.
POPULATION SIZE EXPRESSED PER M^2 BASED ON POOLED REPLICATES

PHYLUM ANNELIDA	A	B1	C1	D1	D2	E1	F1	S
OLIGOCHAETA	-	394	94	531	110	1410	1117	2271
PHYLUM ARTHROPODA - CLASS INSECTA								
ORDER EPHEMEROPTERA								
CAENIS SP	-	-	-	-	-	-	-	-
HEXAGENIA SP	-	-	8	-	42	-	16	33
ORDER ODONATA								
UNIDENTIFIABLE ODONATA	8	-	-	-	-	-	-	-
ORDER PLECOPTERA								
UNIDENTIFIABLE PLECOPTERA	-	-	-	-	-	-	-	-
ORDER TRICOPTERA								
AGRAYLEA SP	-	-	-	-	-	-	-	8
CYRNELLUS MARGINALIS	-	-	-	-	-	8	-	-
ORDER DIPTERA - FAMILY CHIRONOMIDAE								
ABLABESMYIA ANNULATA	-	8	-	-	8	-	8	8
ABLABESMYIA PARAJANTA	-	-	-	-	-	-	-	-
CHIRONOMUS ATTENUATUS	-	-	8	-	-	-	8	8
CLADOTANYTARSUS SP	-	17	-	-	-	-	-	-
COELOTANYPUS CONCINNUS	-	-	-	8	16	-	25	16
COELOTANYPUS SCAPULARIS	-	-	17	-	-	-	-	-
COELOTANYPUS TRICOLOR	-	-	-	-	-	-	-	-
CRYPTOCHIRONOMUS BLARINA	-	17	-	34	-	-	-	25
CRYPTOCHIRONOMUS FULVUS	-	-	-	-	-	8	17	25
HARNISCHIA SP	-	-	17	-	-	-	-	-
PAGASTIELLA SP (TENT.)	-	25	-	-	-	-	-	-
PARALAUTERBORNIELLA NIGROHALTERALE	-	-	-	-	-	-	-	-
PARATENDIPES SP	-	-	-	-	-	-	-	-
POLYPEDILUM HALTERALE	-	-	-	24	-	-	-	-
PROCLADIUS SP	-	-	51	-	-	8	16	16
PSEUDOCHIRONOMUS SP	-	-	43	50	-	-	-	-
RHEOTANYTARSUS SP	-	8	-	-	-	-	-	-
SERGENTIA SP (TENT.)	-	-	-	-	-	-	-	-
TANYPUS CARINATUS	-	8	-	-	-	-	-	-
TANYPUS NEOPUNCTIPENNIS	8	-	-	-	-	-	-	-
TANYTARSUS SP	-	-	-	16	-	-	-	8
CHIRONOMID SP A	-	-	-	-	-	-	-	-
CHIRONOMID SP B	-	-	-	-	-	-	-	-
CHIRONOMIDAE UNIDENTIFIABLE	-	-	-	-	-	-	-	-
ORDER DIPTERA - OTHER								
CHAOBORUS SP	119	-	24	59	205	-	161	85
CERATOPOGONIDAE UNIDENTIFIABLE	-	-	-	-	-	-	-	-

TABLE 9 (CONTINUED)

	A	B1	C1	D1	D2	E1	F1	S
PHYLUM MOLLUSCA								
CLASS GASTROPODA								
PHYSA SP	-	-	-	-	-	-	-	-
CLASS PELECYPODA								
SPHAERIUM SP	-	-	50	8	-	93	5	74
PHYLUM NEMATODA								
NEMATODA	-	33	-	16	8	-	-	8
PHYLUM TURBELLARIA								
TURBELLARIA SP B	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	135	510	312	746	389	1527	1376	2585
NUMBER OF TAXA	3	8	9	9	6	5	9	13

TABLE 9 (CONTINUED)

PHYLUM ANNELIDA	T1	U2	X1	Y1
OLIGOCHAETA	16	246	1100	1986
PHYLUM ARTHROPODA - CLASS INSECTA				
ORDER EPHEMEROPTERA				
CAENIS SP	-	-	42	532
HEXAGENIA SP	16	42	41	-
ORDER ODONATA				
UNIDENTIFIABLE ODONATA	-	-	-	-
ORDER PLECOPTERA				
UNIDENTIFIABLE PLECOPTERA	-	-	8	-
ORDER TRICOPTERA				
AGRAYLEA SP	-	-	-	-
CYRNELLUS MARGINALIS	-	10	-	-
ORDER DIPTERA - FAMILY CHIRONOMIDAE				
ABLABESMYIA ANNULATA	-	21	-	-
ABLABESMYIA PARAJANTA	-	10	-	-
CHIRONOMUS ATTENUATUS	34	10	-	-
CLADOTANYTARSUS SP	-	10	-	110
COELOTANYPUS CONCINNUS	8	-	-	8
COELOTANYPUS SCAPULARIS	16	-	-	-
COELOTANYPUS TRICOLOR	25	-	-	-
CRYPTOCHIRONOMUS BLARINA	-	20	34	25
CRYPTOCHIRONOMUS FULVUS	8	-	8	50
HARNISCHIA SP	-	-	-	-
PAGASTIELLA SP (TENT.)	-	-	-	-
PARALAUTERBORNIELLA NIGROHALTERALE	-	-	8	-
PARATENDIPES SP	-	-	-	8
POLYPEDILUM HALTERALE	-	-	-	8
PROCLADIUS SP	34	10	-	-
PSEUDOCHIRONOMUS SP	-	-	51	273
RHEOTANYTARSUS SP	-	-	-	-
SERGENTIA SP (TENT.)	-	-	17	-
TANYPUS CARINATUS	-	-	-	-
TANYPUS NEOPUNCTIPENNIS	-	-	-	-
TANYTARSUS SP	-	32	8	8
CHIRONOMID SP A	-	-	8	-
CHIRONOMID SP B	-	10	-	-
CHIRONOMIDAE UNIDENTIFIABLE	-	-	8	8
ORDER DIPTERA - OTHER				
CHAOBORUS SP	42	-	-	-
CERATOPOGONIDAE UNIDENTIFIABLE	-	-	8	8

TABLE 9 (CONTINUED)

	T1	U2	X1	Y1
PHYLUM MOLLUSCA				
CLASS GASTROPODA				
PHYSA SP	-	-	-	17
CLASS PELECYPODA				
SPHAERIUM SP	-	10	43	25
PHYLUM NEMATODA				
NEMATODA	-	-	33	-
PHYLUM TURBELLARIA				
TURBELLARIA SP B	25	21	-	-
TOTAL NUMBER OF ORGANISMS	224	452	1417	3066
NUMBER OF TAXA	10	13	15	14

Most of them are scavengers -- filtering algae, bacteria, and suspended detritus from the water.

Oligochaetes are commonly found in standing or slow-moving waters over sediments enriched in organic matter. The presence of aquatic plants increases numbers of taxa and organisms. Plants provide shelter from current and predators and produce detritus as food. Most species are able to tolerate or even thrive in low concentrations of dissolved oxygen. Many can survive anaerobic conditions for extended periods of time.

Artificial Substrates. To document macroinvertebrate response to TNT residues from VAAP, a series of Hester-Dendy (H-D) samplers were placed in Waconda Bay from Stations A through F.

The density and number of taxa were lowest at Station A and ranged from 100 - 400 and 6 - 13, respectively. Chironomids were the most common organisms with *Procladius* dominant in June. In August, *Procladius* was replaced by *Dicrotendipes leucoscelis*. *Cyrenelus*, a tricopteran, also increased markedly in numbers. *Procladius* and *Cyrnellus* are both pollution-tolerant organisms (Weber, 1973). Species diversity, commonly used as an indication of community structure, was employed during this study. Results indicate (Table 10) that the relatively elevated (1.67 and 2.00) values at Station A are misleading due to low densities and numbers of taxa. This phenomenon has been discussed previously in the section on periphyton.

The Pearson-Pinkham Index of Biotic Similarity was also utilized in assessing biological conditions. In this analysis, Station A was unlike all others. In addition, no defined clustering patterns were evident among impact stations or reference areas in the initial survey. In August, Stations A and B-1 were similar and together displayed characteristics different from all other stations (Figures 32 and 33).

Effects of VAAP wastes are evident at Station B and are manifested mainly via biostimulation of photosynthetic autotrophs. Growth of periphyton was greatly increased at Station B and in June supported approximately 60 times as many organisms as at Station A and 3 times as many taxa. A similar trend was reflected by macroinvertebrates where the population increased two orders of magnitude and the number of taxa increased from 6 to 13 at Station A. Principal chironomids were *Glyptotendipes*, *Dicrotendipes* spp., and *Ablabesmyia mallochi*. Oligochaetes were also present in relatively low numbers. Species diversity ranged from 0.83 to 1 (Table 10).

Down bay at transect C, the maximum number of organisms colonized the H-D plates and amounted to 36 x 10^3 per m^2. *Glyptotendipes* accounted for 88 percent of the population. Water quality data do not reveal an association with VAAP wastes or cultural influences which would account for these high numbers. Physical characteristics may be influencing invertebrates in this area, but the data base is insufficient for further conclusions. The invertebrate community at this station may be showing a response to munitions wastes but the level of response is sufficiently subtle that separation of effects from VAAP wastes and other cultural activities occurring in this area (upland erosion and the presence of domestic ducks) cannot be made without further investigation. At transects D and F the macroinvertebrate community

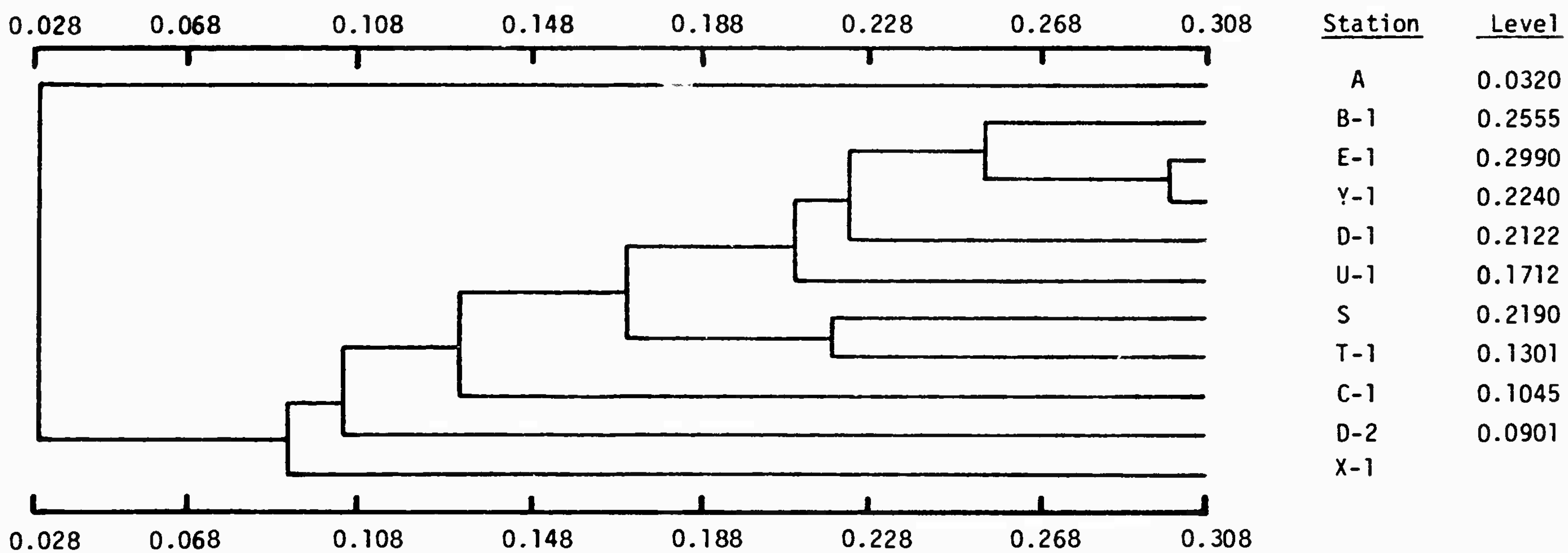

FIGURE 32. PHENOGRAM OF WACONDA BAY AND REFERENCE BAY MACROINVERTEBRATE COMMUNITY RELATIONSHIPS, JUNE, 1975. BASED ON PEARSON-PINKHAM SIMILARITY INDEX, MUTUAL ABSENCE UNIMPORTANT, ARTIFICIAL SUBSTRATE, COPHENETIC CORRELATION COEFFICIENT, 0.882.

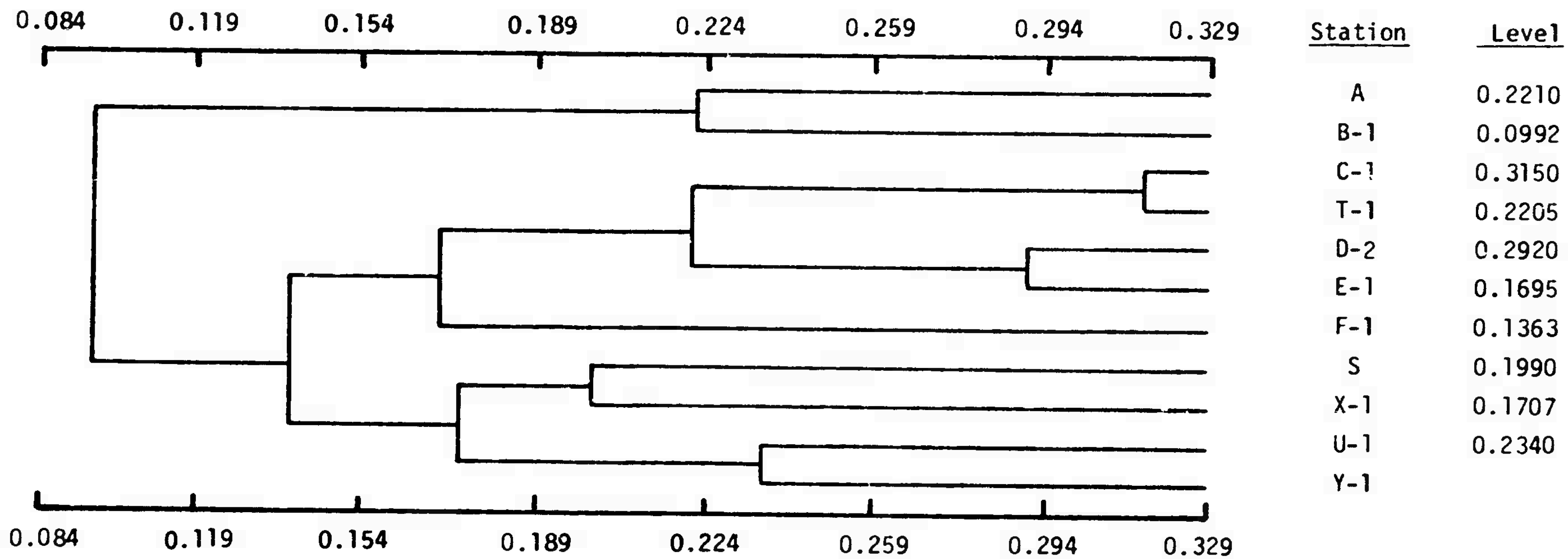

FIGURE 33. PHENOGRAM OF WACONDA BAY AND REFERENCE BAY MACROINVERTEBRATE COMMUNITY RELATIONSHIPS, AUGUST, 1975. BASED ON PEARSON-PINKHAM SIMILARITY INDEX, MUTUAL ABSENCE UNIMPORTANT, ARTIFICIAL SUBSTRATE, COPHENETIC CORRELATION COEFFICIENT, 0.735.

TABLE 10

SHANNON-WEAVER SPECIES DIVERSITY INDICES
VAAP MACROINVERTEBRATES, 1975*

Station	Artificial Substrates		Natural Substrates	
	June	August	June	August
A	1.671	2.080	1.173	0.446
B-1	0.843	0.997	2.390	0.947
B-2	--	--	0.322	--
C-1	0.628	1.760	2.059	1.926
D-1	1.494	--	2.099	1.137
D-2	1.135	1.171	0.928	1.226
E-1	2.053	1.771	1.395	0.327
E-2	--	--	1.543	--
F-1	--	2.359	1.763	0.741
F-2	--	--	1.890	--
S	1.334	2.056	1.031	0.626
T-1	1.933	1.838	1.376	2.179
T-2	--	--	1.348	--
U-1	1.456	1.722	1.749	--
U-2	--	--	2.289	1.753
X-1	1.905	1.729	2.242	1.064
X-2	--	--	2.577	--
Y-1	1.292	1.881	2.160	1.187

*Based on pooled data.

exhibits characteristics of the open lake and therefore these Waconda Bay stations represent areas where VAAP wastes have no discernible impact.

It should be emphasized that the above described effects on the macroinvertebrate community in Waconda Bay are directly correlated with loading from VAAP and therefore can be expected to be manifested further down bay as production levels increase by a reduction in numbers of species and individuals. At the present time impact is evident only at Stations A and B.

Natural Substrates. Invertebrates at Station A respond in a similar manner to those colonizing artificial substrates. That is to say population and taxa were reduced to low levels suggesting inhibition to TNT wastes. The number of organisms and species observed during both surveys may reflect residual toxicity in bay sediments which continued following plant shutdown in May (Tables 8 and 9).

The data show that *Chaoborus* was the most abundant organism at Station A. This contrasts with oligochaetes and chironomids which dominated other station locations, but were observed at relatively low numbers at Station A. It should be noted that the chironomid, *Tanypus neopunctipennis*, was observed only at Station A and may reflect tolerance to VAAP wastes.

Cluster analysis as shown in Figures 34 and 35 for the two surveys characterizes the head of Waconda Bay as dissimilar to upper bay or reference areas. The phenograms suggest, considering the levels of VAAP wastes in sediments at Station A and transect B, that munitions compounds may influence the population level and taxa number.

It is significant to note that densities in sediments varied little between June and August at Stations A, B-1, and C-1. Evidently sediment munitions residues affected benthic macroinvertebrates even after VAAP ceased its discharge. It is also worthy of note that macroinvertebrate densities were depressed further downbay in the natural substrates than in the artificial substrates. A comparison of munitions levels in water and sediments show higher concentrations in the latter which could influence this trend.

Stations D-1, E-1, and F-1 average 2 - 3 times the densities found at B-1 and C-1. Also, numbers of taxa fluctuate but their averages are approximately equivalent from Stations B-1 to F-1. The present techniques were therefore unable to detect effects from munitions on benthic macroinvertebrates downbay from Station C-1.

Examination of the data suggests that recovery in the natural substrates lags behind that on the Hester-Dendy samples. This can be seen by comparing populations and taxa downbay from Stations A through D. There is a general trend (mean value) of increasing numbers of macroinvertebrates and selected taxa at these stations with a peak occurring at Station D (Figures 36 and 37). The results of the study at VAAP indicate that munitions wastes impact the invertebrate community at the head of Waconda Bay. This is represented by an evident toxic response in both natural and artificial substrates. The increase in macroinvertebrates on H-D plates accompanying an increase in

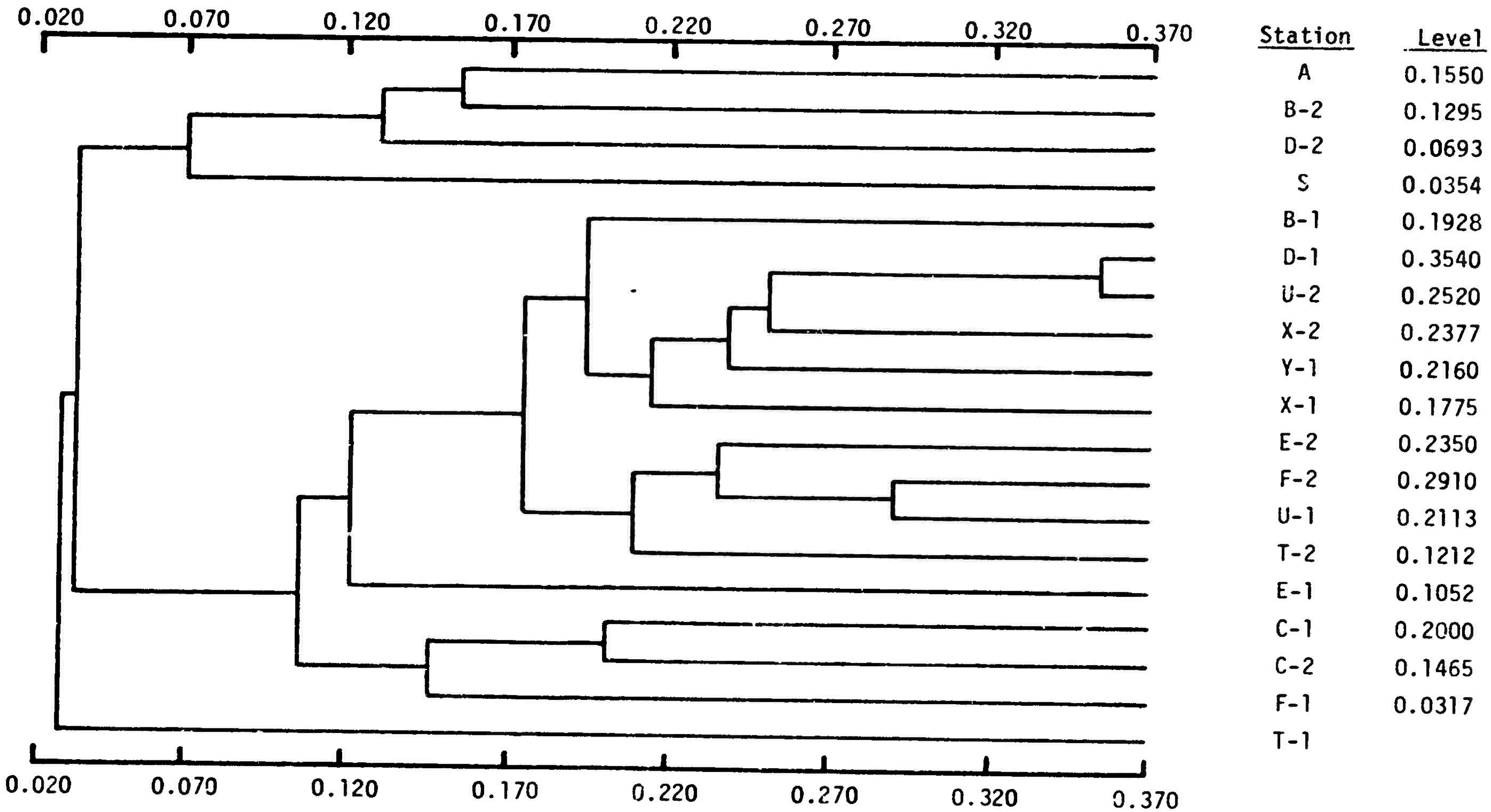

FIGURE 34. PHENOGRAM OF WACONDA BAY AND REFERENCE BAY MACROINVERTEBRATE COMMUNITY RELATIONSHIPS, JUNE, 1975. BASED ON PEARSON-PINKHAM SIMILARITY INDEX, MUTUAL ABSENCE UNIMPORTANT, NATURAL SUBSTRATE. COPHENETIC CORRELATION COEFFICIENT, 0.877.

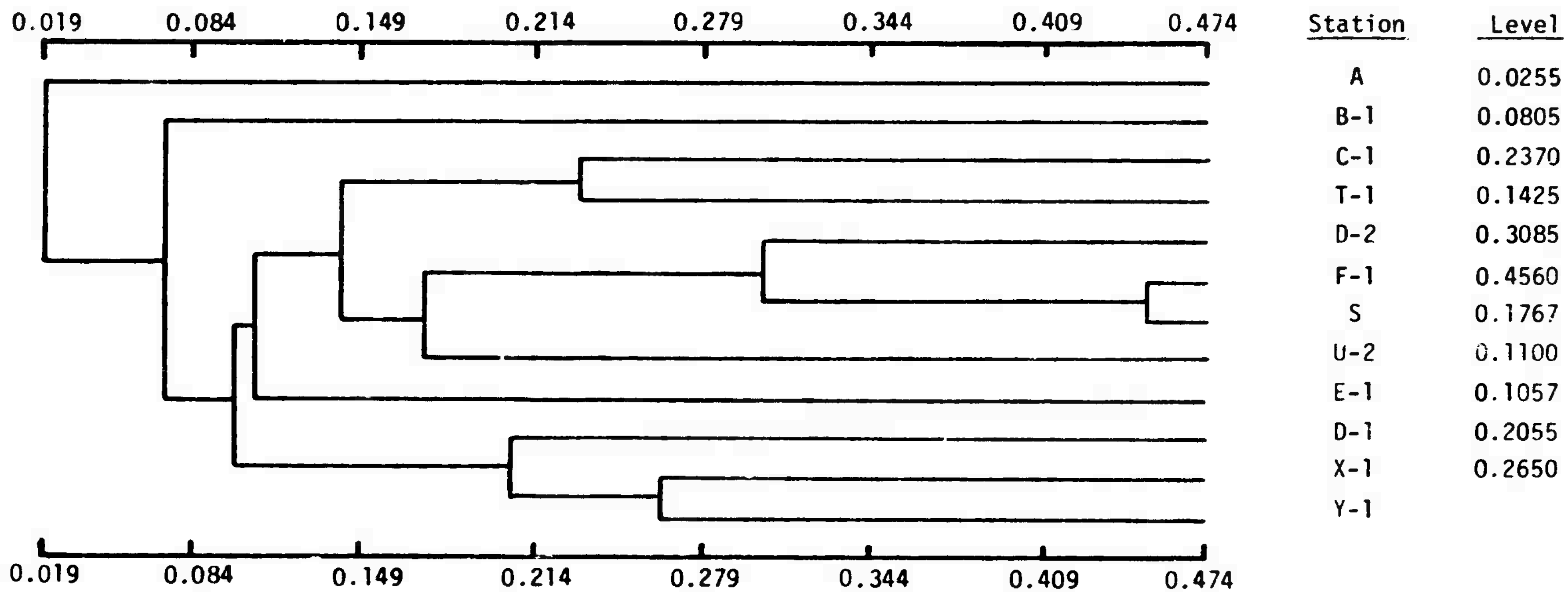

FIGURE 35. PHENOGRAM OF WACONDA BAY AND REFERENCE BAY MACROINVERTEBRATE COMMUNITY RELATIONSHIPS, AUGUST, 1975. BASED ON PEARSON-PINKHAM SIMILARITY INDEX, MUTUAL ABSENCE UNIMPORTANT, NATURAL SUBSTRATE. COPHENETIC CORRELATION COEFFICIENT, 0.853.

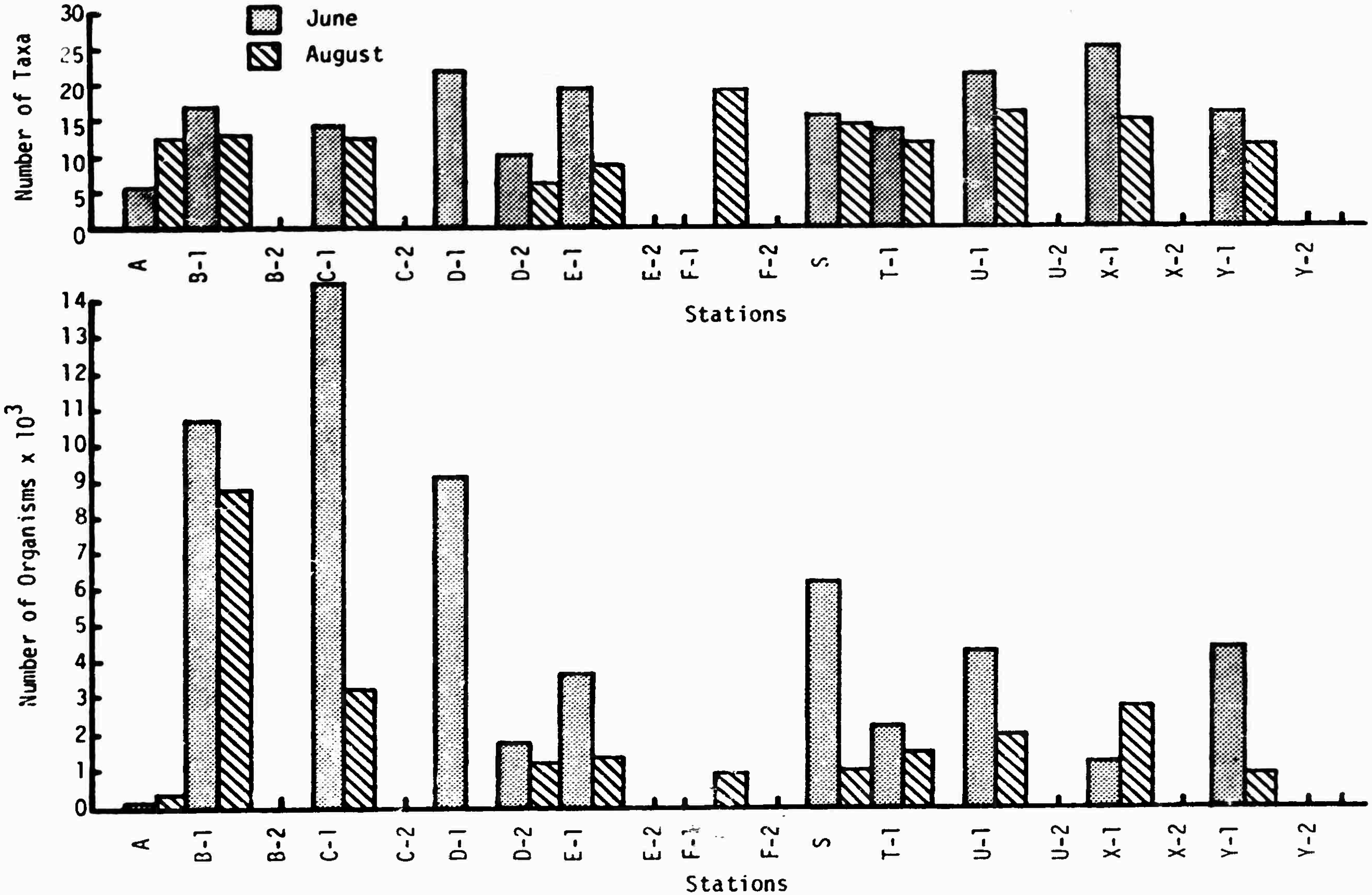

FIGURE 36. TOTAL NUMBERS OF MACROINVERTEBRATE TAXA AND ORGANISMS COLLECTED FROM VAAP ARTIFICIAL SUBSTRATES.

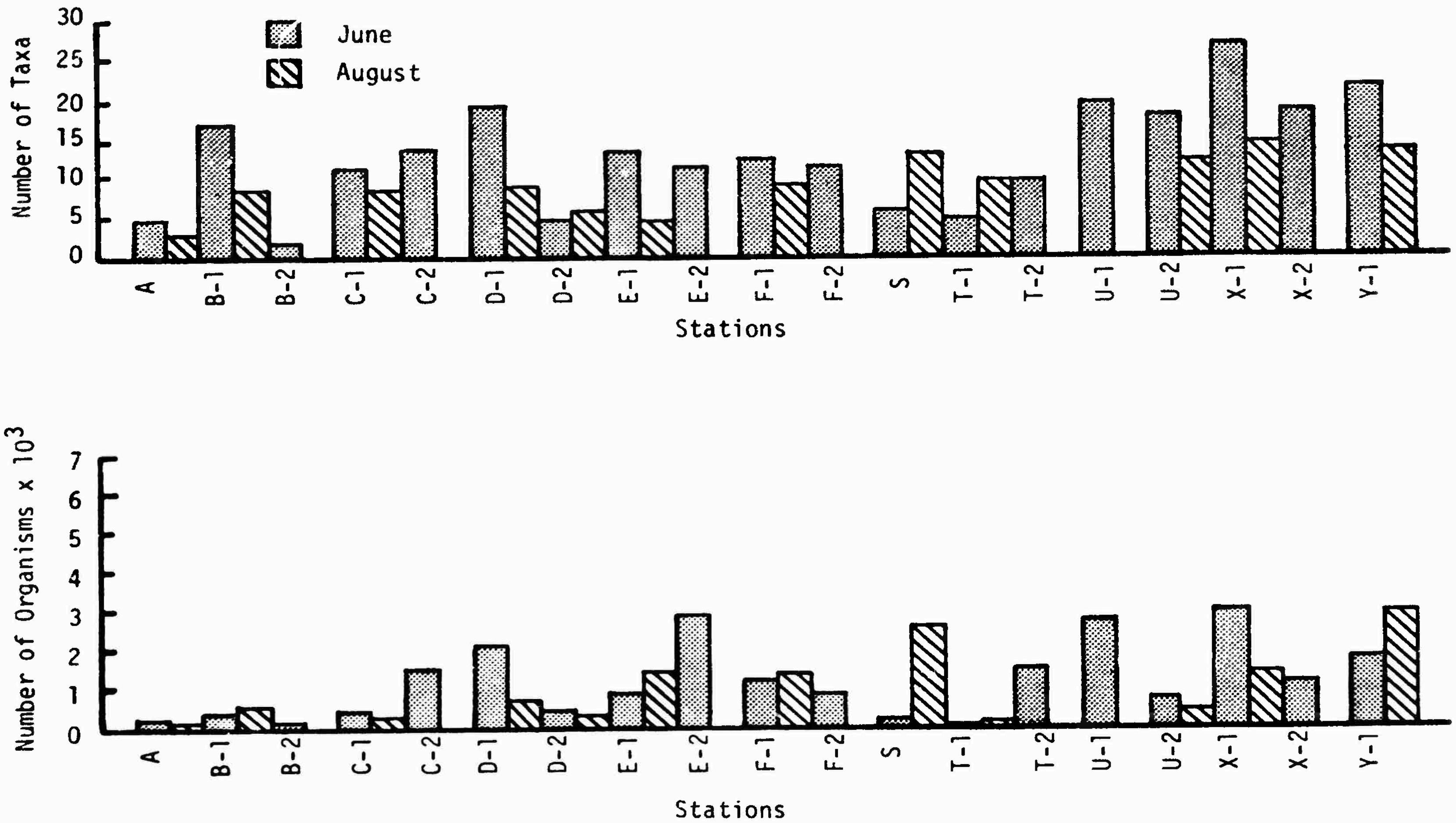

FIGURE 37. TOTAL NUMBERS OF MACROINVERTEBRATE TAXA AND ORGANISMS COLLECTED FROM VAAP NATURAL SUBSTRATES.

primary production is not reflected in the sediments. The variation observed in these two systems probably is caused by differences in habitat and response time to environmental stress, therefore, H-D devices would appear the most appropriate technique for assessing impact of munitions residues over relatively discrete time periods. Careful examination of natural substrates, however, will be the most useful in historically characterizing the system to determine the limits of munitions impact downbay.

CONCLUSIONS

The summer 1975 sampling at VAAP offered a unique opportunity to observe the response of the Waconda Bay ecosystem to the cessation of TNT production waste input. The chemical data showed that the VAAP discharge affected water quality in the upper portion of Waconda Bay by increasing the concentration of TNT, 2,4-DNT, 2,6-DNT, total dissolved solids, hardness, chlorides, ammonia, organic nitrogen, nitrates, and nitrites. Chemically, this effect was noticeable downbay to at least transect C some 0.6 miles from the bayhead. The chemical effects in the upper bay persisted through the August sampling, some 9 weeks after the plant was closed due to a labor dispute. However, the concentrations of munitions and associated materials in August were reduced as compared to June. Samples taken in two reference bays verified that the elevated concentrations observed in Waconda Bay were due to the VAAP discharge.

Biologic response by the periphyton and macrobenthic communities was observed in the same area of Waconda Bay where chemical characteristics were altered. At Station A, the bayhead, toxic effects were noted in both communities. However, at transect B, about 0.3 miles downbay, biostimulation for both periphyton and those macrobenthos colonizing artificial substrates was observed. At transect C, biologic effects were less clear-cut, although there was some suggestion of biostimulation. This pattern of toxicity followed by biostimulation suggests that one or more components in the waste stream are at toxic concentrations in bayhead water. As this material moves downbay, it is either diluted or degrades. When this occurs, nutrients become the controlling factor resulting in biostimulation.

Munitions wastes from VAAP have deposited in bay sediments during the years of plant operation. Analysis revealed a concentration gradient evident from the bayhead to transect C ranging as high as 3.1 mg/kg dry weight. Macroinvertebrate data indicate that the immediate area where VAAP effluent enters Waconda Bay represents a zone of severe inhibition in population size and number of taxa. TNT levels are reduced by an order of magnitude at transect B which is 0.3 miles from Station A.

June data project a picture of inhibition downbay as far as transect C. This trend although not as evident remained during the second survey. When community structure relationships between artificial and natural substrates were compared, there was strong evidence of residual toxicity in bay sediments especially at Station A.

Diatoms seem to be extremely sensitive to munitions wastes. Between the June and August samplings, significantly more recovery occurred in the macroinvertebrate community colonizing artificial substrates than in the periphyton community. It is apparent that diatoms are the most sensitive of the two components to munitions waste and would be the most effective early warning indicator. On the other hand, the above facet of the benthic community would be the most sensitive indicator of recovery. Insufficient time passed between the two studies to observe recovery among the natural sediment community which had been significantly stressed by waste discharges.

Phytoplankton identification and enumeration showed that Waconda Bay and the two reference bays contained sufficient algal populations to change dissolved oxygen values by several units diurnally. However, at this time phytoplankton appears to be of limited use to discriminate waste impact during plant operation. There is some suggestion based on the results of this study that the limnoplankton may be useful to delineate areas of biostimulation associated with TNT decomposition.

Because the observed biologic responses were to a mixed waste milieu, it is not possible to determine precise cause and effect relationships. However, at the bayhead where toxicity was noted in both the periphyton and macrobenthic communities, the median munitions concentrations in June and August were 123 and 56 ppb with individual samples as high as 345 ppb. Little reduction was noted in concentrations of the specific munitions from the bayhead to transect B. Since the biologic response of those organisms in the water column shifted from toxic to biostimulatory, it seems unlikely that the toxicity was due specifically to these compounds. The biotoxic response at A is suggestive of a separate factor, perhaps one of the breakdown products of the munitions specific materials. Concentration gradients of these compounds, not quantitated in this survey may be responsible for the differential response at Stations A and B. Nevertheless, it was observed that when munitions concentration dropped below 20 ppb, no further biologic responses were evident. At munitions concentration between 40 and 80 ppb, as at transect C, slight biostimulatory effects were noted.

Based on these results, it is concluded that the environmental impact of TNT waste effluent at VAAP would be minimal if the combined concentration of munitions residues did not exceed 20 ppb in the receiving waters or 100 ppb in sediments.

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APPENDIX A

WATER QUALITY DATA

LIST OF APPENDIX TABLES

LIST OF APPENDIX TABLES
(Continued)

LIST OF APPENDIX TABLES
(Continued)

APPENDIX A-1

ANALYTICAL METHODOLOGY

Table A-1 lists the specific Standard Methods or EPA procedures used to characterize the background water quality. Metals, except for hardness (calcium and magnesium), were run by flame atomic absorption spectrophotometry on acidified water samples. The expected low concentrations indicated that extraction using ammonia 1-pyrrolidinedithiocarbamate (APDC) and methyl isobutyl ketone (MIBK) (after Nix and Goodwin, 1970) would be necessary to gain the required sensitivity. Mercury was analyzed by cold vapor atomic absorption spectrophotometry.

The nutrient parameters (nitrogen, phosphorus, and carbon) measured were those usually used to characterize trophic state. These results were used to assess what, if any, factors might limit plant growth, whether biostimulatory effects might be expected; and, secondly, to determine what oxygen demands might result. Selection of these parameters was also keyed to those specific to munitions manufacture waste impacts.

In the case of the metal analyses run on the sediments, the digestate contained sufficiently high concentrations of metals to be run directly by flame atomic absorption spectrophotometry making MIBK-APDC extraction unnecessary. The sediment mercuries were analyzed employing cold vapor atomic absorption spectrophotometry after the digestion of a portion of sediment with aqua regia as described in EPA (1974).

Analytical procedures (Table A-2) utilized on the sediment samples came mostly from the Chemistry Laboratory Manual Bottom Sediments (EPA, 1969), with the exceptions of mercury (as described above) and total phosphorus. The total phosphorus procedure employed sulfuric acid-potassium persulfate digestion in an autoclave as specified in "Sludge-Sediment Analysis" (EPA, Region IV, 1973). The numbers of samples collected and analyzed are tabulated in Appendix F by station and analysis.

Munitions Analysis

The munitions samples were collected in amber glass reagent bottles that were pre-rinsed in acetone. The samples were refrigerated until analysis, which consisted of extraction, concentration and gas-liquid chromatography.

Extraction of Water Samples. A sample of 250 ml was measured into a clean 500 ml separatory funnel equipped with a Teflon stopcock. Seventy-five ml of ethyl acetate (pesticide grade) was added, the flask stoppered, and shaken for 2 to 3 minutes. The layers were allowed to separate and the lower (water) layer drained into a second 500 ml separatory funnel and again extracted with 50 ml ethyl acetate. The water layer was discarded. The extracts were combined and filtered through a plug of cotton previously wetted with ethyl acetate. The separatory funnels were rinsed with an additional 10 ml of ethyl acetate and filtered through the cotton plug. The ethyl acetate was evaporated to a volume of 2.5 ml under reduced pressure with the flask temperature not exceeding 40°C.

Extraction of Sediment Samples. In order to dry the wet sediments, 80 gm of sodium sulfate was added to 20 gm of wet sediment. This was then packed into a chromatographic column and extracted for one hour with ethyl acetate. The extraction was followed by evaporation of the ethyl acetate extract to a volume of 2.0 ml under the same conditions as described earlier. The one hour of extraction with ethyl acetate was proven to be sufficient by the fact that quantitative recovery of sediment samples spiked with 2,4-DNT, 2,6-DNT, and α-TNT was obtained.

Three levels of spiking were used as follows:

SEDIMENT SAMPLE WPA 40

Component	Quantity Added mg/kg (Wet Wt.)	Quantity Recovered mg/kg	Percent Recovery
2,4-DNT	0.5	0.48	96
	1.0	1.03	103
	10.0	9.0	90
2,6-DNT	0.5	0.46	92
	1.0	0.97	97
	10.0	9.4	94
2,4,6-DNT	0.5	0.52	104
	1.0	0.93	93
	10.0	9.3	93

Chromatography of Extracts. Samples were chromatographed on a 5 ft. x 1/8 in. glass column packed with 3 percent Dexsil 300 on 80/100 mesh Gas Chrom Q. A Varian Model 1840 Gas Chromatograph with electron capture (EC) and Thermionic (Alkali Flame Ionization Detector) (AFID) detectors was chosen. The readout was obtained by using a Varian Model 285 Electronic Integrator which was recorded permanently by a Beckman 1 mv, 10 inch scale recorder. Peak areas were automatically printed by integrator. Electron capture was chosen as the prime detector with AFID as back-up and confirmation detector.

An alternate column used for confirmatory information was a 4 ft. x 1/8 in. glass column packed with 8 percent UCW 98 on 80/100 mesh Gas Chrom. Q. Instrument conditions for both columns and detectors were:

Column temperature:	185°C, isothermally
Injector temperature:	220°C
Detector temperature:	215°C
Carrier Gas:	Nitrogen @ 40 ml/min.
Electrometer setting:	10^{-10} afs at 1 x attentuation into integrator with appropriate attenuation setting for recorder.

Five microliter portions of standards and samples were injected. The peak heights, peak areas, and retention times were recorded for comparison.

Preparation of Standards. Purified standards of 2,4-Dinitrotoluene; 2,6-Dinitrotoluene; 1,3,5-Trinitrobenzene; and 2,4,6-Trinitrotoluene (TNT) were supplied by the Army Medical Research and Development Command.

Discussion of Procedure. Under test conditions, 2,4-DNT, 2,6-DNT, and 2,4,6-TNT were adequately resolved by both Dexsil 300 and UCW 98 columns. However, 1,3,5-TNB and 2,4,6-TNT were not differentiated by the Dexsil column and only partially by the UCW 98 column; consequently 1,3,5-TNB, if present, was combined with and reported as 2,4,6-TNT.

Five μl injections of sample extracts and standards were first injected onto the Dexsil 300 column using the EC Detector. Peaks corresponding to standards were noted and the areas compared. Samples and standards were next injected onto UCW-98 column and like comparisons were made. Likewise, samples and standards were injected onto the Dexsil 300 column using the Thermionic or Alkali Flame Ionization Detector. Again, peaks corresponding to the standards were noted and the areas were compared. Sample peaks which did not elute at the same times as the standards on both sets of columns and detectors were rejected, and only those that were peaks confirmed on both sets were quantitated.

The AFID was used primarily for confirmation of the presence or absence of various compounds in the samples. However, results were calculated and compared with results from the EC detector. In most cases, quantitative results were comparable with both detectors. Where agreement was not within limits of ± 10 percent, additional injections were made until agreement could be obtained within these limits, or it was determined that substrate interference effected response from one or the other of the detectors. This was normally determined by spiking the sample with the appropriate standard and noting the recovery.

Recovery Studies. Initial recovery studies were made by the addition of standards to tap water and then carrying through the entire extraction, concentration, and gas chromatographic procedures, as previously outlined.

Three levels of spiking were used, as follows:

Component	Quantity Added	Quantity Recovered	Percent Recovery
2,4-DNT	1.00 mg/l	0.95 mg/l	95
	5.00 mg/l	4.80 mg/l	96
	10.00 mg/l	10.05 mg/l	101
2,6-DNT	1.00 mg/l	0.93 mg/l	93
	5.00 mg/l	4.95 mg/l	99
	10.00 mg/l	10.20 mg/l	102
2,4,6-TNT	1.00 mg/l	0.96 mg/l	96
	5.00 mg/l	5.15 mg/l	103
	10.00 mg/l	9.80 mg/l	98

Selected samples containing low levels or no munitions residues were spiked with corresponding low levels of TNT to assess recovery under these conditions. Results of these experiments were:

TABLE A-1

SUMMARY OF ROUTINE LABORATORY ANALYTICAL PROCEDURES
FOR WATER SAMPLES

Parameter	Procedure
Total Alkalinity	Standard Methods, 201: Potentiometric Titration, p. 370.
Chloride	Standard Methods, 112B: Mercuric Nitrate Method, p. 97
Total Hardness	Standard Methods, 112B: EDTA Titrimetric Method, p. 179.
Sulfate	Standard Methods, 156C: Turbidimetric Method, $BaCL_2$, p. 334.
Solids - Total Solids	Standard Methods, 148A: Gravimetric Method Method, p. 288.
Suspended Solids	Standard Methods, 148C: Gravimetric Method Method, p. 291.
Total Dissolved Solids	Standard Methods, 148B: Gravimetric Method Method, p. 290
Ammonia Nitrogen	EPA, STORET #00610: Distillation and Nesslerization, p. 159.
Total Kjeldahl Nitrogen	EPA, STORET #00625: Acid Digestion, Distillation, Nesslerization, p. 175.
Nitrite Nitrogen	EPA, STORET #00630: Automated Analyses, Diazotization, Sulfanilic Acid-Napthylamine Hydrochloride Method, p. 207.
Nitrate Nitrogen	EPA, STORET #00630: Automated Analyses, Cadmium Reduction Method, p. 207.
Total Phosphorus	Standard Methods, 223C.III: Persulfate Digestion Method, p. 526. EPA, STORET #00671: Automated Colorimetric Ascorbic Acid Single Reagent Method, p. 256.
Total Organic Carbon	EPA, STORET #00680, Infrared CO_2 Detection, Carbon Analyzer, p. 236.
Chemical Oxygen Demand	EPA, STORET #00335, Low Level 0.025N $K_2Cr_2O_7$, p. 21.

EPA 1974, "Manual of Methods for Chemical Analysis of Water and Wastes."

Standard Methods for the Examination of Water and Wastewater, 13th Ed., 1971, APHA, AWWA, WPCF.

TABLE A-2

SUMMARY OF ROUTINE LABORATORY ANALYTICAL PROCEDURES
FOR SEDIMENT SAMPLES

Parameter	Procedure
Chemical Oxygen Demand	Bottom Sediments - Great Lakes: High Level 0.250N $K_2Cr_2O_7$, p. 5.
Total Kjeldahl Nitrogen	Bottom Sediments - Great Lakes: Acid Digestion, Distillation, and Titration with 0.02N H_2SO_4, p. 38.
Nitrate Nitrogen	Bottom Sediments - Great Lakes: Acid Digestion, p. 32. Standard Methods, 213B: Cadmium Reduction Method, p. 458.
Nitrite Nitrogen	Bottom Sediments - Great Lakes: Acid Digestion, p. 32. EPA, STORET #00630: Automated Analyses, Diazotization, Sulfanilic Acid-Napthylamine Hydrochloride Method, p.207.
Total Phosphorus	EPA, Region IV, "Sludge-Sediment Analyses," 1973: Sulfuric Acid-Persulfate Digestion using an Autoclave. EPA, STORET #00671: Automated Colorimetric Ascorbic Acid Single Reagent Method, p. 256.
Total Solids	Bottom Sediments - Great Lakes: Gravimetric Method, p. 85.
Total Volatile Solids	Bottom Sediments - Great Lakes: Gravimetric Method, p. 85.
Mercury	EPA, 1974: Aqua Regia Digestion, Potassium Permanganate Oxidation, and Cold Vapor Technique Atomic Absorption Spectrophotometer, p. 134.
Trace Metals (Cd, Cu, Cr, Fe, Pb, Mn, Ni, Zn)	Bottom Sediments - Great Lakes: Nitric Acid - Hydrogen Peroxide Digestion, p. 18. Atomic Absorption Spectrophotometry.

Chemistry Laboratory Manual Bottom Sediments, EPA 1969, compiled by Great Lakes Region Committee on Analytical Methods.

EPA 1974, "Manual of Methods for Chemical Analysis of Water and Wastes".

EPA, Region IV, Surveillance and Analysis Division, Chemical Services Branch, "Sludge-Sediment Analyses," June 7, 1973, mimeograph courtesy of James Finger, EPA, Region IV.

Standard Methods for the Examination of Water and Wastewater, 13th Ed., 1971, APHA, AWWA, WPCF.

TABLE A-2 (CONTINUED)

Sample No.	Residual Component & Concentration		Component Added & Concentration		Percent Recovery
B-41	2,4-DNT	19 μg/l	2,4,6-TNT	4 μg/l	94
				8 μg/l	92
				10 μg/l	98
B-59	--	--	2,4,6-TNT	1 μg/l	89
				2 μg/l	93
				3 μg/l	96
B-39	--	--	2,4,6-TNT	2 μg/l	90
				4 μg/l	93
				6 μg/l	96

Recovery of TNT and its analogs by this procedure appears to be excellent, averaging more than 95 percent from tap water and 93 percent from spiked water samples.

APPENDIX A-2

FIELD MEASUREMENTS:

Dissolved Oxygen, Temperature, pH, and Specific Conductance
Harrison Bay and Lake Chickamauga

June 9-13, 1975
August 11-15, 1975

Waconda Bay
Reference Bay A
Huss Lowe Slough

TABLE A-3

DISSOLVED OXYGEN (ppm)

Station		6/9/75 A.M.	6/9/75 P.M.	6/10/75 A.M.	6/10/75 P.M.	6/11/75 A.M.	6/11/75 P.M.	6/12/75 A.M.	6/12/75 P.M.	6/13/75 A.M.	6/13/75 P.M.	Average	Range
A	S	--	8.5	8.1	--	7.1	--	6.3	--	6.0	--	7.08	6.0 - 8.5
	B	--	--	--	--	--	--	7.0	--	7.4	--		
B-1	S	--	9.1	8.7	--	7.2	--	6.8	--	6.4	--	7.63	6.4 - 9.1
	B	--	--	--	--	--	--	--	--	--	--		
B-2	S	--	9.0	8.4	--	6.8	--	6.5	--	6.3	--	6.46	3.8 - 9.0
	B	--	--	--	--	--	--	4.5	--	3.8	--		
C-1	S	--	9.1	--	8.9	6.7	--	6.0	--	6.2	--	6.69	5.0 - 9.1
	B	--	--	--	--	--	--	5.0	--	5.7	--		
C-2	S	--	9.4	--	8.6	6.5	--	6.5	--	6.4	--	6.53	4.0 - 9.4
	B	--	--	--	--	--	--	4.4	--	4.0	--		
D-1	S	--	9.6	--	9.4	6.7	--	6.3	--	6.6	--	7.0	5.9 - 9.6
	B	--	--	--	--	--	--	6.1	--	5.9	--		
D-2	S	--	9.6	--	8.2	6.1	--	6.4	--	6.7	--	7.0	4.8 - 9.6
	B	--	--	--	--	--	--	6.4	--	4.8	--		
E-1	S	--	9.1	--	8.8	7.0	--	6.6	--	7.3	--	6.82	4.2 - 9.1
	B	--	--	--	--	--	--	4.2	--	4.8	--		
E-2	S	--	9.5	--	8.4	6.6	--	6.5	--	7.3	--	7.13	5.5 - 9.5
	B	--	--	--	--	--	--	5.5	--	6.2	--		
F-1	S	--	9.4	--	8.7	6.8	--	6.9	--	7.5	--	7.02	3.7 - 9.4
	B	--	--	--	--	--	--	6.2	--	3.7	--		
F-2	S	--	9.6	--	7.8	6.7	--	6.8	--	7.3	--	6.75	3.9 - 9.6
	B	--	--	--	--	--	--	5.0	--	3.9	--		

TABLE A-3(Continued)

Station		6/9/75 A.M.	6/9/75 P.M.	6/10/75 A.M.	6/10/75 P.M.	6/11/75 A.M.	6/11/75 P.M.	6/12/75 A.M.	6/12/75 P.M.	6/13/75 A.M.	6/13/75 P.M.	Average	Range
S	S	--	9.3	7.2	--	--	6.2	4.9	--	6.3	--	5.92	3.5 - 9.3
	B	--	--	--	--	--	--	3.5	--	4.9	--		
T-1	S	--	9.8	7.9	--	--	6.1	5.6	--	6.8	--	6.49	4.5 - 9.8
	B	--	--	--	--	--	--	4.5	--	5.5	--		
T-2	S	--	9.6	8.0	--	--	6.2	5.9	--	6.9	--	6.74	5.0 - 9.6
	B	--	--	--	--	--	--	5.0	--	5.6	--		
U-1	S	--	9.5	8.3	--	--	6.7	6.3	--	7.7	--	6.94	5.0 - 9.5
	B	--	--	--	--	--	--	6.0	--	5.0	--		
U-2	S	--	9.4	8.2	--	--	6.9	6.6	--	7.5	--	6.82	4.2 - 9.4
	B	--	--	--	--	--	--	4.2	--	5.0	--		
X-1	S	7.4	--	--	9.0	8.3	--	--	8.6	8.2	--	8.30	7.4 - 9.0
	B	--	--	--	--	--	--	--	8.3	8.3	--		
X-2	S	7.5	--	--	8.5	7.7	--	--	8.8	8.3	--	8.19	7.3 - 8.5
	B	--	--	--	--	--	--	--	8.3	8.2	--		
Y-1	S	8.2	--	--	9.5	8.5	--	--	8.6	8.4	--	8.61	8.2 - 9 5
	B	--	--	--	--	--	--	--	8.5	8.4	--		
Y-2	S	7.7	--	--	9.6	8.6	--	--	8.6	8.4	--	6.42	0.2 - 9.6
	B	--	--	--	--	--	--	--	0.2	1.5	--		

TABLE A-4

DISSOLVED OXYGEN (ppm)

Station		8/11/75 A.M.	8/11/75 P.M.	8/12/75 A.M.	8/12/75 P.M.	8/13/75 A.M.	8/13/75 P.M.	8/14/75 A.M.	8/14/75 P.M.	8/15/75 A.M.	8/15/75 P.M.	Average	Range
A	S	8.4	--	--	9.6	7.4	--	8.6	--	7.6	--	7.10	4.4-9.6
	B	6.6	--	--	4.4	6.1	--	7.3	--	5.0	--		
B-1	S	8.8	--	--	10.6	8.0	--	9.5	--	8.8	--	9.14	8.0-10.6
	B	--	--	--	--	--	--	--	--	--	--		
B-2	S	8.2	--	--	10.2	8.2	--	9.2	--	8.2	--	6.24	1.4-10.2
	B	5.5	--	--	5.8	3.2	--	2.5	--	1.4	--		
C-1	S	7.3	--	--	9.7	9.2	--	9.1	--	7.9	--	7.36	5.0-9.7
	B	5.6	--	--	8.6	5.0	--	5.0	--	6.2	--		
C-2	S	7.5	--	--	9.5	8.9	--	9.3	--	7.8	--	7.56	2.1-10.2
	B	5.5	--	--	10.2	--	--	7.2	--	2.1	--		
D-1	S	--	7.1	8.7	--	9.9	--	9.4	--	7.9	--	7.49	5.0-9.9
	B	--	5.8	8.3	--	6.7	--	6.1	--	5.0	--		
D-2	S	--	7.6	8.5	--	9.7	--	9.2	--	6.6	--	6.36	2.5-9.7
	B	--	6.6	5.0	--	4.2	--	2.5	--	3.7	--		
E-1	S	--	7.3	8.2	--	9.4	--	9.5	--	2.1	--	5.82	1.6-9.4
	B	--	5.8	4.7	--	2.3	--	1.6	--	7.3	--		
E-2	S	--	7.5	8.2	--	9.4	--	8.9	--	7.9	--	7.29	4.5-9.4
	B	--	5.8	4.5	--	6.8	--	6.2	--	7.7	--		
F-1	S	--	7.5	8.0	--	9.2	--	8.9	--	8.5	--	5.52	0.9-9.2
	B	--	3.9	3.1	--	2.7	--	2.5	--	0.9	--		
F-2	S	--	7.7	8.2	--	9.4	--	8.4	--	8.3	--	6.36	2.2-9.4
	B	--	6.2	5.3	--	5.3	--	2.2	--	2.6	--		

TABLE A-4 (Continued)

Station		8/11/75 A.M.	8/11/75 P.M.	8/12/75 A.M.	8/12/75 P.M.	8/13/75 A.M.	8/13/75 P.M.	8/14/75 A.M.	8/14/75 P.M.	8/15/75 A.M.	8/15/75 P.M.	Average	Range
S	S	7.6	--	--	7.9	6.8	--	6.7	--	6.4	--	6.27	4.4-7.9
	B	6.1	--	--	5.7	4.4	--	4.9	--	--	--		
T-1	S	6.4	--	--	8.0	8.3	--	8.1	--	7.6	--	6.87	4.8-8.3
	B	6.2	--	--	5.8	7.0	--	6.5	--	4.8	--		
T-2	S	7.0	--	--	8.2	8.2	--	8.0	--	7.5	--	7.78	7.0-8.2
	B	--	--	--	--	--	--	--	--	--	--		
U-1	S	5.3	--	--	8.3	8.8	--	8.7	--	7.9	--	7.04	5.2-8.8
	B	5.2	--	--	7.3	5.6	--	6.9	--	6.4	--		
U-2	S	5.4	--	--	8.4	8.8	--	8.5	--	8.0	--	6.26	3.3-8.8
	B	5.2	--	--	3.3	4.1	--	5.7	--	5.2	--		
X-1	S	--	8.8	7.8	--	--	9.1	--	9.2	9.1	--	8.40	6.1-9.5
	B	--	9.5	6.1	--	--	6.5	--	9.4	8.5	--		
X-2	S	--	9.1	7.2	--	--	9.2	--	9.0	8.0	--	7.34	4.3-9.2
	B	--	7.9	4.3	--	--	7.0	--	5.1	6.6	--		
Y-1	S	--	9.0	8.6	--	--	9.0	--	9.3	9.5	--	8.87	7.0-10.9
	B	--	7.0	8.3	--	--	9.1	--	10.9	8.0	--		
Y-2	S	--	9.3	8.7	--	--	9.2	--	9.4	9.3	--	6.58	0.2-9.4
	B	--	2.0	8.3	--	--	0.9	--	0.2	8.5	--		

TABLE A-5

TEMPERATURE (^{o}C)

Station		6/9/75 A.M.	6/9/75 P.M.	6/10/75 A.M.	6/10/75 P.M.	6/11/75 A.M.	6/11/75 P.M.	6/12/75 A.M.	6/12/75 P.M.	6/13/75 A.M.	6/13/75 P.M.	Average	Range
A	S	--	26.6	25.0	--	24.0	--	24.1	--	24.6	--	24.0	23.0 - 26.6
	B	--	23.5	23.0	--	23.0	--	23.1	--	24.0	--		
B-1	S	--	27.0	24.5	--	--	--	24.0	--	24.6	--	25.0	24.0 - 27.0
	B	--	25.5	24.5	--	--	--	--	--	--	--		
B-2	S	--	26.5	24.5	--	--	--	24.0	--	24.6	--	24.2	22.9 - 26.5
	B	--	25.0	23.0	--	--	--	22.9	--	23.3	--		
C-1	S	--	26.5	--	25.0	--	--	24.0	--	24.1	--	24.4	23.0 - 26.5
	B	--	25.0	--	23.5	--	--	23.0	--	24.0	--		
C-2	S	--	27.0	--	25.0	23.5	--	24.2	--	24.1	--	24.3	23.1 - 27.0
	B	--	23.8	--	23.5	23.5	--	23.1	--	24.1	--		
D-1	S	--	27.0	--	25.0	23.5	--	24.0	--	24.5	--	24.4	23.5 - 27.0
	B	--	25.1	--	23.9	23.5	--	23.5	--	24.1	--		
D-2	S	--	26.5	--	24.8	23.5	--	23.8	--	24.4	--	24.2	23.0 - 26.5
	B	--	24.9	--	23.4	23.3	--	23.0	--	24.1	--		
E-1	S	--	26.0	--	24.9	23.5	--	23.8	--	25.1	--	23.9	22.0 - 26.0
	B	--	22.0	--	23.3	23.0	--	23.0	--	24.0	--		
E-2	S	--	26.0	--	24.9	23.2	--	23.9	--	24.8	--	24.2	23.0 - 26.0
	B	--	24.8	--	23.8	23.0	--	23.1	--	24.2	--		
F-1	S	--	25.5	--	24.9	23.5	--	24.0	--	25.2	--	23.4	21.0 - 25.5
	B	--	21.9	--	21.7	21.0	--	22.8	--	23.6	--		
F-2	S	--	25.8	--	24.8	23.2	--	24.0	--	25.1	--	23.6	21.9 - 25.8
	B	--	21.9	--	22.2	23.0	--	23.0	--	23.8	--		

TABLE A-5(Continued)

Station		6/9/75		6/10/75		6/11/75		6/12/75		6/13/75		Average	Range
		A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.		
S	S	--	26.8	24.8	--	--	--	21.8	--	25.3	--	24.1	20.9 - 26.8
	B	--	25.0	24.0	--	--	--	20.9	--	24.1	--		
T-1	S	--	26.5	24.5	--	--	--	23.5	--	25.4	--	24.4	23.1 - 26.5
	B	--	24.8	23.2	--	--	--	23.1	--	24.2	--		
T-2	S	--	26.5	24.8	--	--	--	23.7	--	25.8	--	24.8	23.5 - 26.5
	B	--	25.5	24.2	--	--	--	23.5	--	24.6	--		
U-1	S	--	26.0	24.8	--	--	--	23.7	--	25.3	--	24.4	23.2 - 26.0
	B	--	24.9	23.3	--	--	--	23.2	--	24.0	--		
U-2	S	--	26.0	24.5	--	--	--	23.7	--	25.1	--	24.4	23.1 - 26.0
	B	--	24.9	24.0	--	--	--	23.1	--	23.8	--		
X-1	S	25.0	--	--	25.3	24.8	--	--	25.5	25.4	--	25.0	24.3 - 25.4
	B	24.3	--	--	25.1	24.8	--	--	24.5	25.3	--		
X-2	S	24.0	--	--	25.9	24.8	--	--	26	25.7	--	25.2	24.0 - 26.0
	B	25.0	--	--	25.1	24.8	--	--	24.8	25.5	--		
Y-1	S	25.0	--	--	25.5	24.5	--	--	24.9	25.7	--	25.0	24.0 - 25.7
	B	24.0	--	--	24.9	24.5	--	--	24.9	25.6	--		
Y-2	S	25.0	--	--	25.5	24.6	--	--	25.1	25.9	--	24.2	22.0 - 25.9
	B	22.0	--	--	23.0	23.0	--	--	22.0	24.1	--		

TABLE A-6

TEMPERATURE (°C)

Station		8/11/75 A.M.	8/11/75 P.M.	8/12/75 A.M.	8/12/75 P.M.	8/13/75 A.M.	8/13/75 P.M.	8/14/75 A.M.	8/14/75 P.M.	8/15/75 A.M.	8/15/75 P.M.	Average	Range
A	S	26.0	--	--	32.0	27.5	--	28.9	--	27.2	--	27.0	24.5 - 32.0
	B	24.5	--	--	25.1	25.2	--	26.7	--	26.5	--		
B-1	S	26.0	--	--	31.0	28.0	--	29.0	--	27.7	--	28.3	26.0 - 31.0
	B	--	--	--	--	--	--	--	--	--	--		
B-2	S	25.0	--	--	31.0	27.9	--	28.9	--	27.5	--	26.6	24.0 - 28.9
	B	24.0	--	--	25.0	25.0	--	25.5	--	25.8	--		
C-1	S	26.2	--	--	30.3	28.2	--	28.8	--	27.3	--	27.6	25.4 - 30.3
	B	25.4	--	--	28.0	27.5	--	27.2	--	27.1	--		
C-2	S	26.4	--	--	30.5	28.0	--	28.8	--	27.1	--	27.7	25.9 - 30.5
	B	25.9	--	--	29.0	--	--	27.0	--	27.0	--		
D-1	S	--	27.7	28.3	--	29.6	--	28.8	--	27.2	--	27.7	26.0 - 29.6
	B	--	26.0	28.0	--	27.5	--	27.0	--	27.1	--		
D-2	S	--	28.0	28.2	--	29.1	--	28.0	--	25.9	--	27.0	25.2 - 29.1
	B	--	26.0	26.5	--	26.3	--	26.6	--	25.2	--		
E-1	S	--	28.1	27.9	--	28.9	--	28.0	--	27.4	--	27.1	26.0 - 28.1
	B	--	26.0	26.1	--	26.1	--	26.1	--	26.3	--		
E-2	S	--	28.5	27.9	--	28.6	--	29.9	--	27.5	--	27.6	26.1 - 29.9
	B	--	26.1	26.2	--	26.9	--	27.0	--	27.1	--		
F-1	S	--	28.8	27.8	--	28.0	--	27.9	--	28.0	--	27.0	25.9 - 28.8
	B	--	26.0	25.9	--	26.0	--	25.9	--	25.9	--		
F-2	S	--	29.0	27.7	--	28.1	--	27.8	--	27.9	--	27.1	26.0 - 29.0
	B	--	26.0	26.1	--	26.2	--	26.0	--	26.1	--		

TABLE A-6(Continued)

Station		8/11/75 A.M.	8/11/75 P.M.	8/12/75 A.M.	8/12/75 P.M.	8/13/75 A.M.	8/13/75 P.M.	8/14/75 A.M.	8/14/75 P.M.	8/15/75 A.M.	8/15/75 P.M.	Average	Range
S	S	25.0	--	--	30.1	28.0	--	28.3	--	28.1	--	27.4	24.1 - 30.1
	B	24.1	--	--	27.0	27.0	--	28.8	--	27.1	--		
T-1	S	26.0	--	--	29.1	28.0	--	27.3	--	27.9	--	27.0	25.0 - 29.1
	B	25.0	--	--	27.5	26.0	--	25.2	--	27.5	--		
T-2	S	25.9	--	--	29.9	28.0	--	28.8	--	28.0	--	28.1	25.9 - 29.9
	B	--	--	--	--	--	--	--	--	--	--		
U-1	S	26.0	--	--	29.1	28.1	--	28.9	--	28.0	--	27.4	26.0 - 29.1
	B	26.0	--	--	26.9	26.4	--	27.2	--	27.5	--		
U-2	S	26.1	--	--	29.0	28.0	--	28.9	--	27.9	--	27.2	26.0 - 29.0
	B	26.0	--	--	26.0	26.1	--	26.9	--	26.8	--		
X-1	S	--	30.5	26.9	--	--	30.5	--	31.0	30.0	--	28.9	26.5 - 31.0
	B	--	27.2	26.5	--	--	27.5	--	29.2	29.9	--		
X-2	S	--	29.1	26.9	--	--	30.2	--	30.8	28.8	--	28.3	26.5 - 30.8
	B	--	26.9	26.5	--	--	28.0	--	27.6	28.0	--		
Y-1	S	--	29.8	27.0	--	--	29.7	--	31.0	30.0	--	28.6	26.8 - 31.0
	B	--	26.8	26.9	--	--	26.1	--	29.2	29.0	--		
Y-2	S	--	28.0	27.1	--	--	30.5	--	30.1	30.0	--	27.9	26.1 - 30.5
	B	--	26.3	26.8	--	--	26.1	--	26.2	28.0	--		

TABLE A-7

pH

Station	6/9/75 A.M.	6/9/75 P.M.	6/10/75 A.M.	6/10/75 P.M.	6/11/75 A.M.	6/11/75 P.M.	6/12/75 A.M.	6/12/75 P.M.	6/13/75 A.M.	6/13/75 P.M.	Median	Range
A	--	7.8	7.6	--	7.5	--	7.5	--	7.4	--	7.5	7.4 - 7.8
B-1	--	8.2	7.8	--	7.5	--	7.5	--	7.4	--	7.5	7.4 - 8.2
B-2	--	8.0	7.7	--	7.5	--	7.6	--	7.5	--	7.6	7.5 - 8.0
C-1	--	8.4	--	8.0	7.6	--	7.7	--	7.6	--	7.7	7.6 - 8.4
C-2	--	8.3	--	7.7	7.5	--	7.6	--	7.5	--	7.6	7.5 - 8.3
D-1	--	8.5	--	7.7	7.5	--	7.7	--	7.7	--	7.7	7.5 - 8.5
D-2	--	8.4	--	8.0	7.5	--	7.6	--	7.8	--	7.8	7.6 - 8.4
E-1	--	7.9	--	7.7	7.5	--	7.8	--	7.7	--	7.7	7.5 - 7.9
E-2	--	8.4	--	7.9	7.5	--	7.8	--	7.8	--	7.8	7.5 - 8.4
F-1	--	7.8	--	7.9	7.4	--	7.8	--	7.5	--	7.8	7.4 - 7.9
F-2	--	-	--	7.7	7.6	--	7.8	--	7.6	--	7.6	7.6 - 7.8
S	--	8.1	7.5	--	--	7.4	7.1	--	7.4	--	7.4	7.1 - 8.1
T-1	--	8.3	7.7	--	--	7.5	7.4	--	7.7	--	7.7	7.4 - 8.3
T-2	--	8.5	7.7	--	--	7.5	7.4	--	7.7	--	7.7	7.4 - 8.5
U-1	--	8.4	7.6	--	--	7.6	7.5	-	7.7	--	7.6	7.5 - 8.4
U-2	--	8.4	7.6	--	--	7.6	7.6	--	7.6	--	7.6	7.6 - 8.4
X-1	7.5	--	--	8.4	8.2	--	--	8.4	8.2	--	8.2	7.6 - 8.4
X-2	7.7	--	--	8.3	7.9	--	--	8.1	8.1	--	8.1	7.7 - 8.3
Y-1	7.9	--	--	8.4	8.2	--	--	8.4	8.2	--	8.2	7.9 - 8.4
Y-2	7.6	--	--	7.5	7.9	--	--	7.8	7.6	--	7.6	7.5 - 7.9

TABLE A-8

pH

Station	8/11/75 A.M.	8/11/75 P.M.	8/12/75 A.M.	8/12/75 P.M.	8/13/75 A.M.	8/13/75 P.M.	8/14/75 A.M.	8/14/75 P.M.	8/15/75 A.M.	8/15/75 P.M.	Median	Range
A	7.7	--	--	7.9	7.5	--	7.6	--	7.7	--	7.7	7.5 - 7.9
B-1	7.7	--	--	8.3	7.6	--	8.2	--	8.0	--	8.0	7.6 - 8.3
B-2	7.6	--	--	8.1	7.6	--	7.7	--	7.6	--	7.6	7.6 - 8.1
C-1	7.7	--	--	8.4	8.0	--	8.0	--	7.6	--	8.0	7.6 - 8.4
C-2	7.6	--	--	8.4	8.4	--	8.1	--	8.0	--	8.1	7.6 - 8.4
D-1	--	7.6	8.2	--	8.5	--	8.3	--	8.1	--	8.3	7.6 - 8.5
D-2	--	7.7	8.0	--	8.1	--	8.0	--	7.6	--	7.7	7.6 - 8.1
E-1	--	7.5	7.6	--	7.7	--	7.6	--	7.6	--	7.6	7.5 - 7.7
E-2	--	7.7	7.9	--	8.3	--	7.9	--	8.1	--	7.9	7.7 - 8.3
F-1	--	7.5	7.6	--	7.6	--	7.5	--	7.6	--	7.6	7.5 - 7.6
F-2	--	7.7	7.7	--	7.9	--	7.8	--	7.5	--	7.7	7.5 - 7.9
S	7.5	--	--	7.8	7.4	--	7.4	--	7.3	--	7.4	7.3 - 7.8
T-1	7.5	--	--	7.9	8.0	--	8.0	--	7.8	--	7.9	7.5 - 8.0
T-2	7.6	--	--	7.9	8.0	--	7.9	--	7.8	--	7.9	7.6 - 8.0
U-1	7.4	--	--	8.0	8.1	--	8.0	--	8.0	--	8.0	7.4 - 8.1
U-2	7.4	--	--	7.8	7.8	--	7.8	--	7.8	--	7.8	7.4 - 7.8
X-1	--	8.3	8.0	--	--	8.5	--	8.7	8.6	--	8.5	8.0 - 8.7
X-2	--	8.4	7.7	--	--	8.6	--	8.7	8.6	--	8.6	7.7 - 8.7
Y-1	--	8.1	8.4	--	--	8.5	--	8.7	8.8	--	8.5	8.1 - 8.8
Y-2	--	8.0	8.3	--	--	7.7	--	7.6	8.8	--	8.0	7.6 - 8.8

TABLE A-9

SPECIFIC CONDUCTANCE (μmhos/cm)

Station		6/9/75		6/10/75		6/11/75		6/12/75		6/13/75		Average	Range
		A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.		
A	S	--	330	370	--	420		EQUIPMENT MALFUNCTION		EQUIPMENT MALFUNCTION		774	330 - 1350
	B	--	1350	1150	--	1100							
B-1	S	--	305	290	--	--						287	260 - 305
	B	--	260	292	--	--							
B-2	S	--	320	255	--	--						388	255 - 700
	B	--	275	700	--	--							
C-1	S	--	210	--	215	--						221	170 - 265
	B	--	265	--	245	--							
C-2	S	--	210	--	260	230						283	160 - 700
	B	--	700	--	160	200							
D-1	S	--	175	--	220	185						185	170 - 220
	B	--	175	--	170	180							
D-2	S	--	175	--	170	170						180	170 - 225
	B	--	225	--	170	170							
E-1	S	--	160	--	188	172						170	150 - 188
	B	--	180	--	161	179							
E-2	S	--	158	--	160	170						161	150 - 172
	B	--	155	--	150	172							
F-1	S	--	163	--	160	168						181	155 - 270
	B	--	181	--	197	270							
F-2	S	--	157	--	155	170						164	148 - 177
	B	--	175	--	177	175							

TABLE A-9 (Continued)

Station		6/9/75 A.M.	6/9/75 P.M.	6/10/75 A.M.	6/10/75 P.M.	6/11/75 A.M.	6/11/75 P.M.	6/12/75 A.M.	6/12/75 P.M.	6/13/75 A.M.	6/13/75 P.M.	Average	Range
S	S	--	185	198	--	--		EQUIPMENT MALFUNCTION		EQUIPMENT MALFUNCTION		223	185 - 290
	B	--	190	240	--	--							
T-1	S	--	170	161	--	--						169	155 - 190
	B	--	190	155	--	--							
T-2	S	--	167	158	--	--						162	158 - 167
	B	--	165	158	--	--							
U-1	S	--	165	156	--	--						162	156 - 165
	B	--	165	160	--	--							
U-2	S	--	165	160	--	--						160	150 - 165
	B	--	165	150	--	--							
X-1	S	170	--	--	148	165						162	148 - 170
	B	170	--	--	150	168							
X-2	S	175	--	--	148	162						163	148 - 175
	B	175	--	--	149	168							
Y-1	S	160	--	--	148	168						159	148 - 170
	B	159	--	--	149	170							
Y-2	S	163	--	--	148	170						168	148 - 190
	B	190	--	--	152	187							

TABLE A-10

SPECIFIC CONDUCTANCE (μmhos/cm)

Station		8/11/75 A.M.	8/11/75 P.M.	8/12/75 A.M.	8/12/75 P.M.	8/13/75 A.M.	8/13/75 P.M.	8/14/75 A.M.	8/14/75 P.M.	8/15/75 A.M.	8/15/75 P.M.	Average	Range
A	S	375	--	--	340	480	--	430	--	340	--	498.0	340-700
	B	600	--	--	700	465	--	550	--	600	--		
B-1	S	370	--	--	280	276	--	380	--	310	--	323.2	276-380
	B	--	--	--	--	--	--	--	--	--	--		
B-2	S	330	--	--	265	325	--	360	--	300	--	412.5	265-640
	B	640	--	--	480	485	--	460	--	480	--		
C-1	S	203	--	--	200	251	--	265	--	260	--	243.0	200-296
	B	220	--	--	260	245	--	296	--	230	--		
C-2	S	210	--	--	200	205	--	270	--	198	--	244.2	190-490
	B	490	--	--	210	--	--	190	--	225	--		
D-1	S	--	190	190	--	230	--	253	--	188	--	205.4	188-253
	B	--	198	191	--	220	--	204	--	190	--		
D-2	S	--	240	183	--	290	--	211	--	171	--	238.5	171-340
	B	--	340	260	--	220	--	282	--	188	--		
E-1	S	--	170	170	--	191	--	199	--	171	--	208.6	170-280
	B	--	175	280	--	255	--	240	--	235	--		
E-2	S	--	175	170	--	185	--	179	--	180	--	176.1	168-185
	B	--	183	171	--	170	--	168	--	180	--		
F-1	S	--	170	168	--	175	--	191	--	179	--	192.9	168-260
	B	--	170	230	--	189	--	260	--	197	--		
F-2	S	--	175	168	--	178	--	170	--	180	--	173.4	165-183
	B	--	165	168	--	170	--	177	--	183	--		

TABLE A-10 (Continued)

Station		8/11/75 A.M.	8/11/75 P.M.	8/12/75 A.M.	8/12/75 P.M.	8/13/75 A.M.	8/13/75 P.M.	8/14/75 A.M.	8/14/75 P.M.	8/15/75 A.M.	8/15/75 P.M.	Average	Range
S	S	168	--	--	181	192	--	200	--	220	--	202.6	168-230
	B	192	--	--	205	218	--	220	--	230	--		
T-1	S	170	--	--	175	178	--	183	--	181	--	191.3	170-235
	B	221	--	--	180	235	--	200	--	190	--		
T-2	S	168	--	--	179	178	--	180	--	178	--	176.6	168-180
	B	--	--	--	--	--	--	--	--	--	--		
U-1	S	167	--	--	175	175	--	177	--	174	--	172.8	167-177
	B	170	--	--	172	173	--	173	--	172	--		
U-2	S	169	--	--	173	175	--	178	--	177	--	176.7	169-190
	B	170	--	--	179	181	--	175	--	190	--		
X-1	S	--	170	159	--	--	173	--	175	172	--	167.6	158-175
	B	--	158	161	--	--	165	--	168	175	--		
X-2	S	--	168	160	--	--	171	--	177	175	--	168.3	158-179
	B	--	158	161	--	--	166	--	168	179	--		
Y-1	S	--	168	161	--	--	178	--	176	173	--	168.4	160-178
	B	--	160	163	--	--	165	--	168	172	--		
Y-2	S	--	165	162	--	--	175	--	173	175	--	168.9	162-175
	B	--	165	165	--	--	170	--	169	170	--		

APPENDIX A-3

CHEMICAL WATER QUALITY

Waconda Bay
Reference Bay "A"
Huss Lowe Slough
Chickamauga Lake

TABLE A-11

TOTAL HARDNESS
(mg $CaCO_3/l$)

JUNE SURVEY

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	87.0	103.0	147.0	146.0	143.0	125.0	28
B-1	79.0	80.0	85.0	89.0	110.0	88.6	13
B-2	82.0	95.0	75.0	114.0	123.0	97.8	20
C-1	67.0	72.0	75.0	71.0	73.0	71.6	2.9
C-2	79.0	67.0	77.0	74.0	79.0	75.2	5
D-1	64.0	71.0	67.0	74.0	72.0	69.6	4
D-2	66.0	65.0	65.0	65.0	67.0	65.6	1.0
E-1	66.0	-	64.0	63.0	66.0	64.8	1.5
E-2	62.0	65.0	65.0	67.0	71.0	66	3.3
F-1	63.0	65.0	63.0	70.0	63.0	64.8	3.0
F-2	63.0	62.0	65.0	66.0	62.0	63.6	1.8
S	69.0	79.0	81.0	71.0	76.0	75.2	5.1
T-1	59.0	67.0	67.0	67.0	66.0	65.2	3.5
T-2	65.0	65.0	70.0	65.0	67.0	66.4	2.2
U-1	65.0	65.0	67.0	52.0	67.0	65.2	2.0
U-2	67.0	66.0	64.0	65.0	63.0	65	1.6
X-1	61.0	61.0	65.0	61.0	59.0	61.4	2.2
X-2	67.0	63.0	59.0	61.0	60.0	62	3.2
Y-1	60.0	63.0	60.0	61.0	61.0	61	1.2
Y-2	63.0	61.0	61.0	61.0	65.0	62.2	1.8

TABLE A-12

TOTAL HARDNESS
(mg $CaCO_3$/l)
AUGUST SURVEY

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	110	103	-	103	-	105	4.0
B-1	109	85.0	-	99.0	-	97.7	12.0
B-2	106	97.0	-	90.0	-	97.7	8.0
C-1	75.0	69.0	-	87.0	-	77.0	9.2
C-2	86.0	70.0	-	82.0	-	79.3	8.3
D-1	69.0	69.0	-	81.0	-	73.0	6.9
D-2	73.0	70.0	-	70.0	-	71.0	1.7
E-1	66.0	73.0	-	71.0	-	70.0	3.6
E-2	84.0	66.0	-	68.0	-	72.7	9.9
F-1	64.0	65.0	-	65.0	-	64.7	0.6
F-2	64.0	66.0	-	67.0	-	65.7	1.5
S	70.0	68.0	-	81.0	-	73.0	7.0
T-1	67.0	66.0	-	69.0	-	67.3	1.5
T-2	66.0	67.0	-	69.0	-	67.3	1.5
U-1	66.0	67.0	-	67.0	-	66.7	0.6
U-2	64.0	66.0	-	66.0	-	65.3	1.2
X-1	65.0	66.0	-	66.0	-	65.7	0.6
X-2	65.0	65.0	-	65.0	-	65.0	0.0
Y-1	66.0	66.0	-	60.0	-	64.0	3.5
Y-2	67.0	65.0	-	65.0	-	65.7	1.2

TABLE A-13

SULFATE
(mg SO_4/1)

Station	June 6/10/75	6/12/75	Mean	8/11/75	August 8/12/75	Mean
A	100	115	108	69.0	55.4	62.2
B-1	55.8	48.6	52.6	67.5	33.0	50.3
B-2	76.8	83.2	80.0	56.4	49.6	53.0
C-1	29.4	23.8	26.6	20.2	17.2	18.7
C-2	23.6	27.4	25.5	30.4	16.5	23.5
D-1	26.9	23.6	25.3	16.9	16.8	16.9
D-2	12.7	16.7	14.7	18.6	16.8	17.7
E-1	39.7	15.0	27.4	11.5	17.0	14.3
E-2	17.2	15.4	16.3	11.4	16.7	14.1
F-1	15.3	13.3	14.3	11.3	12.0	11.7
F-2	19.5	13.2	16.4	11.0	11.9	11.5
S	27.6	27.0	27.3	14.4	13.8	14.1
T-1	18.6	16.2	17.4	-	12.8	12.8
T-2	18.0	16.4	17.2	11.6	12.8	12.2
U-1	15.7	15.0	15.4	11.7	12.3	12.0
U-s	14.0	12.8	13.4	11.5	13.5	12.5
X-1	11.2	10.5	10.9	9.5		10.0
X-2	10.7	10.6	10.7	9.5		10.0
Y-1	10.7	10.4	10.6	9.9		10.3
Y-2	10.9	11.0	11.0	9.9		10.3

TABLE A-14

TOTAL ALKALINITY
(mg $CaCO_3$/l)
JUNE SURVEY

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	55	51	40.5	47	39	46.5	6.8
B-1	50	52.5	51.5	53	45	50.4	3.2
B-2	52	49.5	48.5	51	43	48.8	3.5
C-1	48	50	52.5	52	45	49.5	3.1
C-2	47	51	52	53	46	49.8	3.1
D-1	48	51	51	52	45	49.4	2.9
D-2	48	48.5	51.5	52	45	49.0	2.8
E-1	47	49.5	50.5	53	44	48.8	3.4
E-2	48	49	48	52	47	48.3	1.9
F-1	46	49	49.5	52.5	44	48.2	3.3
F-2	46	50	51	53	45	49.0	3.4
S	46	51	54	50	48	49.8	3.0
T-1	45	48.5	53	53	46	49.1	3.8
T-2	46	47.5	51.5	52	46	48.6	2.9
U-1	44	51	48	51.5	45	47.9	3.4
U-2	50	50.5	51.5	52	47	50.2	2.0
X-1	48	50	50	51.5	43	48.5	3.3
X-2	50	50	52.5	51	47	50.1	2.0
Y-1	46	50.5	51.5	53	46	49.4	3.2
Y-2	48	50.5	50.5	54	45	49.6	3.3

TABLE A-15

TOTAL ALKALINITY
(mg $CaCO_3$/1)
AUGUST SURVEY

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	47	43	48	59	55	50.4	6.4
B-1	52	57	57	52	56	54.8	2.6
B-2	57	53	55	58	57	56.0	2.0
C-1	57	55	55	59	60	57.2	2.3
C-2	56	55	54	57	57	55.8	1.3
D-1	57	54	55	59	57	56.4	1.9
D-2	54	54	53	58	56	55.0	2.0
E-1	55	56	54	58	55	55.6	1.5
E-2	55	55	51	57	57	55.0	2.4
F-1	47	54	53	57	58	53.8	4.3
F-2	55	54	56	56	57	55.6	1.1
S	64	55	59	67	70	63.0	6.0
T-1	55	56	55	57	60	56.6	2.1
T-2	54	56	53	60	59	56.4	3.0
U-1	53	56	54	57	55	55.0	1.6
U-2	54	55	53	58	56	55.2	1.9
X-1	58	56	54	59	59	57.2	2.2
X-2	55	55	51	55	60	55.2	3.2
Y-1	57	59	56	59	62	58.6	2.3
Y-2	55	56	53	55	57	55.2	1.5

TABLE A-16

CHLORIDE
(mg Cl/l)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	12.5	13.0	25.0	21.5	15.0	17.4	5.6
B-1	6.5	9.0	8.5	7.5	11.0	8.5	1.7
B-2	9.5	9.5	15.0	11.5	14.5	12.0	2.6
C-1	3.5	4.0	6.5	6.5	3.5	4.8	1.6
C-2	5.5	9.5	5.5	6.0	4.5	6.2	1.9
D-1	4.0	-	3.0	3.0	3.0	3.3	0.5
D-2	4.0	3.5	4.5	4.0	3.5	3.9	0.4
E-1	2.5	4.8	2.5	4.5	2.5	3.3	1.2
E-2	2.5	2.5	3.5	3.0	2.5	2.8	0.4
F-1	3.5	4.0	7.0	2.5	4.5	4.3	1.7
F-2	3.0	2.5	3.5	4.0	2.5	3.1	0.7
S	3.5	5.0	5.0	3.0	6.0	4.5	1.2
T-1	3.0	4.0	4.0	4.0	2.0	3.4	0.9
T-2	2.0	4.0	3.5	3.0	3.0	3.1	0.7
U-1	3.0	3.0	3.5	3.5	5.0	3.6	0.8
U-2	4.0	2.5	2.0	2.0	2.5	2.6	0.8
X-1	2.0	3.0	3.0	4.0	3.0	3.0	0.7
X-2	2.5	2.0	3.0	3.5	3.5	2.9	0.7
Y-1	4.0	3.5	2.5	2.5	3.5	3.2	0.7
Y-2	2.5	3.0	2.0	2.5	4.0	2.8	0.8

TABLE A-17

CHLORIDE
(mg Cl/l)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	38.0	36.0	-	51.0	-	41.7	8.1
B-1	33.5	16.0	-	36.0	-	28.5	10.9
B-2	30.0	29.5	-	24.5	-	28.0	3.0
C-1	10.5	9.0	-	14.5	-	11.3	2.8
C-2	17.0	9.5	-	14.0	-	13.5	3.8
D-1	9.5	9.0	-	12.5	-	10.3	1.9
D-2	10.0	8.5	-	9.5	-	9.3	0.8
E-1	6.5	9.5	-	9.0	-	8.3	1.6
E-2	6.5	7.5	-	6.5	-	6.8	0.6
F-1	6.5	7.0	-	5.0	-	6.2	1.0
F-2	6.0	5.5	-	5.5	-	5.7	0.3
S	7.0	5.0	-	5.5	-	5.8	1.0
T-1	5.5	6.5	-	6.5	-	6.2	0.6
T-2	8.0	6.0	-	6.0	-	6.7	1.2
U-1	7.0	6.5	-	6.5	-	6.7	0.3
U-2	6.5	7.5	-	6.0	-	6.7	0.8
X-1	6.0	4.5	-	6.5	-	5.7	1.0
X-2	6.0	6.0	-	5.5	-	5.8	0.3
Y-1	5.5	6.5	-	6.0	-	6.0	0.5
Y-2	6.0	5.0	-	5.5	-	5.5	0.5

TABLE A-18

TOTAL DISSOLVED SOLIDS
(mg/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	224	-	317	-	284	275	47
B-1	170	-	171	-	208	183	22
B-2	190	-	172	-	242	201	36
C-1	107	-	124	-	96	109	14
C-2	128	-	129	-	124	127	2.6
D-1	107	-	115	-	105	109	5.3
D-2	112	-	96	-	101	103	8.2
E-1	95	-	102	-	84	94	9.1
E-2	94	-	89	-	80	88	7.1
F-1	127	-	103	-	84	105	22
F-2	120	-	103	-	82	102	19
S	141	-	130	-	120	130	11
T-1	130	-	103	-	76	103	27
T-2	115	-	96	-	99	103	10
U-1	103	-	96	-	88	96	7.5
U-2	104	-	101	-	91	99	6.8
X-1	86	-	99	-	78	88	11
X-2	79	-	78	-	64	74	8.4
Y-1	73	-	105	-	82	87	17
Y-2	99	-	91	-	65	85	18

TABLE A-19

TOTAL DISSOLVED SOLIDS
(mg/1)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	163	-	143	-	248	190	65
B-1	173	-	250	-	273	232	58
B-2	182	-	193	-	208	201	32
C-1	112	-	145	-	187	146	35
C-2	102	-	208	-	251	193	74
D-1	79	-	113	-	133	90	46
D-2	82	-	139	-	200	153	78
E-1	93	-	155	-	184	158	70
E-2	65	-	185	-	115	121	60
F-1	94	-	120	-	142	124	37
F-2	65	-	205	-	227	170	100
S	113	-	192	-	172	158	45
T-1	118	-	155	-	185	154	32
T-2	70	-	174	-	187	140	70
U-1	130	-	135	-	227	150	73
U-2	113	-	135	-	174	139	32
X-1	71	-	132	-	185	128	61
X-2	61	-	143	-	190	131	69
Y-1	61	-	120	-	176	119	58
Y-2	243	-	150	-	203	201	47

TABLE A-20

SUSPENDED SOLIDS
(mg/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	14	-	3	-	13	10	6.0
B-1	6	-	15	-	6	9	5.2
B-2	13	-	11	-	6	10	4.0
C-1	7	-	18	-	14	13	5.6
C-2	6	-	16	-	11	11	5.0
D-1	11	-	10	-	2	8	4.9
D-2	5	-	8	-	2	5	3.0
E-1	8	-	6	-	13	9	3.6
E-2	6	-	12	-	8	8.9	3.0
F-1	6	-	8	-	7	7	1.0
F-2	8	-	7	-	8	7.8	0.6
S	8	-	21	-	14	14	6.5
T-1	12	-	5	-	7	8	3.6
T-2	8	-	10	-	11	10	1.5
U-1	10	-	5	-	12	9	3.6
U-2	11	-	6	-	11	9	2.9
X-1	12	-	2	-	4	6	5.2
X-2	24	-	17	-	11	17	6.5
Y-1	21	-	3	-	2	9	11
Y-2	5	-	4	-	17	9	7.2

TABLE A-21

SUSPENDED SOLIDS
(mg/l)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	3	-	14	-	26	14	12
B-1	27	-	4	-	24	18	13
B-2	15	-	19	-	36	23	11
C-1	13	-	8	-	44	22	20
C-2	16	-	2	-	24	14	11
D-1	3	-	2	-	26	10	14
D-2	4	-	6	-	24	11	11
E-1	5	-	<2	-	26	10	14
E-2	7	-	3	-	18	9	8
F-1	9	-	3	-	6	6	3
F-2	3	-	2	-	20	8	10
S	15		17	-	32	21	9
T-1	7	-	4	-	22	11	10
T-2	13	-	2	-	18	11	8
U-1	8	-	<2	-	4	4	4
U-2	8	-	<2	-	2	3	4
X-1	11	-	3	-	22	12	10
X-2	6	-	3	-	2	4	2
Y-1	6	-	3	-	6	5	2
Y-2	4	-	3	-	30	12	15

TABLE A-22

TOTAL SOLIDS
(mg/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	138	-	320	-	297	285	42
B-1	176	-	186	-	214	192	20
B-2	203	-	183	-	248	211	32
C-1	114	-	142	-	110	122	17
C-2	134	-	145	-	135	138	6.1
D-1	118	-	125	-	107	117	9.1
D-2	117	-	104	-	103	111	8.4
E-1	103	-	108	-	97	103	5.5
E-2	100	-	101	-	88	96	7.2
F-1	133	-	111	-	91	112	21
F-2	128	-	110	-	90	109	19
S	149	-	151	-	134	145	9.3
T-1	142	-	108	-	83	111	30
T-2	123	-	106	-	110	113	8.9
U-1	113	-	101	-	100	105	7.2
U-2	115	-	107	-	102	108	6.6
X-1	98	-	101	-	82	94	10
X-2	103	-	95	-	75	91	14
Y-1	94	-	108	-	84	95	12
Y-2	104	-	95	-	82	94	11

TABLE A-23

TOTAL SOLIDS
(mg/l)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/76	Mean	Standard Deviation
A	170	-	151	-	272	198	65
B-1	190	-	252	-	288	243	50
B-2	191	-	204	-	251	215	32
C-1	120	-	150	-	208	159	44
C-2	112	-	232	-	262	202	79
D-1	49	-	113	-	127	97	41
D-2	84	-	154	-	242	160	79
E-1	96	-	164	-	233	164	68
E-2	68	-	181	-	130	127	56
F-1	101	-	124	-	158	128	29
F-2	66	-	220	-	239	175	95
S	119		202	-	191	170	45
T-1	122	-	167	-	193	161	36
T-2	76	-	173	-	192	147	62
U-1	97	-	134	-	226	152	66
U-2	114	-	134	-	173	140	30
X-1	76	-	134	-	196	135	60
X-2	65	-	146	-	190	134	64
Y-1	65	-	125	-	176	122	56
Y-2	246	-	158	-	221	208	45

TABLE A-24

CHEMICAL OXYGEN DEMAND
(mg/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	10.1	6.1	8.9	10.5	10.6	9.2	1.9
B-1	8.7	6.9	7.1	7.9	9.2	8.0	1.0
B-2	10.2	7.5	7.3	7.9	12.1	9.0	2.1
C-1	7.5	6.8	6.7	5.2	6.9	6.6	0.9
C-2	8.3	6.3	8.5	7.1	7.5	7.6	0.9
D-1	8.7	6.4	5.3	5.1	8.9	6.9	1.8
D-2	7.9	4.9	4.3	4.3	8.5	6.0	2.1
E-1	8.6	5.4	4.3	5.8	7.7	6.4	1.8
E-2	7.7	5.8	5.1	5.0	6.7	6.1	1.1
F-1	7.9	6.6	4.9	5.5	7.1	6.4	1.2
F-2	6.7	3.8	3.3	7.1	5.9	5.4	1.7
S	8.1	6.1	10.2	9.5	6.6	8.1	1.8
T-1	7.9	4.7	4.5	9.3	7.7	6.8	2.1
T-2	7.0	5.5	6.9	2.3	6.9	5.7	2.0
U-1	7.9	5.7	5.7	4.9	6.3	6.1	1.1
U-2	8.7	4.1	4.5	5.9	7.5	6.1	2.0
X-1	8.7	5.3	5.5	6.7	7.9	6.8	1.5
X-2	6.7	6.9	6.5	6.7	7.6	6.9	0.4
Y-1	8.5	5.2	5.7	4.3	6.7	6.1	1.6
Y-2	7.8	4.4	4.7	8.1	7.9	6.6	1.9

TABLE A-25

CHEMICAL OXYGEN DEMAND
(mg/1)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	9.5	3.5	3.1	5.0	7.8	5.8	2.8
B-1	18.4	6.1	7.8	12.8	9.7	11.0	4.8
B-2	10.2	9.0	4.7	10.0	9.1	8.6	2.2
C-1	14.1	3.8	7.2	10.0	11.9	9.4	4.0
C-2	11.8	3.2	2.8	8.1	12.5	7.7	4.6
D-1	7.2	6.1	3.4	10.6	7.5	7.0	2.6
D-2	6.2	6.7	3.4	5.6	8.7	6.1	1.9
E-1	5.6	1.0	0.9	7.5	10.0	5.0	4.0
E-2	3.0	3.8	0.6	8.7	8.4	4.9	3.5
F-1	0.7	<0.5	0.9	5.9	10.3	3.6	4.4
F-2	<0.5	2.6	2.8	5.0	10.3	4.1	3.9
S	8.5	4.2	8.1	7.5	7.2	7.1	1.7
T-1	8.2	<0.5	6.9	5.3	1.6	4.4	3.5
T-2	3.9	0.3	6.9	6.6	4.1	4.4	2.7
U-1	8.2	2.6	5.3	4.1	0.6	4.2	2.9
U-2	5.6	1.6	6.7	3.4	5.3	4.5	2.0
X-1	6.9	3.8	6.2	2.5	2.5	4.4	2.1
X-2	6.2	5.4	4.4	2.8	5.6	4.9	1.3
Y-1	6.9	4.2	5.9	4.1	0.9	4.4	2.3
Y-2	7.5	4.5	5.6	3.7	0.6	4.4	2.5

TABLE A-26

TOTAL ORGANIC CARBON
(mg C/l)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	11	6	7.5	6	5.0	7.1	2.4
B-1	8	6	6	5.5	5.0	6.1	1.1
B-2	8.5	6	5.5	7	5.5	6.5	1.3
C-1	7	7	6	6	4.5	6.1	1.0
C-2	7.5	7	6.5	5.5	5.0	6.3	1.0
D-1	6.5	7	4.5	5.5	4.0	5.5	1.3
D-2	8	6	5	5.5	4.5	5.8	1.4
E-1	7.5	6	5	5	4.0	5.5	1.3
E-2	7	5	5.5	4.5	4.5	5.5	1.1
F-1	8	6	5	5.5	5.0	5.9	1.2
F-2	10	6	5	6	4.5	6.3	2.2
S	9.5	6	6.5	8	5.5	7.1	1.6
T-1	8.5	6	6	5.5	4.5	6.1	1.5
T-2	7	6.5	6	5	4.5	5.8	1.0
U-1	11	7.5	6	6	5.5	7.2	2.3
U-2	7.5	6.5	5.5	4.5	5.5	5.9	1.1
X-1	7	5.5	6.5	5.5	5.0	5.9	0.8
X-2	7	7	6	5.5	5.0	6.1	0.9
Y-1	7	6	6	4	4.5	5.5	1.2
Y-2	8	6	4	6	4.5	5.7	1.6

TABLE A-27

TOTAL ORGANIC CARBON
(mg C/1)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	4.5	-	6.0	3.5	5.0	4.8	1.0
B-1	8.5	-	6.0	4.5	5.5	6.1	1.7
B-2	6.0	-	6.0	6.5	5.0	5.9	0.6
C-1	7.0	-	8.0	11.5	5.5	8.0	2.5
C-2	6.5	-	6.0	10.0	6.0	7.1	1.9
D-1	6.5	-	5.0	6.5	5.0	5.8	0.9
D-2	5.0	-	8.0	5.0	4.5	5.6	1.6
E-1	4.0	-	5.0	5.5	5.0	4.9	0.6
E-2	6.5	-	5.0	5.5	5.0	5.5	0.7
F-1	4.0	-	6.0	17.5	5.0	8.1	6.3
F-2	6.0	-	5.0	7.5	5.5	6.0	1.1
S	5.5	-	7.0	7.0	7.0	6.6	0.8
T-1	5.0	-	8.0	5.5	5.5	6.0	1.4
T-2	7.5	-	5.0	6.0	5.0	5.9	1.2
U-1	4.5	-	7.0	12.0	5.0	7.1	3.4
U-2	5.0	-	6.0	6.0	5.5	5.6	0.5
X-1	6.0	-	7.0	4.5	4.0	5.4	1.4
X-2	7.5	-	6.0	5.0	5.5	6.0	1.1
Y-1	7.0	-	5.0	4.0	5.0	5.3	1.3
Y-2	6.0	-	5.0	6.5	5.0	5.6	0.8

TABLE A-28

TOTAL KJELDAHL NITROGEN
(mg N/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	0.62	0.56	0.84	0.94	-	0.74	0.18
B-1	0.84	0.54	0.61	0.67	0.80	0.69	0.13
B-2	0.60	0.62	0.65	0.84	1.09	0.76	0.21
C-1	0.31	0.41	0.47	0.40	0.50	0.42	0.07
C-2	0.30	0.33	0.27	0.34	0.46	0.34	0.07
D-1	0.32	0.39	0.37	0.37	0.32	0.36	0.03
D-2	0.31	0.40	0.34	0.34	0.42	0.36	0.05
E-1	0.35	0.32	0.40	0.36	0.44	0.37	0.05
E-2	0.30	0.29	0.37	0.40	0.36	0.34	0.05
F-1	0.32	0.33	0.27	0.42	0.30	0.33	0.06
F-2	0.32	0.20	0.50	0.25	0.71	0.40	0.21
S	0.32	0.38	0.41	0.52	0.53	0.43	0.09
T-1	0.29	0.21	0.28	0.34	0.55	0.33	0.13
T-2	0.31	0.24	0.16	0.28	0.50	0.30	0.13
U-1	0.37	0.21	0.22	0.27	0.47	0.31	0.11
U-2	0.30	0.21	0.20	0.37	-	0.27	0.08
X-1	0.27	0.42	0.26	-	0.31	0.32	0.07
X-2	0.26	0.30	0.34	0.39	0.34	0.33	0.05
Y-1	0.30	0.38	0.26	0.38	0.31	0.33	0.05
Y-2	0.28	0.46	0.27	0.43	0.38	0.36	0.09

TABLE A-29

TOTAL KJELDAHL NITROGEN
(mg N/1)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	0.75	0.74	0.72	0.75	6.45	1.88	2.55
B-1	0.65	0.68	0.76	0.78	1.58	0.89	0.39
B-2	0.74	0.59	0.71	0.78	1.43	0.85	0.33
C-1	0.40	0.32	0.41	0.68	0.74	0.51	0.19
C-2	0.46	0.40	0.39	0.62	0.64	0.50	0.12
D-1	0.38	0.26	0.37	0.62	0.41	0.41	0.13
D-2	0.42	0.21	0.43	-	0.38	0.36	0.10
E-1	0.31	0.28	0.29	0.39	0.34	0.32	0.04
E-2	0.39	0.19	0.27	0.30	0.32	0.29	0.07
F-1	0.30	0.20	0.27	0.52	0.46	0.35	0.13
F-2	0.23	0.22	0.28	0.37	0.40	0.30	0.08
S	0.42	0.23	0.40	0.32	0.38	0.35	0.08
T-1	0.27	0.14	0.32	0.45	0.41	0.32	0.12
T-2	0.27	0.13	0.37	0.52	0.44	0.35	0.15
U-1	0.44	0.25	0.37	0.45	0.47	0.40	0.09
U-2	0.33	0.23	0.30	0.43	0.48	0.35	0.10
X-1	0.45	0.21	0.30	0.43	0.47	0.37	0.11
X-2	0.47	0.20	0.34	0.53	0.42	0.39	0.13
Y-1	0.51	0.22	0.25	0.25	0.65	0.38	0.19
Y-2	0.67	0.23	0.33	0.29	0.67	0.44	0.21

TABLE A-30

AMMONIA
(mg N/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	0.08	0.07	0.36	0.48	0.60	0.32	0.24
B-1	0.03	0.35	0.06	0.13	0.37	0.19	0.16
B-2	0.03	0.06	0.12	0.25	0.37	0.17	0.14
C-1	0.01	0.02	0.06	0.04	0.12	0.05	0.04
C-2	0.01	0.02	0.05	0.06	0.02	0.03	0.02
D-1	0.01	0.03	0.04	0.04	0.01	0.03	0.02
D-2	0.01	0.02	0.05	0.06	0.01	0.03	0.02
E-1	0.01	0.02	0.04	0.04	0.01	0.02	0.02
E-2	0.01	0.01	0.05	0.04	0.01	0.02	0.02
F-1	<0.01	0.01	0.02	0.03	0.01	0.01	0.01
F-2	0.01	0.01	0.05	0.04	0.01	0.02	0.02
S	0.01	0.04	0.06	0.11	<0.01	0.06	0.04
T-1	0.01	0.02	0.06	0.07	0.01	0.03	0.03
T-2	0.01	0.02	0.03	0.07	0.02	0.03	0.02
U-1	0.02	0.04	0.04	0.06	0.37	0.11	0.14
U-2	0.01	0.01	0.04	0.03	0.07	0.03	0.02
X-1	0.06	0.01	0.02	0.01	0.01	0.02	0.02
X-2	0.03	0.01	0.01	<0.01	0.01	0.02	0.01
Y-1	0.04	0.01	0.02	0.02	0.02	0.02	0.01
Y-2	0.02	0.02	0.01	0.02	0.02	0.02	0.004

TABLE A-31

AMMONIA
(mg N/1)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	0.33	0.10	0.07	0.13	4.99	1.12	2.16
B-1	0.25	0.11	0.04	0.06	1.22	0.34	0.50
B-2	0.26	0.20	0.15	0.06	1.02	0.34	0.39
C-1	0.06	0.06	0.05	0.05	0.23	0.09	0.08
C-2	0.16	0.05	0.04	0.05	0.09	0.08	0.05
D-1	0.08	0.13	0.09	0.06	0.06	0.08	0.03
D-2	0.07	0.13	<0.02	0.07	0.11	0.08	0.05
E-1	0.05	0.16	0.03	0.09	0.07	0.08	0.05
E-2	0.04	0.13	<0.02	0.07	0.08	0.06	0.05
F-1	0.07	0.16	0.08	0.09	0.08	0.10	0.04
F-2	0.03	0.14	0.06	0.08	0.12	0.09	0.04
S	0.07	<0.02	0.04	0.03	0.08	0.04	0.03
T-1	0.16	0.05	0.04	0.08	0.08	0.08	0.05
T-2	0.14	0.05	<0.02	0.09	0.05	0.07	0.05
U-1	0.06	<0.02	<0.02	0.03	0.05	0.03	0.03
U-2	0.15	<0.02	<0.02	0.03	0.05	0.05	0.06
X-1	0.06	0.06	<0.02	0.07	0.04	0.05	0.03
X-2	0.12	0.04	<0.02	0.05	0.04	0.05	0.04
Y-1	0.12	<0.02	<0.02	<0.02	<0.02	0.02	0.05
Y-2	0.15	<0.02	<0.02	0.03	0.04	0.04	0.[illegible]

TABLE A-32

NITRITE
(mg N/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	0.189	0.217	0.271	0.310	0.270	0.251	0.048
B-1	0.112	0.142	0.076	0.073	0.182	0.117	0.046
B-2	0.135	0.142	0.126	0.193	0.226	0.164	0.043
C-1	0.027	0.047	0.039	0.038	0.037	0.038	0.007
C-2	0.051	0.040	0.056	0.049	0.069	0.053	0.010
D-1	0.028	0.043	0.029	0.040	0.040	0.036	0.007
D-2	0.029	0.026	0.023	0.026	0.035	0.028	0.005
E-1	0.023	0.024	0.022	0.023	0.025	0.023	0.001
E-2	0.013	0.025	0.022	0.024	0.023	0.021	0.005
F-1	0.022	0.020	0.021	0.021	0.020	0.021	0.001
F-2	0.015	0.019	0.020	0.020	0.019	0.019	0.002
S	0.018	0.020	0.025	0.027	0.028	0.024	0.004
T-1	0.018	0.019	0.020	0.022	0.022	0.020	0.002
T-2	0.017	0.018	0.019	0.021	0.021	0.019	0.002
U-1	0.019	0.020	0.019	0.022	0.023	0.021	0.002
U-2	0.019	0.019	0.020	0.021	0.022	0.020	0.001
X-1	0.009	0.010	0.008	0.009	0.009	0.009	0.001
X-2	0.009	0.009	0.008	0.008	0.008	0.008	0.001
Y-1	0.010	0.009	0.008	0.009	0.009	0.009	0.001
Y-2	0.013	0.013	0.009	0.014	0.015	0.013	0.002

TABLE A-33

NITRITE
(mg N/1)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	0.183	0.158	0.216	0.178	0.170	0.181	0.021
B-1	0.179	0.072	0.053	0.141	0.113	0.112	0.051
B-2	0.149	0.132	0.102	0.092	0.100	0.115	0.024
C-1	0.034	0.026	0.045	0.051	0.057	0.043	0.013
C-2	0.067	0.020	0.027	0.048	0.025	0.037	0.020
D-1	0.027	0.023	0.030	0.043	0.019	0.028	0.009
D-2	0.034	0.023	0.029	0.022	0.009	0.023	0.009
E-1	0.014	0.022	0.018	0.021	0.009	0.017	0.005
E-2	0.012	0.012	0.013	0.009	0.014	0.012	0.002
F-1	0.011	0.009	0.010	0.009	0.012	0.010	0.001
F-2	0.009	0.008	0.008	0.007	0.013	0.009	0.002
S	0.010	0.010	0.010	0.011	0.014	0.011	0.002
T-1	0.012	0.010	0.010	0.008	0.009	0.010	0.001
T-2	0.012	0.010	0.009	0.008	0.009	0.010	0.002
U-1	0.013	0.010	0.009	0.008	0.009	0.010	0.002
U-2	0.014	0.012	0.009	0.008	0.008	0.010	0.003
X-1	0.005	0.005	0.004	0.004	0.005	0.005	0.001
X-2	0.005	0.005	0.004	0.003	0.004	0.004	0.001
Y-1	0.005	0.005	0.004	0.004	0.005	0.005	0.001
Y-2	0.005	0.005	0.005	0.004	0.005	0.005	0.000

TABLE A-34

NITRATE
(mg N/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	3.84	3.41	4.96	5.84	7.17	5.04	1.52
B-1	2.18	2.40	2.23	2.20	3.82	2.57	0.71
B-2	2.45	2.50	2.48	3.96	5.33	3.34	1.28
C-1	0.59	1.13	0.95	0.89	1.04	0.92	0.21
C-2	1.00	0.85	1.26	0.99	1.61	1.14	0.30
D-1	0.55	1.06	0.66	0.93	0.95	0.83	0.21
D-2	0.56	0.69	0.52	0.56	0.82	0.63	0.12
E-1	0.52	0.92	0.50	0.54	0.68	0.63	0.18
E-2	0.18	0.63	0.51	0.56	0.53	0.48	0.17
F-1	0.27	0.44	0.42	0.46	0.43	0.40	0.76
F-2	0.35	0.40	0.43	0.49	0.40	0.41	0.05
S	0.61	1.03	1.34	1.29	1.46	1.15	0.34
T-1	0.40	0.56	0.59	0.58	0.58	0.54	0.09
T-2	0.39	0.52	0.46	0.58	0.68	0.52	0.11
U-1	0.37	0.46	0.48	0.56	0.65	0.50	0.11
U-2	0.39	0.47	0.46	0.47	0.86	0.53	0.19
X-1	0.15	0.23	0.23	0.26	0.19	0.21	0.04
X-2	0.24	0.25	0.23	0.25	0.18	0.23	0.03
Y-1	0.17	0.26	0.25	0.32	0.22	0.24	0.06
Y-2	0.17	0.26	0.25	0.27	0.33	0.26	0.06

TABLE A-35

NITRATE
(mg N/1)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	2.45	2.38	2.32	1.97	1.30	2.08	0.48
B-1	2.51	1.42	1.52	1.81	1.10	1.67	0.53
B-2	2.45	1.85	1.62	1.41	1.09	1.68	0.51
C-1	1.01	0.76	1.26	1.41	1.44	1.18	0.29
C-2	1.40	0.57	1.37	1.18	0.52	1.01	0.43
D-1	0.80	0.79	1.00	1.14	0.43	0.83	0.27
D-2	0.73	0.56	1.13	0.59	0.35	0.67	0.29
E-1	0.41	0.72	0.47	0.53	0.37	0.50	0.14
E-2	0.39	0.46	0.41	0.30	0.51	0.41	0.08
F-1	0.46	0.44	0.36	0.29	0.41	0.39	0.07
F-2	0.49	0.46	0.34	0.27	0.39	0.39	0.09
S	0.61	0.41	0.62	0.69	0.96	0.66	0.20
T-1	0.48	0.34	0.37	0.33	0.37	0.38	0.06
T-2	0.40	0.35	0.35	0.29	0.26	0.33	0.06
U-1	0.69	0.33	0.37	0.28	0.24	0.38	0.18
U-2	0.39	0.36	0.37	0.32	0.25	0.34	0.06
X-1	0.34	0.09	0.24	0.13	0.06	0.17	0.12
X-2	0.13	0.09	0.12	0.12	0.05	0.10	0.03
Y-1	0.16	0.10	0.15	0.23	0.07	0.14	0.06
Y-2	0.15	0.14	0.20	0.15	0.06	0.14	0.05

TABLE A-36

TOTAL PHOSPHORUS
(mg P/1)

Station	6/9/75	6/10/75	6/11/75	6/12/75	6/13/75	Mean	Standard Deviation
A	0.022	0.023	0.012	0.015	0.016	0.018	0.005
B-1	0.017	0.017	0.032	0.043	0.019	0.025	0.012
B-2	0.020	0.022	0.027	0.031	0.022	0.024	0.005
C-1	0.020	0.025	0.033	0.042	0.025	0.030	0.009
C-2	0.020	0.025	0.034	0.034	0.022	0.027	0.007
D-1	0.018	0.024	0.029	0.034	0.022	0.025	0.006
D-2	0.020	0.021	0.024	0.028	0.018	0.022	0.004
E-1	0.023	0.021	0.025	0.027	0.021	0.023	0.003
E-2	0.011	0.018	0.023	0.029	0.018	0.020	0.007
F-1	0.017	0.020	0.019	0.031	0.021	0.022	0.005
F-2	0.022	0.019	0.023	0.030	0.021	0.023	0.004
S	0.011	0.025	0.037	0.043	0.027	0.029	0.012
T-1	0.012	0.021	0.022	0.033	0.020	0.022	0.008
T-2	0.009	0.020	0.025	0.027	0.017	0.020	0.007
U-1	0.011	0.019	0.021	0.030	0.018	0.020	0.007
U-2	0.013	0.020	0.022	0.028	0.019	0.020	0.005
X-1	0.018	0.019	0.042	0.031	0.019	0.026	0.011
X-2	0.036	0.016	0.026	0.026	0.016	0.024	0.008
Y-1	0.019	0.019	0.028	0.028	0.017	0.022	0.005
Y-2	0.017	0.021	-	0.028	0.020	0.022	0.005

TABLE A-37

TOTAL PHOSPHORUS
(mg P/1)

Station	8/11/75	8/12/75	8/13/75	8/14/75	8/15/75	Mean	Standard Deviation
A	0.019	0.033	0.023	0.025	0.030	0.026	0.006
B-1	0.027	0.038	0.074	0.053	0.025	0.043	0.020
B-2	0.031	0.032	0.046	0.037	0.038	0.037	0.006
C-1	0.042	0.030	0.051	0.065	0.048	0.047	0.013
C-2	0.031	0.032	0.024	0.037	0.054	0.036	0.011
D-1	0.025	0.033	0.020	0.033	0.031	0.028	0.006
D-2	0.030	0.034	0.031	0.034	0.032	0.032	0.002
E-1	0.019	0.034	0.028	0.029	0.027	0.027	0.005
E-2	0.030	0.075	0.016	0.027	0.022	0.034	0.024
F-1	0.021	0.024	0.025	0.024	0.024	0.024	0.002
F-2	0.019	0.029	0.029	0.096	0.041	0.043	0.031
S	0.030	0.034	0.041	0.025	0.041	0.034	0.007
T-1	0.029	0.027	0.026	0.023	0.030	0.027	0.003
T-2	0.028	0.032	0.025	0.193	0.027	0.061	0.074
U-1	0.021	0.027	0.022	0.115	0.022	0.041	0.041
U-2	0.032	0.027	0.022	0.039	0.021	0.028	0.007
X-1	0.020	0.025	0.016	0.115	0.014	0.038	0.043
X-2	0.023	0.024	0.018	0.017	0.015	0.019	0.004
Y-1	0.024	0.020	0.015	0.018	0.015	0.018	0.004
Y-2	0.030	0.187	0.026	0.020	0.013	0.055	0.074

APPENDIX A-4

TRACE METALS IN HARRISON BAY, LAKE CHICKAMAUGA

JUNE 9-13, 1975
AUGUST 11-15, 1975

Waconda Bay
Reference Bay A
Huss Lowe Slough

TABLE A-38

DAY TO DAY VARIATION IN IRON AND LEAD
AT SELECTED STATIONS IN WACONDA BAY
JUNE 2-6, 1975

Iron (mg Fe/l)

Date	A	Station C-1	C-2
June 2	0.31	0.17	0.30
June 3	0.27	0.21	0.23
June 4	0.19	0.17	0.29
June 5	0.25	0.25	0.31
June 6	0.27	0.22	0.28

Lead (mg Pb/l)

Date	A	Station C-1	C-2
June 2	0.006	0.014	0.008
June 3	0.018	0.014	0.008
June 4	0.015	0.017	0.012
June 5	0.012	0.006	0.012
June 6	0.010	0.008	<0.002

TABLE A-39

SELECTED METALS IN HARRISON BAY, CHICKAMAUGA LAKES, JUNE 4, 1975

Station	Metal Concentration (μg/l)						
	Cd	Cr^{+6}	Cu	Fe	Pb	Ni	Zn
A	<5	<5	7	190	15	6	<2
C-1	<5	<5	<5	170	17	5	2
F-1	<5	<5	<5	82	17	5	<2
S	<5	<5	<5	160	21	<5	<2
X-1	<5	<5	<5	120	17	<5	<2

TABLE A-40

SELECTED METALS IN HARRISON BAY, CHICKAMAUGA LAKE, AUGUST SURVEY, 1975

Metal	Date	A	B-1	B-2	C-1	C-2	D-1	D-2	F-1	F-2	S	Y-1	Y-2
Pb	August 11	<15	<15								<15	<15	
	12	21/15	<15	<15	<15	<15	<5		<15		<15	<15	<15/<15/<15
	13	<15	8								<15	<15	
	14	18			<15	<15			<15		<15	<15	
	15	<15/<15	<15/<15								<15	<15/15	
Ni	August 11	<5	7								6	<5	
	12	<5/6	17	<5	5	16	<5		<5		<5	<5	<5/<5/<5
	13	<5	<5								15	<5	
	14	9			7	14			20		<5	8	
	15	<5/<5	6/5								<5	12/12	
Zn	August 11	26	85								19	8	
	12	18/30	21	46	28	21	57		48		23	14/2/15	
	13	19	15								46	33	
	14	22			35	22			30		22	48	
	15	38/40	34/26								19	35/48	
Fe	August 12		259	221			126					113	
Cr^{+6}	August 12		<5	<5			<5					<5	
Cu	August 12		<5	<5			<5					<5	

APPENDIX A-5

MUNITIONS RESIDUES IN CHICKAMAUGA LAKE
JUNE AND AUGUST, 1975

Waconda Bay
Reference Bay A
Huss Lowe Slough

TABLE A-41

VOLUNTEER ARMY AMMUNITIONS PLANT MUNITIONS RESIDUES
JUNE, 1975

STATION	A				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-161	B-58	B-205	B-190	B-124
2,4 DNT, ppb	40	0	130	172	0
2,6 DNT, ppb	81	0	144	0	0
TNT, ppb	2	0	71	51	0

STATION	B-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-27	B-57	B-45	B-183	B-132
2,4 DNT, ppb	19	56	26	52	87
2,6 DNT, ppb	19	0	4	16	40
TNT, ppb	11	<2	3	17	51

STATION	B-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-25	B-54	B-46	B-191	B-128
2,4 DNT, ppb	0	0	80	137	114
2,6 DNT, ppb	0	0	87	0	45
TNT, ppb	<2	0	10	63	102

STATION	C-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-157	B-166	B-38	B-198	B-44
2,4 DNT, ppb	0	<2	<2	<2	<2
2,6 DNT, ppb	0	0	0	68	0
TNT, ppb	0	<2	0	12	0

STATION	C-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-160	B-49	B-42	B-203	B-43
2,4 DNT, ppb	<2	0	31	51	52
2,6 DNT, ppb	0	0	64	96	0
TNT, ppb	0	0	2	0	2

TABLE A-41 (Continued)

STATION	D-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-34	B-93	B-37	B-188	B-92
2,4 DNT, ppb	0	<2	<2	0	<2
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	<2	0	0

STATION	D-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-30	B-90	B-41	B-184	B-85
2,4 DNT, ppb	16	40	19	32	17
2,6 DNT, ppb	0	<2	0	0	0
TNT, ppb	0	4	0	6	3

STATION	E-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-32	B-94	B-211	B-195	B-31
2,4 DNT, ppb	<2	0	0	0	<2
2,6 DNT, ppb	<2	0	0	0	0
TNT, ppb	2	0	<2	15	2

STATION	E-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-168	B-96	B-214	B-187	B-197
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

STATION	F-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-35	B-95	B-206	B-202	B-193
2,4 DNT, ppb	0	0	0	0	Sample broken
2,6 DNT, ppb	0	0	0	0	in shipment
TNT, ppb	0	0	0	0	

TABLE A-41 (Continued)

STATION	F-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-33	B-53	B-208	B-196	B-201
2,4 DNT, ppb	12	0	10	0	13
2,6 DNT, ppb	16	0	0	0	21
TNT, ppb	0	8	6	4	0

STATION	S-[illegible]				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-26	B-56	B-39	B-181	B-129
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	<.2	0	0	0	<2

STATION	T-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-29	B-51	B-47	B-182	B-130
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

STATION	T-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-159	B-52	B-40	B-189	B-126
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

STATION	U-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-36	B-55	B-209	B-185	B-131
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

TABLE A-41 (Continued)

STATION	U-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-162	B-50	B-48	B-186	B-127
2,4 DNT, ppb	0	2	0	0	0
2,6 DNT, ppb	0	0	0	0	<2
TNT, ppb	0	0	0	0	0

STATION	X-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-165	B-86	B-210	B-192	B-209
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	<2	0	0	0	0

STATION	X-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-165	B-86	B-210	B-192	B-209
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	<2	0	0	0

STATION	Y-1				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-164	B-91	B-216	B-199	B-213
2,4 DNT, ppb	<2	0	<2	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

STATION	Y-2				
DATE	6-9-75	6-10-75	6-11-75	6-12-75	6-13-75
SAMPLE NO.	B-158	B-89	B-215	B-204	B-194
2,4 DNT, ppb	0	0	[illegible]	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	<2	0	0

TABLE A-42

VOLUNTEER ARMY AMMUNITIONS PLANT MUNITIONS RESIDUES
AUGUST, 1975

STATION	A				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-186	BA-153	BA-96	BA-47	BA-16
2,4 DNT, ppb	12	71	17	58	Sample broken in shipment
2,6 DNT, ppb	20	100	28	31	
TNT, ppb	14	24	38	70	

STATION	B-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-182	BA-152	Ba-89	BA-41	BA-10
2,4 DNT, ppb	30	< 2	< 2	< 2	45
2,6 DNT, ppb	10	< 2	< 2	< 2	11
TNT, ppb	11	< 2	10	< 2	12

STATION	B-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-187	BA-151	BA-88	BA-44	BA-11
2,4 DNT, ppb	51	86	45	27	62
2,6 DNT, ppb	65	116	60	72	88
TNT, ppb	8	9	15	28	8

STATION	C-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-183	BA-146	BA-129	BA-46	BA-18
2,4 DNT, ppb	8	0	44	38	42
2,6 DNT, ppb	< 2	70	71	97	< 2
TNT, ppb	0	7	0	< 2	0

STATION	C-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-189	BA-145	BA-95	BA-37	BA-19
2,4 DNT, ppb	27	< 2	11	< 2	28
2,6 DNT, ppb	30	28	0	38	35
TNT, ppb	0	< 2	0	< 2	0

TABLE A-42 (Continued)

STATION	D-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-217	BA-94	BA-195	BA-38	BA-22
2,4 DNT, ppb	0	0	0	0	Sample broken in shipment
2,6 DNT, ppb	0	0	0	0	
TNT, ppb	0	0	0	0	

STATION	D-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-220	BA-90	BA-198	BA-39	BA-14
2,4 DNT, ppb	15	< 2	< 2	0	0
2,6 DNT, ppb	0	< 2	< 2	0	0
TNT, ppb	0	0	0	< 2	0

STATION	E-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-224	BA-87	BA-196	BA-48	BA-8
2,4 DNT, ppb	< 2	0	< 2	0	0
2,6 DNT, ppb	< 2	0	0	0	0
TNT, ppb	0	0	< 2	0	0

STATION	E-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-225	BA-91	BA-197	BA-45	BA-1
2,4 DNT, ppb	0	< 2	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	< 2	0	0	0	0

STATION	F-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-226	BA-147	BA-202	BA-43	BA-2
2,4 DNT, ppb	0	0	0	0	< 2
2,6 DNT, ppb	10	0	0	0	0
TNT, ppb	< 2	< 2	0	0	0

TABLE A-42 (Continued)

STATION	F-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-221	BA-148	BA-203	BA-40	BA-5
2,4 DNT, ppb	<2	<2	Sample	0	<2
2,6 DNT, ppb	15	20	broken in	0	0
TNT, ppb	<2	2	shipment	0	<2

STATION	S				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-181	BA-157	BA-201	BA-42	BA-20
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNR, ppb	0	0	0	0	0

STATION	T-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-191	BA-149	BA-184	BA-68	BA-3
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

STATION	T-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-192	BA-155	BA-223	BA-61	BA-9
2,4 DNT, ppb	0	<2	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

STATION	U-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-190	BA-150	BA-188	BA-67	BA-4
2,4 DNT, ppb	<2	<2	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

TABLE A-42 (Continued)

STATION	U-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-185	BA-154	BA-130	BA-62	BA-6
2,4 DNT, ppb	0	0	<2	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

STATION	X-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-222	BA-86	BA-199	BA-64	BA-24
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	<2	0	0	0	0

STATION	X-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-219	BA-92	BA-204	BA-63	BA-23
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	<2	0

STATION	Y-1				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-227	BA-93	BA-193	BA-66	BA-21
2,4 DNT, ppb	0	Sample	0	0	0
2,6 DNT, ppb	0	broken in	0	0	0
TNT, ppb	0	shipment	0	0	0

STATION	Y-2				
DATE	8-11-75	8-12-75	8-13-75	8-14-75	8-15-75
SAMPLE NO.	BA-218	BA-85	BA-200	BA-65	BA-15
2,4 DNT, ppb	0	0	0	0	0
2,6 DNT, ppb	0	0	0	0	0
TNT, ppb	0	0	0	0	0

APPENDIX A-6

HISTORICAL WATER QUALITY
CHICKAMAUGA LAKE

TABLE A-43

SUMMARY OF WATER QUALITY DATA
CHICKAMAUGA LAKE, EPA
JUNE - OCTOBER, 1973*

Parameter	Mean	Maximum	Minimum
Water Temperature (°C)	21.6	26.5	18.9
Transparency (Secchi in inches)	38.0	42.0	33.0
Field Conductivity (μmhos/cm)	162	176	150
Dissolved Oxygen (mg/l)	6.9	8.0	5.8
pH (SU)	7.5	7.6	7.3
Total Alkalinity (mg $CaCO_3$/l)	54.6	62.0	46.0
Ammonia (mg N/l)	0.08	0.11	0.05
Total Kjeldahl N (mg N/l)	0.34	0.7	0.2
Nitrite plus Nitrate (mg N/l)	0.37	0.43	0.32
Total Phosphorus (mg P/l)	0.03	0.05	0.21
Chlorophyll a (μg/l)	4.07	5.8	2.3
Water Depth (feet)	55.0	65.0	50.0

*Mile 477.3, Mid-channel South of Black Can Buoy. At Jct. of River Channels at tip of Harrison Bluff, 240° from center of John A. Patten Island, 100 yards East of bluff with caves at water level.

TABLE A-44

SUMMARY OF WATER QUALITY DATA
CHICKAMAUGA LAKE AT DAM WALL
JUNE - OCTOBER, 1973, EPA *

Parameter	Mean	Maximum	Minimum
Water Temperature (°C)	21.6	26.6	19.0
Transparency (Secchi in inches)	38.3	40.0	36.0
Field Conductivity (μmhos/cm)	157	120	120
Dissolved Oxygen (mg/l)	6.95	8.4	5.8
pH (SU)	7.46	7.6	7.3
Total Alkalinity (mg $CaCo_3$/l)	59.4	61.0	57.0
Ammonia (mg N/l)	0.07	0.09	0.05
Total Kjeldahl N (mg N/l)	0.28	0.60	0.20
Nitrite plus Nitrate (mg N/l)	0.37	0.40	0.34
Total Phosphorus (mg P/l)	0.03	0.04	0.02
Chlorophyll <u>a</u> (μg/l)	3.0	3.7	2.3
Water Depth (feet)	50.0	54.0	47.0

*130° from flags at lock of Chickamauga Dam, adjacent to middle of 3 "danger" buoys, east of sluice gates about 150 yards.

TABLE A-45

CHICKAMAUGA LAKE WATER QUALITY DATA
TVA, (1974) TENNESSEE RIVER MILE 472.3

Date	Depth, Feet	Total Coliforms, MPN/100 ml	Temperature, °C	D.O., mg/l	BOD, mg/l	Color, PCU	Turbidity, JTU	Alkalinity, mg/l	Hard. $CaCO_3$, mg/l	pH,	Specific Resistance, µmhos	Cl, mg/l
1960												
7/12	Surf.	11	28.0	7.70	1.90	5	6.0	48.4	75.2	8.2	4,800	13.4
	10		27.2	7.40						8.1		
	20		26.2	6.49						7.9		
	30		25.4	5.15						7.6		
	40		24.4	4.40						7.6		
	50		24.2	4.00						7.5		
	55		24.3	3.92						7.4		
8/5	Surf.	5.2	28.8	7.96	1.37	10	5.2	53.0	74.4	8.2	5,300	12.7
	10		28.4	7.78						8.1		
	20		26.9	5.40						7.8		
	30		25.6	3.81						7.4		
	40		25.3	3.61	1.39	10	9.4	53.9	78.3	7.4	5,000	12.9
	50		24.9	3.57						7.4		
	54		24.9	3.50						7.9		
8/23	Surf.	2.6	29.1	8.11	1.74	10	3.8	51.2	75.0	8.3	5,400	9.93
	5		27.2	8.06						8.1		
	10		25.8	6.63						7.9		
	20		25.7	5.65						7.7		
	30		25.3	5.32						7.6		
	40		25.1	4.83	0.77	10	21	50.5	74.6	7.6	5,400	10.2
	50		25.0	4.73						7.6		
	55		24.7	4.64						7.7		
9/22	Surf.	110	24.8	6.63	1.33	10	6.3	47.2	75.0	7.6	4,800	18.9
	5		24.3	6.63						7.6		
	10		24.2	6.31						7.6		
	20		24.1	6.31						7.6		
	30		24.2	6.33	1.38	10	11	47.0	72.2	7.6	4,900	18.8
	40		24.1	6.33						7.6		
	50		24.1	6.14						7.6		
	55		24.0	6.17						7.6		

TABLE A-45 (Continued)

Date 1960	Depth Feet	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Fe, Total	Nitrite+ Nitrate Nitrogen mg/l	SiO_2 mg/l	SO_4 mg/l	Solids: Suspended mg/l	Solids: Dissolved mg/l	Solids: Total mg/l
7/12	Surf.	23.4	8.60	7.40	0.80	0.19	0.00	0.80	17.6	21	83	104
8/5	Surf.	22.6	5.09	6.90	0.80	0.10	0.00	3.56	18.2	4	114	118
	40	22.8	6.10	7.10	0.85	0.28	0.18	3.88	18.2	28	96	124
8/23	Surf.	22.1	5.66	6.60	0.85	0.03	0.00	3.70	17.3	4	92	96
	40	23.0	4.84	6.10	0.85	0.07	0.42	3.90	18.2	6	112	118
9/22	Surf.	22.3	5.54	8.90	0.90	0.24	0.08	5.92	15.5	12	128	140
	30	22.0	4.91	9.40	1.00	0.33	0.22	6.64	15.5	38	109	147

TABLE A-45 (Continued)

Date	Depth Feet	Total Coliforms, MPN/100 ml	Temperature ° C	D.O., mg/l	BOD, mg/l	Color, PCU	Turbidity, JTU	Alkalinity, mg/l	Hard. $CaCO_3$, mg/l	pH,	Specific Resistance, µmhos	Cl mg/l
1960												
10/18	Surf.	160	23.6	8.08	1.84	10	6.3	50.3	74.4	7.9	4,500	21.6
	5		23.1	7.97						7.9		
	10		22.7	7.24						7.8		
	20		22.4	6.67						7.8		
	30		22.4	6.66	0.99	10	9.8	49.2	73.5	7.7	4,700	19.3
	40		22.4	6.72						7.7		
	50		22.4	6.67						7.7		
11/22	Surf.	280	13.9	9.23	1.64	15	6.7	46.4	70.2	7.6	4,800	19.0
	5		13.1	8.84						7.5		
	10		12.8	8.71						7.5		
	20		12.8	9.31						7.6		
	30		12.8	8.65	1.50	15	8.6	47.0	70.2	7.5	4,700	20.1
	42		12.8	8.60						7.5		
12/13	Surf.	6,200	8.9	10.28	2.94	15	11	48.0	70.0	7.6	5,000	18.6
	10		8.9	10.30						-		
	20		8.9	10.20						-		
	30		8.9	10.18						-		
	40		8.9	10.26						-		
	50		8.9	10.20	1.46	15	14	48.5	70.0	7.6	5,000	18.1
1961												
1/19	Surf.	70,000	6.0	11.35	1.34	15	9.4	46.0	64.0	7.3	5,600	13.6
	5		6.0	11.36						-		
	10		6.0	11.35						-		
	20		6.0	11.38						-		
	30		6.0	11.35	1.36	15	11	45.0	62.9	-	5,600	13.6
	40		6.0	11.54						-		
	48		6.0	11.42						7.3		
2/21	Surf.	220	8.3	12.14	1.73	20	14	55.4	76.2	7.5	4,800	15.2
	5		8.3	12.12						-		
	10		8.3	11.98						-		
	20		8.3	12.12						-		
	30		8.3	11.99	1.38	15	14	56.0	76.2	7.5	4,800	15.4
	40		8.3	11.02						-		
	50		8.3	12.05						-		

TABLE A-45 (Continued)

Date	Depth Feet	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Fe, Total mg/l	Nitrite+ Nitrate Nitrogen mg/l	SiO_2 mg/l	SO_4 mg/l	Solids Suspended mg/l	Solids Dissolved mg/l	Solids Total mg/l
1960 10/18	Surf.	22.1	5.47	9.50	1.00	0.16	0.48	6.12	15.5	21	67	88
	30	22.1	5.22	9.50	1.00	0.28	0.08	7.20	15.5	5	96	101
11/22	Surf.	18.9	6.54	10.0	0.95	0.32	0.10	6.12	18.2	27	70	97
	30	19.0	6.48	11.0	1.00	0.44	0.15	6.80	15.5	16	92	108
12/13	Surf.	21.1	4.91	9.80	1.00	0.39	0.10	7.04	19.1	4	91	95
	50	21.7	4.53	9.80	1.00	0.42	0.10	7.54	18.2	37	100	137
1961 1/19	Surf.	18.8	4.72	7.50	0.85	0.29	0.22	7.00	18.2	19	75	94
	30	19.2	4.09	6.90	0.85	0.27	0.32	6.64	16.4	14	75	89
2/21	Surf.	22.6	5.41	7.90	0.90	0.19	0.22	6.48	20.9	16	107	123
	30	22.7	5.35	7.50	0.85	0.25	0.28	6.28	20.9	33	93	126

TABLE A-45 (Continued)

Date	Depth Feet	Total Coliforms, MPN/100 ml	Temperature ° C	D.O., mg/l	BOD, mg/l	Color, PCU	Turbidity, JTU	Alkalinity, mg/l	Hard. $CaCO_3$, mg/l	pH,	Specific Resistance, µmhos	Cl mg/l
1961												
3/21	Surf.	1,300	11.3	9.68	1.12	10	30	45.8	58.7	8.1	6,600	5.84
	10		11.3	9.62						8.1		
	20		11.3	9.54						8.1		
	30		11.3	9.54	1.58	15	29	46.5	59.2	8.0	6,600	5.84
	40		11.3	9.61						8.0		
	50		11.3	9.59						7.9		
4/18	Surf.	36	14.0	10.17	1.44	15	21	40.8	58.1	8.0	7,200	7.42
	5		14.0	10.21						8.0		
	10		14.0	10.07						8.0		
	20		14.0	10.07						7.9		
	30		14.0	10.01						7.9		
	40		14.0	9.93	1.36	15	23	41.4	58.3	7.9	7,100	7.56
	50		14.0	10.00						7.8		
	60		13.3	10.00						7.8		
5/16	Surf.	6.0	21.0	9.08	1.14	10	5.0	44.9	55.6	7.9	7,700	4.30
	5		20.8	9.10						-		
	10		20.6	9.03						-		
	20		19.6	8.80						-		
	30		18.6	8.31						-		
	40		17.8	8.57	1.53	15	17	46.0	54.1	7.7	7,300	4.50
	55		17.4	8.27						-		
6/14	Surf.	2.6	26.2	8.40	1.40	15	5.0	48.9	63.6	8.8	7,200	6.99
	5		26.2	8.42						8.8		
	10		25.7	8.33						8.6		
	20		23.7	7.82						8.5		
	30		22.6	6.17	0.86	15	11	48.8	63.6	8.0	6,900	7.09
	40		22.1	5.26						7.9		
	50		21.9	4.97						7.8		
Maximum Values		70,000	29.1	12.14	2.94	20	30	56.0	78.3	8.8	7,700	21.6
Minimum Values		2.6	6.0	3.50	0.77	5	3.8	40.8	54.1	7.3	4,500	4.30

TABLE A-45 (Continued)

Date	Depth Feet	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Fe, Total mg/l	Nitrite+ Nitrate Nitrogen mg/l	SiO_2 mg/l	SO4 mg/l	Solids Suspended mg/l	Solids Dissolved mg/l	Solids Total mg/l
1961 3/21	Surf.	17.6	2.86	3.50	1.00	1.88	0.28	7.90	30.4	11	103	114
	30	17.1	3.32	3.00	0.95	1.58	0.22	8.40	30.4	11	109	120
4/18	Surf.	14.9	4.31	4.30	0.85	0.64	0.18	5.92	13.6	6	80	86
	40	15.2	4.43	4.50	0.80	0.77	0.18	6.02	13.6	4	72	76
5/16	Surf.	16.9	4.03	4.64	0.95	0.08	0.00	5.20	11.8	26	66	92
	40	17.8	2.96	4.20	0.80	0.12	0.10	6.44	27.9	6	85	91
6/14	Surf.	19.4	5.85	4.55	0.95	0.01	0.10	4.74	12.8	29	90	119
	30	18.2	5.41	4.35	0.90	0.15	0.15	5.40	12.8	16	71	87
Maximum Values		23.4	8.60	11.0	1.00	1.88	0.48	8.40	30.4	38	128	147
Minimum Values		14.9	2.86	3.00	0.80	0.01	0.00	0.80	11.8	4	66	76

TABLE A-46

OBSERVED TRACE METAL CONCENTRATIONS (TOTAL) IN VICINITY OF WATER INTAKE

SEQUOYAH NUCLEAR PLANT

Tennessee River Mile 484.1

All results expressed as micrograms per liter (ug/l)

Date of Sample	Depth ft.	Fe	Mn	Cu	Zn	Cr*	Ni	Al	Ag	Pb	Hg	Ba	As	Cd	Se	Be
5/3/71	3	310		<10	20	<50	<50									
8/2/71	3	300		<10	70	<50	<50									
11/8/71	3	370	90.0	<10	30	<50	<50									
2/1/72	3	510		<10	50	12	<50									
5/2/72	3	280	50.0	10	50	<10	<50									
8/1/72	3	310	60.0	<10	20	<5	<50									
11/8/72	3	590	80.0	<10	20	<5	<50									
2/28/73	3	690	60.0	<10	60	<5	<50	700	<10	<10	0.2	<100	<5	<1	1	<10
	39	710	70.0	<10	150	<5	<50	1200	<10	<10	0.4	<100	<5	<1	1	<10
5/21/73	3	450	60.0	20	80	<5	<50	1000	<10	<10	<0.2	<100	<5	<1	<1	<10
	39	620	80.0	10	80	<5	<50	1200	<10	<10	<0.2	<100	<5	<1	<1	<10

*Precision of analysis was improved during the sampling period

TABLE A-47

SEDIMENT CHEMICAL CHARACTERISTICS
HARRISON BAY, LAKE CHICKAMAUGA AT VAAP, JUNE 1975

Station	Solids % Total	Solids % Volatile	TKN (gm/Kg Dry Wt)	COD (gm/Kg Dry Wt)	Total P (gm Kg Dry Wt)	NO_2-N (mg/Kg Dry Wt)	NO_3-N (mg/Kg Dry Wt
A	41.9	9.3	1.4	8.3	2.40	1.8	44
B-1	59.6	6.8	1.3	12.7	0.91	1.5	54
B-2	50.7	8.8	1.1	8.6	1.80	1.4	92
C-1	62.7	4.2	1.2	9.9	0.57	1.3	-
C-2	54.4	6.9	1.6	14.6	0.45	2.3	46
D-1	74.0	1.4	0.4	5.7	0.47	<1	42
D-2	49.1	11.0	1.8	11.2	1.10	2.3	47
E-1	63.4	6.7	0.7	9.6	0.44	1.3	26
E-2	77.4	1.1	-	2.5	0.18	<1	10
F-1	51.9	5.0	1.9	11.1	0.59	1.8	21
F-2	59.9	3.9	0.3	1.7	0.26	<1	11
S	68.1	3.1	0.3	4.5	0.26	1.2	-
T-1	62.4	4.6	-	12.5	0.34	<1	37
T-2	65.0	3.9	0.8	6.2	0.46	<1	190
U-1	47.3	4.3	-	1.4	0.41	<1	100
U-2	53.8	2.7	0.6	3.3	0.32	1.3	31
X-1	78.9	1.3	0.3	6.4	0.13	2.0	43
X-2	67.7	3.2	0.7	9.1	0.12	1.4	110
Y-1	63.3	5.7	0.4	3.6	0.22	<1	50
Y-2	63.6	5.3	0.5	2.3	0.24	1.3	120

TABLE A-48

SEDIMENT CHEMICAL CHARACTERISTICS
HARRISON BAY, LAKE CHICKAMAUGA AT VAAP, AUGUST 1975

Station	Solids % Total	Solids % Volatile	TKN (gm/Kg Dry Wt)	COD (gm/Kg Dry Wt)	Total P (gm Kg Dry Wt)	NO_2-N (mg Kg Dry Wt)	NO_3-N (mg Kg Dry Wt)
A	23.5	16.5	4.6	15.0	0.51	4.1	66
B-1	65.0	7.1	1.0	5.6	1.40	1.4	45
B-2	64.0	5.5	0.4	1.2	0.24	0.83	120
C-1	54.0	5.7	1.6	4.4	0.41	2.0	65
C-2	42.0	8.5	2.1	8.7	2.10	3.1	26
D-1	62.0	3.4	0.5	3.5	0.34	1.2	16
D-2	41.5	2.9	2.1	82.	1.00	1.7	180
E-1	64.0	5.3	0.4	1.8	0.3	1.2	12
E-2	75.0	3.2	0.5	1.7	0.4	2.5	11
F-1	33.0	8.4	2.8	8.2	0.6	1.7	11
F-2	75.0	0.9	0.1	0.4	0.2	0.67	7
S	68.0	4.6	0.4	2.5	0.23	1.2	9
T-1	56.0	7.1	1.2	5.1	0.34	2.2	39
T-2	59.0	4.9	0.4	2.6	0.42	3.9	8
U-1	63.0	5.5	0.7	0.8	0.34	0.51	23
U-2	62.0	5.5	0.8	2.0	0.41	1.2	57
X-1	77.0	2.0	0.03	1.6	-	0.78	26
X-2	69.0	4.0	0.4	1.2	0.11	<0.81	6
Y-1	66.0	5.8	0.7	0.6	0.18	0.66	16
Y-2	72.0	5.0	0.4	0.6	0.19	0.66	22

TABLE A-49

SEDIMENT METAL CONCENTRATIONS
HARRISON BAY, LAKE CHICKAMAUGA, JUNE 1975

Station	Metal Concentration (mg/Kg Dry Wt)							Metal Concentration (gm/Kg Dry Wt)	
	Cd	Cr^{+6}	Cu	Hg	Ni	Pb	Zn	Fe	Mn
A	3.5	140	22	0.67	36	200	160	60	0.50
B-1	2.1	58	14	0.54	16	310	130	29	0.71
B-2	3.1	72	32	0.38	20	370	270	43	0.46
C-1	2.0	23	9	-	18	75	70	25	0.76
C-2	2.2	61	25	1.90	34	240	140	41	1.60
D-1	1.6	-	5	-	7	57	43	30	0.52
D-2	2.4	79	21	-	25	310	340	38	0.70
E-1	1.9	-	20	-	24	110	280	40	0.73
E-2	1.6	49	1	-	3	9	44	23	1.60
F-1	0.6	41	15	-	25	120	420	39.5	1.40
F-2	1.6	80	3	0.17	4	16	28	21	0.66
S	1.7	99	9	-	13	79	89	47	2.60
T-1	1.9	-	10	-	10	71	120	22	1.20
T-2	1.9	-	11	-	15	130	140	47	10.00
U-1	2.5	-	19	-	30	140	280	60	4.90
U-2	2.2	42	<1	-	22	160	16	35	4.30
X-1	1.5	-	2	-	4	5	4	14	0.20
X-2	1.8	42	1	-	2	12	13	22	0.03
Y-1	1.9	-	8	0.10	17	25	42	40	0.31
Y-2	1.9	-	9	-	19	13	50	37	0.20

TABLE A-50

SEDIMENT METAL CONCENTRATIONS
HARRISON BAY, LAKE CHICKAMAUGA, AUGUST 1, 1975

Station	Metal Concentration (mg/Kg Dry Wt)							Metal Concentration (gm/Kg Dry Wt)	
	Cd	Cr^{+6}	Cu	Hg	Ni	Pb	Zn	Fe	Mn
A	<1	740	130	0.77	110	860	690	140	6.1
B-1	<1	53	15	-	14	360	140	33	0.9
B-2	-	-	-	<0.10	-	-	-	-	-
C-1	-	31	11	-	10	120	120	28	0.59
D-1	<1	86	7	0.17	4	79	73	32	0.74
E-1	<1	34	13	-	16	78	150	34	0.68
F-1	<1	55	31	-	19	170	540	58	2.00
S	<1	61	9	0.17	6	82	76	34	2.00
T-1	<1	21	12	0.1	8	96	140	28	1.30
U-1	<1	140	18	1.3	15	140	110	48	2.80
X-1	<1	30	1	0.10	3	19	15	17	1.90
Y-1	<1	38	9	-	8	18	36	37	2.20

A P P E N D I X B

VAAP Periphyton Collections
from
Lake Chickamauga, Tennessee

June - July and August - September
1975

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TABLE B-1

A SUMMARY OF SUCCESSIVE MICROSCOPIC FIELD COUNTS DEVELOPED FROM VAAP DIATOM SLIDES, JUNE 11-25, 1975, STATION T-1

No. of Fields Counted	$\overline{H}$*	Total No. of Species	"New" Species Recorded After 30 Fields	Total No. of Individuals	Density of "New" Species Recorded After 30 Fields	$\frac{\text{Density of "New" Species Recorded After 30 Fields}}{\text{Total No. of Individuals}} \times 100$
30	0.689	19	0	662	0	0
45	0.667	23	4	825	4	0.48%
60	0.615	25	6	1004	9	0.90%
75	0.637	27	8	1165	13	1.12%
90	0.644	31	12	1345	17	1.26%
120	0.597	34	15	1680	21	1.25%
150	0.626	34	15	1983	21	1.06%

*Shannon-Weaver Species Diversity Index.

TABLE B-2
VAAP PERIPHYTON ARTIFICIAL SUBSTRATE, JUNE 11-25, 1975

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATIONS							
	[illegible]	[illegible]	[illegible]	C1	[illegible]	[illegible]	[illegible]	[illegible]
BACILLARIOPHYTA (DIATOMS)								
Achnanthes exigua v. heterovalvata	-	-	-	-	-	-	-	-
Achnanthes lanceolata v. apiculata	-	-	-	-	-	-	-	-
Achnanthes lanceolata v. dubia	-	15	-	-	-	-	-	-
Achnanthes minutissima	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Achnanthes [illegible]	-	-	-	-	-	-	[illegible]	[illegible]
Amphipleura pellucida	-	-	7	[illegible]	-	-	[illegible]	-
Amphora ovalis v. affinis	-	-	-	-	-	-	-	-
Amphora perpusilla	-	-	-	-	-	-	-	-
Anomoeoneis vitrea	-	-	-	-	16	-	[illegible]	-
Asterionella formosa	-	[illegible]	-	-	-	-	-	-
Caloneis bacillum	-	-	7	-	-	-	-	-
Cocconeis placentula v. euglypta	[illegible]	[illegible]	-	[illegible]	[illegible]	-	[illegible]	[illegible]
Cocconeis pediculus	-	-	-	-	[illegible]	-	-	-
Cyclotella stelligera	-	[illegible]	30	-	7	7	[illegible]	-
Cymbella affinis	-	[illegible]	10	3	7	7	[illegible]	[illegible]
Cymbella laevis	-	-	-	-	-	-	[illegible]	3
Cymbella microcephala	-	-	-	3	-	-	[illegible]	3
Cymbella prostrata	-	7	-	-	7	-	[illegible]	3
Cymbella sinuata	-	-	-	-	65	-	-	-
Cymbella triangulum	-	-	-	-	-	-	-	-
Cymbella tumida	-	[illegible]	[illegible]	-	7	7	[illegible]	-
Cymbella ventricosa	7	[illegible]	-	[illegible]	-	-	-	16
Diploneis ovalis	-	-	-	-	-	-	-	-
Diploneis sp. A	-	-	7	-	-	-	-	-
Eunotia pectinalis v. minor	-	7	-	-	-	-	-	-
Fragilaria capucina	-	[illegible]	[illegible]	56	[illegible]	75	[illegible]	7
Fragilaria construens v. [illegible]	-	-	-	-	-	-	-	-
Fragilaria construens v. venter	-	-	-	-	-	-	-	-
Fragilaria crotonensis	-	-	36	-	7	-	[illegible]	-
Fragilaria pinnata	-	-	-	-	-	-	-	-
Fragilaria vaucheriae	-	135	-	-	[illegible]	7	[illegible]	-
Gomphonema [illegible]	-	[illegible]	-	-	[illegible]	-	-	-
Gomphonema angustatum v. producta	-	7	-	-	-	-	-	-
Gomphonema gracile v. lanceolata	-	[illegible]	[illegible]	-	[illegible]	7	-	-
Gomphonema gracile v. naviculoides	-	-	-	-	-	-	-	-
Gomphonema intricatum v. pumila	[illegible]	-	-	[illegible]	[illegible]	-	[illegible]	-
Gomphonema montanum v. subclavatum	-	[illegible]	-	-	[illegible]	-	-	7
Gomphonema parvulum	15	[illegible]	37	[illegible]	[illegible]	-	25	76
Gomphonema sphaerophorum	-	-	-	-	-	-	-	-
Gyrosigma attenuatum	-	[illegible]	-	-	-	-	-	-
Melosira ambigua	7	[illegible]	12	[illegible]	[illegible]	65	[illegible]	16
Melosira distans	7	65	[illegible]	-	[illegible]	[illegible]	-	-
Melosira granulata	-	65	30	-	-	-	[illegible]	-
Melosira granulata v. angustissima	-	-	-	-	-	-	-	-
Melosira varians	-	-	[illegible]	[illegible]	[illegible]	-	-	-
Navicula accomoda	-	[illegible]	-	[illegible]	-	-	-	-
Navicula arvensis	-	[illegible]	[illegible]	-	-	-	[illegible]	-
Navicula capitata	-	-	-	3	-	-	[illegible]	-
Navicula contenta v. biceps	-	-	-	-	-	-	-	-
Navicula cryptocephala v. intermedia	-	-	-	-	[illegible]	[illegible]	-	-
Navicula cryptocephala v. veneta	-	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-
Navicula decussis	-	-	-	-	-	-	-	-
Navicula [illegible]	-	-	-	-	-	-	-	-
Navicula lanceolata	-	-	16	-	-	-	-	-
Navicula menisculus v. upsaliensis	-	-	-	-	-	-	-	-
Navicula minima	-	7	16	-	-	[illegible]	[illegible]	-
Navicula pupula	-	-	-	-	-	-	-	-
Navicula pygmaea	-	7	-	-	-	-	-	-
Navicula rhynchocephala	-	-	-	-	-	-	-	-
Navicula [illegible] v. [illegible]	-	-	-	-	-	-	-	-
Navicula [illegible]	[illegible]	-	-	-	[illegible]	-	-	-
Navicula tenera	-	[illegible]	12	-	-	-	-	-
Navicula [illegible]	-	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	-
Navicula tridentula	-	-	-	-	-	-	-	-
Navicula tuscula	-	-	-	-	-	-	-	-
Navicula viridula v. linearis	-	[illegible]	-	-	[illegible]	[illegible]	-	-
Nitzschia acicularis	-	-	-	-	-	[illegible]	-	-
Nitzschia amphibia	-	-	-	-	-	-	-	-
Nitzschia capitellata	[illegible]	[illegible]	[illegible]	-	-	-	-	-
Nitzschia clausii	-	-	-	-	-	-	-	-
Nitzschia dissipata	-	[illegible]	[illegible]	[illegible]	-	-	-	-
Nitzschia fonticola	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-
Nitzschia [illegible]	[illegible]	-	-	-	-	-	-	-
Nitzschia kutzingiana	-	[illegible]	[illegible]	-	[illegible]	-	-	-
Nitzschia linearis	-	-	-	-	-	-	-	-
Nitzschia palea	185	[illegible]	16	-	[illegible]	-	[illegible]	-
Nitzschia [illegible]	-	[illegible]	-	-	-	[illegible]	[illegible]	-
Nitzschia sp. 1	-	[illegible]	-	[illegible]	[illegible]	-	[illegible]	16
Nitzschia sp. 2	-	-	-	-	-	-	-	-
Nitzschia sinuata v. tabellaria	-	-	-	-	-	-	-	-
Nitzschia tryblionella v. victoriae	-	-	-	-	-	-	-	-
[illegible]	-	16	-	-	-	-	-	-
Rhoicosphenia curvata	-	-	-	-	-	-	-	-
Stephanodiscus [illegible]	-	-	-	-	-	-	-	-
Stephanodiscus sp. 1	-	-	-	[illegible]	[illegible]	-	-	[illegible]
Surirella ovata	-	-	-	-	-	-	-	-
Synedra acus	-	-	-	-	-	-	-	-
Synedra pulchella	-	-	-	-	-	-	-	-
Synedra [illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]
Synedra rumpens	36	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]
Synedra ulna	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Tabellaria fenestrata	-	[illegible]	-	3	-	-	-	-
[illegible]								
[illegible]	-	-	-	-	-	-	-	-
TOTAL [illegible] OF ORGANISMS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NUMBER OF TAXA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE B-2 (CONTINUED)

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATION							
	F2	8	11	12	J5	41	4[illegible]	V1
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES EXIGUA V HETEROVALVE	-	-	-	-	-	8	-	-
ACHNANTHES LANCEOLATA V APICULATA	7	-	7	-	-	-	-	-
ACHNANTHES LANCEOLATA V DUBIA	30	-	-	-	-	17	8	8
ACHNANTHES MINUTISSIMA	3287	10305	10621	10001	10950	10744	5700	8170
ACHNANTHES NOLLII	60	-	-	-	-	8	-	60
AMPHIPLEURA PELLUCIDA	-	-	8	8	37	-	-	-
AMPHORA OVALIS V LIBYCA	7	-	-	-	-	-	-	-
AMPHORA PERPUSILLA	-	-	-	-	-	-	-	7
ANOMOEONEIS VITREA	29	8	-	8	19	234	151	80
ASTERIONELLA FORMOSA	-	-	-	-	-	-	-	-
CALONEIS BACILLUM	-	-	-	-	-	-	-	-
COCCONEIS PLACENTULA V EUGLYPTA	-	-	-	-	-	8	13	-
COCCONEIS PEDICULUS	-	-	-	-	-	-	-	-
CYCLOTELLA STELLIGERA	16	-	7	4	7	8	-	7
CYMBELLA AFFINIS	75	8	22	29	22	131	43	800
CYMBELLA LAEVIS	7	-	-	-	-	-	-	-
CYMBELLA MICROCEPHALA	15	8	-	56	-	332	78	821
CYMBELLA PROSTRATA	212	-	7	8	36	8	15	7
CYMBELLA SINUATA	-	-	-	-	-	-	-	-
CYMBELLA TRIANGULUM	-	-	-	-	7	-	-	-
CYMBELLA TUMIDA	22	-	37	12	14	8	5	-
CYMBELLA VENTRICOSA	105	8	7	70	15	46	5	27
DIPLONEIS OVALIS	-	-	7	-	-	-	-	8
DIPLONEIS SP A	-	-	-	-	-	-	-	-
EUNOTIA PECTINALIS V MINOR	-	-	-	-	-	-	-	-
FRAGILARIA CAPUCINA	30	110	244	144	443	868	173	56
FRAGILARIA CONSTRUENS	60	-	-	-	-	90	53	65
FRAGILARIA CONSTRUENS V VENTER	7	-	-	-	-	60	25	21
FRAGILARIA CROTONENSIS	-	-	-	22	19	13	27	8
FRAGILARIA PINNATA	-	-	-	-	7	101	63	30
FRAGILARIA VAUCHERIAE	165	-	23	33	87	36	5	22
GOMPHONEMA APICATUM	88	-	50	33	14	64	83	16
GOMPHONEMA ANGUSTATUM V PRODUCTA	-	54	-	16	-	30	-	-
GOMPHONEMA GRACILE V LANCEOLATA	7	48	106	-	14	38	5	15
GOMPHONEMA GRACILE V NAVICULOIDES	1	-	-	-	-	-	-	-
GOMPHONEMA INTRICATUM V PUMILA	-	-	-	-	22	-	-	-
GOMPHONEMA MONTANUM V SUBCLAVATA	66	8	37	8	37	19	-	7
GOMPHONEMA PARVULUM	146	218	274	35	92	113	23	89
GOMPHONEMA SPHAEROPHORUM	-	-	-	-	-	-	-	-
GYROSIGMA ATTENUATUM	-	-	-	-	-	-	-	-
MELOSIRA AMBIGUA	30	5	45	34	59	48	13	108
MELOSIRA DISTANS	22	4	-	8	-	86	13	10
MELOSIRA GRANULATA	7	-	-	-	-	10	5	-
MELOSIRA GRANULATA V ANGUSTISSIMA	22	-	-	-	-	-	-	-
MELOSIRA VARIANS	31	8	22	-	7	-	-	-
NAVICULA ACCOMODA	42	-	-	-	-	-	-	-
NAVICULA ARVENSIS	16	-	-	-	-	-	-	-
NAVICULA CAPITATA	7	-	7	-	4	-	-	-
NAVICULA CONTENTA V BICEPS	-	-	-	-	-	8	-	-
NAVICULA CRYPTOCEPHALA V INTERMEDIA	44	-	-	5	67	-	-	-
NAVICULA CRYPTOCEPHALA V VENETA	350	8	27	53	44	30	35	100
NAVICULA CUSPIDATA	21	-	-	-	-	-	-	-
NAVICULA DISJUNCTA	-	-	-	-	-	-	-	-
NAVICULA LANCEOLATA	-	-	-	-	-	4	-	-
NAVICULA MENISCULUS V UPSALIENSIS	-	-	-	-	22	-	-	-
NAVICULA MINIMA	8	-	-	-	-	-	8	7
NAVICULA PUPULA	-	-	-	4	8	-	5	-
NAVICULA PYGMAEA	-	-	-	-	-	-	-	-
NAVICULA RHYNCHOCEPHALA	-	-	-	-	-	-	-	-
NAVICULA SCHROETERI V ESCAMBIA	16	-	-	-	-	-	-	16
NAVICULA SUBHAMULATA	14	-	-	-	-	8	-	-
NAVICULA TENERA	-	-	-	-	-	-	-	-
NAVICULA THIENEMANNII	16	-	-	-	7	8	-	-
NAVICULA TRIPUNCTATA	-	-	-	-	-	12	-	8
NAVICULA TUSCULA	-	-	-	-	-	8	-	-
NAVICULA VIRIDULA V LINEARIS	-	-	-	-	-	-	-	-
NITZSCHIA ACICULARIS	-	-	-	-	-	-	-	-
NITZSCHIA AMPHIBIA	-	-	-	-	-	8	-	-
NITZSCHIA CAPITELLATA	-	-	-	-	-	-	-	-
NITZSCHIA CLAUSII	-	-	-	-	-	12	-	-
NITZSCHIA DISSIPATA	67	-	-	13	22	-	-	-
NITZSCHIA DENTICULA	27	44	8	827	93	70	35	120
NITZSCHIA GRACILIS	-	-	-	-	-	-	-	-
NITZSCHIA KUETZINGIANA	10	-	-	-	-	8	-	-
NITZSCHIA LINEARIS	-	-	-	-	-	-	-	-
NITZSCHIA PALEA	14	8	-	-	-	8	-	-
NITZSCHIA PARVULA	-	-	-	-	-	-	-	-
NITZSCHIA SP 1	66	-	14	22	22	20	-	52
NITZSCHIA SP 2	-	-	-	-	-	-	-	7
NITZSCHIA SINUATA V TABELLARIA	25	-	7	124	-	81	5	68
NITZSCHIA TRYBLIONELLA V VICTORIAE	-	-	7	-	-	-	-	-
PINNULARIA BRAUNII	-	-	-	-	-	-	-	-
RHOICOSPHENIA CURVATA	-	-	-	-	-	-	-	-
STEPHANODISCUS ASTRAEA	-	-	-	-	-	-	-	-
STEPHANODISCUS SP 1	-	-	-	8	7	8	-	-
SURIRELLA OVATA	-	-	-	-	-	8	-	-
SYNEDRA ACUS	52	-	-	-	-	-	11	8
SYNEDRA PULCHELLA	-	-	-	11	-	-	-	-
SYNEDRA DELICATISSIMA	8	8	14	59	15	196	107	20
SYNEDRA RUMPENS	67	48	54	83	42	55	25	-
SYNEDRA ULNA	416	16	42	44	76	47	13	88
TABELLARIA FENESTRATA	4	-	-	-	-	-	-	20
UNSPECIFIED IN MASTER FILE								
UNSPECIFIED TAXON	22	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	5844	11604	12901	[illegible]	14804	14404	[illegible]	8480
NUMBER OF TAXA	61	16	20	34	34	45	35	36

TABLE B-3
VAAP PERIPHYTON ARTIFICIAL SUBSTRATE, JUNE 11 - JULY 10, 1975

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATIONS: [illegible]	B1	B2	C1	D1	[illegible]	[illegible]	[illegible]
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES SP. A	7	-	91	102	-	[illegible]	[illegible]	30
ACHNANTHES LANCEOLATA V. APICULATA	-	-	-	-	-	-	[illegible]	-
ACHNANTHES LANCEOLATA V. DUBIA	-	-	-	-	-	-	[illegible]	-
ACHNANTHES MINUTISSIMA	9010	73142	84343	84030	[illegible]	32700	47080	45700
ACHNANTHES [illegible]	-	-	91	30	[illegible]	701	1010	-
AMPHIPLEURA PELLUCIDA	-	-	-	103	100	103	30	-
AMPHORA OVALIS V PEDICULUS	-	-	-	103	-	-	-	-
AMPHORA OVALIS V LIBYCA	7	-	-	-	-	-	-	-
AMPHORA [illegible]	-	-	-	-	-	-	30	-
AMPHORA SP.	-	-	-	-	-	-	[illegible]	[illegible]
ANOMOEONEIS VITREA	-	-	-	-	190	60	[illegible]	137
CALONEIS BACILLUM	7	-	-	-	-	-	-	-
COCCONEIS PLACENTULA V EUGLYPTA	-	-	-	914	-	90	-	-
CYCLOTELLA MENEGHINIANA	-	91	-	30	[illegible]	-	-	-
CYCLOTELLA STELLIGERA	-	182	-	-	[illegible]	30	103	102
CYCLOTELLA SP. 2	[illegible]	[illegible]	-	-	-	-	-	-
CYMBELLA AFFINIS	[illegible]	[illegible]	91	137	700	[illegible]	[illegible]	60
CYMBELLA LAEVIS	7	91	274	-	-	[illegible]	30	-
CYMBELLA MICROCEPHALA	7	60	103	137	480	[illegible]	[illegible]	-
CYMBELLA PROSTRATA	-	-	-	-	[illegible]	[illegible]	[illegible]	34
CYMBELLA TUMIDA	-	91	102	-	[illegible]	[illegible]	[illegible]	-
CYMBELLA VENTRICOSA	7	[illegible]	91	274	100	40	103	34
DIPLONEIS SP. A	-	[illegible]	91	30	-	-	-	-
FRAGILARIA CAPUCINA	-	[illegible]	2203	34	250	-	40	171
FRAGILARIA CONSTRUENS [illegible]	-	-	-	-	-	-	[illegible]	-
FRAGILARIA CONSTRUENS V VENTER	-	-	-	-	-	-	[illegible]	-
FRAGILARIA CROTONENSIS	-	40	91	-	-	60	-	-
FRAGILARIA PINNATA	-	91	-	-	-	-	[illegible]	-
FRAGILARIA VAUCHERIAE	-	-	91	-	90	142	[illegible]	-
GOMPHONEMA APICATUM	7	45	-	-	-	-	-	-
GOMPHONEMA ANGUSTATUM V PRODUCTA	-	-	-	-	-	30	-	-
GOMPHONEMA AUGUR	-	-	-	30	190	-	[illegible]	34
GOMPHONEMA GRACILE V LANCEOLATA	7	137	-	-	-	-	[illegible]	34
GOMPHONEMA INTRICATUM	-	65	-	805	-	34	-	[illegible]
GOMPHONEMA MONTANUM V SUBCLAVATA	-	-	-	-	[illegible]	-	[illegible]	[illegible]
GOMPHONEMA PARVULUM	90	321	91	172	[illegible]	137	[illegible]	[illegible]
GOMPHONEMA SP. A	-	[illegible]	-	-	-	-	-	-
MELOSIRA AMBIGUA	90	[illegible]	1280	[illegible]	[illegible]	674	[illegible]	209
MELOSIRA DISTANS	-	[illegible]	91	[illegible]	[illegible]	-	[illegible]	-
MELOSIRA GRANULATA V [illegible]	-	720	275	34	104	34	-	60
MELOSIRA VARIANS	-	91	-	-	-	-	34	-
NAVICULA CAPITATA	-	137	-	-	-	-	-	-
NAVICULA CRYPTOCEPHALA V INTERMEDIA	-	80	-	64	60	-	300	-
NAVICULA CRYPTOCEPHALA V VENETA	30	134	103	134	350	171	1017	200
NAVICULA HEUFLERI V LEPTOCEPHALA	7	800	-	-	-	-	-	-
NAVICULA LANCEOLATA	-	-	91	-	-	-	-	-
NAVICULA MINIMA	-	227	41	-	60	-	610	740
NAVICULA [illegible]	7	60	-	-	-	-	-	-
NAVICULA MUTICA	-	91	-	-	40	-	-	-
NAVICULA PUPULA	-	41	-	-	140	-	90	-
NAVICULA PYGMAEA	-	330	-	34	-	-	-	-
NAVICULA RHYNCHOCEPHALA V GERMAINII	-	-	-	-	90	-	-	-
NAVICULA SCHROETERI V ESCAMBIA	-	-	-	-	-	30	-	-
NAVICULA SUBHAMULATA	-	91	-	-	-	-	-	34
NAVICULA [illegible]	90	[illegible]	91	40	-	34	30	-
NAVICULA [illegible]	-	[illegible]	103	-	90	34	137	-
NAVICULA TRIDENTULA	-	-	-	-	-	-	-	-
NAVICULA VIRIDULA V LINEARIS	-	60	-	-	90	-	-	-
NAVICULA SP.	30	91	-	-	-	-	-	-
NITZSCHIA AMPHIBIA	-	-	-	-	-	-	-	-
NITZSCHIA [illegible]	-	[illegible]	-	-	-	-	-	-
NITZSCHIA [illegible]	[illegible]	1850	274	740	[illegible]	-	[illegible]	209
NITZSCHIA FONTICOLA	7	-	-	-	[illegible]	-	[illegible]	-
NITZSCHIA GRACILIS	-	-	-	-	90	-	-	-
NITZSCHIA [illegible]	7	40	91	-	-	-	64	30
NITZSCHIA MICROCEPHALA	7	-	-	-	-	-	-	-
NITZSCHIA PALEA	673	[illegible]	[illegible]	-	[illegible]	-	-	-
NITZSCHIA SP. A	-	[illegible]	[illegible]	170	[illegible]	60	[illegible]	[illegible]
NITZSCHIA SINUATA V TABELLARIA	-	-	-	-	-	-	[illegible]	[illegible]
NITZSCHIA TRYBLIONELLA V VICTORIAE	-	-	-	-	-	-	-	-
[illegible]	-	-	-	-	-	-	-	-
STEPHANODISCUS ASTRAEA	-	45	91	34	90	-	-	-
STEPHANODISCUS SP. 1	-	130	102	30	300	102	274	-
SURIRELLA LINEARIS	-	[illegible]	-	-	-	-	-	-
SURIRELLA OVATA	-	[illegible]	-	30	-	-	-	-
SURIRELLA ANGUSTA	-	90	-	-	-	-	-	-
SYNEDRA ACUS	-	-	-	-	-	-	34	-
SYNEDRA PULCHELLA	-	-	-	-	-	-	-	30
SYNEDRA DELICATISSIMA	-	[illegible]	[illegible]	[illegible]	[illegible]	34	[illegible]	[illegible]
SYNEDRA RUMPENS	60	[illegible]	[illegible]	[illegible]	[illegible]	60	[illegible]	[illegible]
SYNEDRA ULNA	-	-	103	-	-	-	-	-
SYNEDRA ULNA V DANICA	90	307	270	-	690	300	343	274
TABELLARIA FENESTRATA	-	-	-	34	-	-	-	30
TOTAL NUMBER OF ORGANISMS	6300	96100	92250	97070	90673	87190	91244	48274
NUMBER OF TAXA	80	60	31	30	30	20	64	20

TABLE B-3 (CONTINUED).

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATIONS T1	R6	V8	*******	*******	*******	*******	*******
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES SP. A	36	*	66	*****	*****	*****	*****	*****
ACHNANTHES LANCEOLATA V. APICULATA	*	*	*	*****	*****	*****	*****	*****
ACHNANTHES LANCEOLATA V. DUBIA	86	*	66	*****	*****	*****	*****	*****
ACHNANTHES MINUTISSIMA	88479	58117	19898	*****	*****	*****	*****	*****
ACHNANTHES NOLLII	18	36	718	*****	*****	*****	*****	*****
AMPHIPLEURA PELLUCIDA	136	*	*	*****	*****	*****	*****	*****
AMPHORA OVALIS V. PEDICULUS	*	*	M	*****	*****	*****	*****	*****
AMPHORA OVALIS V. LIBYCA	*	*	*	*****	*****	*****	*****	*****
AMPHORA VENETA	*	*	*	*****	*****	*****	*****	*****
AMPHORA SP.	*	*	*	*****	*****	*****	*****	*****
ANOMOEONEIS VITREA	46	1010	67	*****	*****	*****	*****	*****
CALONEIS BACILLUM	*	M	*	*****	*****	*****	*****	*****
COCCONEIS PLACENTULA V. EUGLYPTA	*	*	*	*****	*****	*****	*****	*****
CYCLOTELLA MENEGHINIANA	*	*	*	*****	*****	*****	*****	*****
CYCLOTELLA STELLIGERA	80	80	*	*****	*****	*****	*****	*****
CYCLOTELLA SP. 2	*	*	*	*****	*****	*****	*****	*****
CYMBELLA AFFINIS	202	171	917	*****	*****	*****	*****	*****
CYMBELLA LAEVIS	102	*	*	*****	*****	*****	*****	*****
CYMBELLA MICROCEPHALA	171	8071	851	*****	*****	*****	*****	*****
CYMBELLA PROSTRATA	*	*	*	*****	*****	*****	*****	*****
CYMBELLA TUMIDA	171	*	11	*****	*****	*****	*****	*****
CYMBELLA VENTRICOSA	56	171	102	*****	*****	*****	*****	*****
DIPLONEIS SP. A	*	*	*	*****	*****	*****	*****	*****
FRAGILARIA CAPUCINA	56	804	79	*****	*****	*****	*****	*****
FRAGILARIA CONSTRUENS V. [illegible]	*	308	80	*****	*****	*****	*****	*****
FRAGILARIA CONSTRUENS V. VENTER	*	878	11	*****	*****	*****	*****	*****
FRAGILARIA CROTONENSIS	*	64	22	*****	*****	*****	*****	*****
FRAGILARIA PINNATA	*	608	137	*****	*****	*****	*****	*****
FRAGILARIA VAUCHERIAE	*	[illegible]	45	*****	*****	*****	*****	*****
GOMPHONEMA ABBREVIATUM	*	*	*	*****	*****	*****	*****	*****
GOMPHONEMA ANGUSTATUM V. PRODUCTA	*	*	*	*****	*****	*****	*****	*****
GOMPHONEMA AUGUR	171	171	*	*****	*****	*****	*****	*****
GOMPHONEMA GRACILE V. LANCEOLATA	88	56	12	*****	*****	*****	*****	*****
GOMPHONEMA INTRICATUM	*	*	*	*****	*****	*****	*****	*****
GOMPHONEMA MONTANUM V. SUBCLAVATA	*	*	*	*****	*****	*****	*****	*****
GOMPHONEMA PARVULUM	137	*	114	*****	*****	*****	*****	*****
GOMPHONEMA SP. A	*	*	11	*****	*****	*****	*****	*****
MELOSIRA AMBIGUA	591	171	82	*****	*****	*****	*****	*****
MELOSIRA DISTANS	18	56	46	*****	*****	*****	*****	*****
MELOSIRA GRANULATA V. [illegible]	137	*	82	*****	*****	*****	*****	*****
MELOSIRA VARIANS	*	*	*	*****	*****	*****	*****	*****
NAVICULA CAPITATA	*	*	*	*****	*****	*****	*****	*****
NAVICULA CRYPTOCEPHALA V. INTERMEDIA	*	*	11	*****	*****	*****	*****	*****
NAVICULA CRYPTOCEPHALA V. VENETA	308	68	685	*****	*****	*****	*****	*****
NAVICULA HEUFLERI V. LEPTOCEPHALA	*	*	M	*****	*****	*****	*****	*****
NAVICULA LANCEOLATA	*	*	*	*****	*****	*****	*****	*****
NAVICULA MINIMA	618	885	807	*****	*****	*****	*****	*****
NAVICULA MURALIS	*	*	*	*****	*****	*****	*****	*****
NAVICULA MUTICA	*	*	*	*****	*****	*****	*****	*****
NAVICULA PUPULA	*	*	*	*****	*****	*****	*****	*****
NAVICULA PYGMAEA	*	*	11	*****	*****	*****	*****	*****
NAVICULA RHYNCHOCEPHALA V. GERMAINII	*	*	*	*****	*****	*****	*****	*****
NAVICULA SCHROETERI V. ESCAMBIA	*	*	*	*****	*****	*****	*****	*****
NAVICULA SUBMURALIS	56	*	11	*****	*****	*****	*****	*****
NAVICULA TENERA	*	*	11	*****	*****	*****	*****	*****
NAVICULA TRIPUNCTATA	68	*	11	*****	*****	*****	*****	*****
NAVICULA TANTULA	*	80	22	*****	*****	*****	*****	*****
NAVICULA VIRIDULA V. LINEARIS	*	M	*	*****	*****	*****	*****	*****
NAVICULA SP. [illegible]	*	*	*	*****	*****	*****	*****	*****
NITZSCHIA AMPHIBIA	*	*	11	*****	*****	*****	*****	*****
NITZSCHIA [illegible]	*	*	*	*****	*****	*****	*****	*****
NITZSCHIA DISSIPATA	102	134	118	*****	*****	*****	*****	*****
NITZSCHIA [illegible]	16	M	*	*****	*****	*****	*****	*****
NITZSCHIA GRACILIS	*	*	*	*****	*****	*****	*****	*****
NITZSCHIA KUTZINGIANA	*	16	65	*****	*****	*****	*****	*****
NITZSCHIA MICROCEPHALA	*	*	*	*****	*****	*****	*****	*****
NITZSCHIA PALEA	38	*	*	*****	*****	*****	*****	*****
NITZSCHIA SP. [illegible]	16	*	74	*****	*****	*****	*****	*****
NITZSCHIA SINUATA V. TABELLARIA	16	68	116	*****	*****	*****	*****	*****
NITZSCHIA TRYBLIONELLA V. VICTORIAE	V	*	*	*****	*****	*****	*****	*****
RHOICOSPHENIA CURVATA	*	*	11	*****	*****	*****	*****	*****
STEPHANODISCUS ASTRAEA	*	*	*	*****	*****	*****	*****	*****
STEPHANODISCUS SP. 1	*	80	11	*****	*****	*****	*****	*****
SURIRELLA LINEARIS	*	*	*	*****	*****	*****	*****	*****
SURIRELLA OVATA	*	*	M	*****	*****	*****	*****	*****
SURIRELLA ROBUSTA	M	*	*	*****	*****	*****	*****	*****
SYNEDRA ACUS	*	*	11	*****	*****	*****	*****	*****
SYNEDRA PULCHELLA	*	*	*	*****	*****	*****	*****	*****
SYNEDRA DELICATISSIMA	88	178	111	*****	*****	*****	*****	*****
SYNEDRA RUMPENS	66	68	11	*****	*****	*****	*****	*****
SYNEDRA ULNA	*	*	*	*****	*****	*****	*****	*****
SYNEDRA ULNA V. DANICA	137	137	817	*****	*****	*****	*****	*****
TABELLARIA FENESTRATA	16	68	11	*****	*****	*****	*****	*****
TOTAL NUMBER OF ORGANISMS	38168	59085	81011	******	******	******	******	******
NUMBER OF TAXA	55	87	61	*****	*****	*****	*****	*****

TABLE B-4
VAAP PERIPHYTON ARTIFICIAL SUBSTRATE, AUGUST 12-26, 1975

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATIONS							
	A	B1	B2	C1	C2	D1	D2	E1
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES SP A	-	42	-	90	48	42	101	198
ACHNANTHES EXIGUA V HETEROVALVA	-	-	-	-	-	-	10	80
ACHNANTHES LANCEOLATA V DUBIA	-	42	11	22	19	22	-	45
ACHNANTHES MINUTISSIMA	626	14084	8168	25031	19430	10070	14790	18897
ACHNANTHES HOLLII	-	-	11	790	65	137	1119	550
AMPHIPLEURA PELLUCIDA	-	-	-	-	-	-	101	879
AMPHORA OVALIS V PEDICULUS	-	-	-	-	19	-	-	-
AMPHORA OVALIS V LIBYCA	-	-	-	-	-	-	-	48
AMPHORA PERPUSILLA	-	-	-	-	-	-	-	-
AMPHORA SP 1	-	-	-	-	-	-	-	-
ANOMOEONEIS VITREA	-	-	-	45	-	-	19	49
CALONEIS BACILLUM	-	-	-	-	-	-	-	-
COCCONEIS PLACENTULA V EUGLYPTA	-	119	-	48	-	-	30	48
CYCLOTELLA MENEGHINIANA	-	22	11	67	-	-	-	-
CYCLOTELLA STELLIGERA	-	-	67	136	30	22	49	48
CYCLOTELLA SP 6	-	-	-	-	-	-	-	-
CYCLOTELLA SP 3	-	-	-	-	-	-	-	49
CYMBELLA AFFINIS	11	44	470	84	65	20	101	90
CYMBELLA DELICATULA	-	-	-	-	-	-	-	-
CYMBELLA LAEVIS	-	-	-	-	30	88	30	142
CYMBELLA MICROCEPHALA	-	82	136	67	61	-	81	678
CYMBELLA SINUATA	-	-	-	-	-	-	-	-
CYMBELLA TURGIDA	-	-	-	88	-	-	19	67
CYMBELLA VENTRICOSA	-	-	11	-	-	-	10	81
CYMBELLA SP 2	-	-	-	-	-	-	-	-
DIPLONEIS OVALIS	-	-	-	-	-	-	-	-
DIPLONEIS SP A	-	-	-	26	16	42	-	-
FRAGILARIA CAPUCINA	-	44	520	300	184	-	1060	558
FRAGILARIA CONSTRUENS	-	-	-	-	-	-	-	-
FRAGILARIA CONSTRUENS V VENTER	-	-	-	-	-	-	-	-
FRAGILARIA CROTONENSIS	-	-	-	-	-	-	899	49
FRAGILARIA PINNATA	-	-	-	-	-	-	-	-
FRAGILARIA VAUCHERIAE	-	-	11	-	-	22	-	-
GOMPHONEMA APICATUM	-	-	-	44	19	-	30	-
GOMPHONEMA ANGUSTATUM V PRODUCTA	-	-	56	26	-	-	-	-
GOMPHONEMA AUGUR	-	42	33	-	30	-	30	134
GOMPHONEMA CONSTRICTUM V. SUBCAPITATA	-	-	-	-	-	-	30	-
GOMPHONEMA GRACILE V LANCEOLATA	-	-	-	72	-	-	88	136
GOMPHONEMA GRACILE V NAVICULOIDES	-	-	-	26	-	-	-	-
GOMPHONEMA INTRICATUM V PUMILA	-	91	-	-	-	-	10	88
GOMPHONEMA ACUMINATUM V SUBCLAVATA	-	44	-	-	-	-	-	-
GOMPHONEMA PARVULUM	11	828	29	115	48	42	-	40
MELOSIRA AMBIGUA	22	190	874	136	191	139	81	142
MELOSIRA DISTANS	22	88	81	675	107	81	-	193
MELOSIRA GRANULATA	90	-	-	116	75	40	81	-
MELOSIRA GRANULATA V ANGUSTISSIMA	-	-	-	-	-	-	-	-
NAVICULA ARVENSIS	-	42	-	-	-	-	-	-
NAVICULA CAPITATA	11	113	-	-	-	-	-	-
NAVICULA CRYPTOCEPHALA V INTERMEDIA	-	44	-	-	-	-	-	-
NAVICULA CRYPTOCEPHALA V VENETA	-	82	11	67	19	65	65	142
NAVICULA DECUSSIS	-	26	-	-	-	-	-	-
NAVICULA HEUFLERI V LEPTOCEPHALA	40	220	-	45	10	48	-	49
NAVICULA LANCEOLATA	-	26	-	-	-	-	-	-
NAVICULA LUZONENSIS	11	-	-	88	-	-	-	49
NAVICULA MENISCULUS V UPSALIENSIS	-	-	-	-	-	-	-	-
NAVICULA MINIMA	-	-	-	64	137	65	75	416
NAVICULA MUTICA	-	-	-	-	-	-	-	-
NAVICULA PUPULA	-	22	-	-	19	-	-	-
NAVICULA PUPULA V. ELLIPTICA	-	-	-	-	-	-	-	-
NAVICULA PYGMAEA	-	-	11	-	-	26	-	-
NAVICULA RADIOSA V TENELLA	-	-	-	-	-	-	19	-
NAVICULA RHYNCHOCEPHALA V GERMAINII	-	42	44	-	10	-	-	48
NAVICULA SCHROETERI V ESCAMBIA	-	-	-	-	-	-	-	136
NAVICULA CF. SIMULA	-	-	-	-	-	-	-	-
NAVICULA SUBHAMULATA	-	-	-	-	-	-	-	-
NAVICULA TENERA	-	90	-	115	-	-	-	-
NAVICULA THIENEMANNII	-	119	40	26	19	87	20	142
NAVICULA TRIDENTULA	-	-	-	-	-	-	19	-
NAVICULA SP 3	-	-	-	-	-	-	-	-
NAVICULA SP A	-	-	-	22	-	-	-	-
NITZSCHIA ACICULARIS	-	-	11	-	58	22	-	-
NITZSCHIA AMPHIBIA	-	-	-	-	15	-	-	-
NITZSCHIA DISSIPATA	11	22	22	-	-	-	-	61
NITZSCHIA DENTICULA	-	112	111	90	-	22	-	141
NITZSCHIA FONTICOLA	-	-	11	-	-	-	-	-
NITZSCHIA KUTZINGIANA	102	127	194	136	107	90	102	676
NITZSCHIA IGNORATA	-	-	-	-	-	-	-	-
NITZSCHIA LINEARIS	-	-	11	-	-	-	-	-
NITZSCHIA MICROCEPHALA	-	-	-	-	-	-	-	-
NITZSCHIA PALEA	100	100	45	-	10	-	19	96
NITZSCHIA RECTA	-	40	-	-	-	-	-	-
NITZSCHIA SP 1	-	-	87	45	90	-	81	-
NITZSCHIA SP 6	-	-	-	-	-	-	58	-
NITZSCHIA SP 9	11	22	70	20	-	-	-	-
NITZSCHIA SP 4	-	-	-	-	-	-	-	51
NITZSCHIA SINUATA V TABELLARIA	-	-	-	-	-	-	-	48
NITZSCHIA TRYBLIONELLA V VICTORIAE	-	-	-	-	-	-	-	-
OPEPHORA MARTYI	-	-	-	22	-	-	-	-
PINNULARIA BRAUNII	-	-	-	26	-	-	-	-
RHOICOSPHENIA CURVATA	-	45	-	-	-	-	-	-
STEPHANODISCUS ASTRAEA	-	-	-	-	-	65	-	-
STEPHANODISCUS SP 1	-	90	44	82	88	113	19	187
SURIRELLA OVATA	-	-	-	22	-	-	-	-
SYNEDRA ACUS	-	-	-	42	-	-	-	-
SYNEDRA PULCHELLA	-	-	-	-	-	-	-	-
SYNEDRA DELICATISSIMA	26	119	102	113	507	-	669	847
SYNEDRA RUMPENS	-	44	33	22	184	65	188	136
SYNEDRA ULNA	-	-	-	281	184	44	887	-
SYNEDRA ULNA V DANICA	-	22	46	-	-	-	-	884
TABELLARIA FENESTRATA	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	988	18369	11556	28074	19468	20967	18726	28481
NUMBER OF TAXA	14	38	24	40	32	26	33	41

TABLE B-4 (CONTINUED).

TAXONOMIC CLASSIFICATION	F2	HO BARF	7 BUOY	9	T1	12	U1	U2
	NUMBER OF ORGANISMS AT STATIONS							
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES SP 6	44	34	-	-	50	-	11	-
ACHNANTHES EXIGUA V HETEROVALVA	-	-	-	-	-	-	-	-
ACHNANTHES LANCEOLATA V DUBIA	45	22	-	-	-	-	22	22
ACHNANTHES MINUTISSIMA	27441	11058	4404	14304	17020	15348	3187	22071
ACHNANTHES HOLLII	804	324	344	-	62	44	22	102
AMPHIPLEURA PELLUCIDA	-	-	-	-	-	-	11	80
AMPHORA OVALIS V PEDICULUS	-	-	-	-	-	-	-	22
AMPHORA OVALIS V LIBYCA	40	-	-	-	-	22	11	-
AMPHORA PERPUSILLA	-	-	-	-	-	-	-	-
AMPHORA SP 1	40	-	-	-	-	-	-	-
ANOMOEONEIS VITREA	-	22	-	90	22	120	11	40
CALONEIS BACILLUM	-	22	-	-	-	-	-	-
COCCONEIS PLACENTULA V EUGLYPTA	-	-	-	-	91	41	34	-
CYCLOTELLA MENEGHINIANA	-	22	-	-	-	22	-	-
CYCLOTELLA STELLIGERA	80	-	22	-	22	22	11	-
CYCLOTELLA SP 2	-	-	-	-	-	-	-	-
CYCLOTELLA SP 1	-	-	-	-	-	-	-	-
CYMBELLA AFFINIS	130	27	22	80	-	44	145	220
CYMBELLA DELICATULA	-	-	22	-	-	-	-	-
CYMBELLA LAEVIS	-	22	-	-	-	-	22	-
CYMBELLA MICROCEPHALA	80	-	80	107	88	88	88	84
CYMBELLA SINUATA	-	-	-	-	22	88	-	-
CYMBELLA TUMIDA	-	22	-	-	-	-	22	-
CYMBELLA VENTRICOSA	-	-	-	32	-	50	-	81
CYMBELLA SP 2	-	-	-	-	-	-	-	-
DIPLONEIS OVALIS	-	-	-	-	-	22	-	-
DIPLONEIS SP 2	-	-	-	-	-	22	-	-
FRAGILARIA CAPUCINA	1914	841	240	430	-	1057	401	1308
FRAGILARIA CONSTRUENS	213	-	-	14	-	-	-	-
FRAGILARIA CONSTRUENS V VENTER	-	-	-	-	-	-	-	-
FRAGILARIA CROTONENSIS	40	-	42	-	-	88	-	44
FRAGILARIA PINNATA	224	-	-	-	-	-	-	114
FRAGILARIA VAUCHERIAE	-	-	27	-	-	-	11	22
GOMPHONEMA APICATUM	-	22	-	-	-	-	-	22
GOMPHONEMA ANGUSTATUM V PRODUCTA	-	-	-	15	45	-	21	-
GOMPHONEMA AUGUR	90	113	-	30	-	81	22	-
GOMPHONEMA CONSTRICTUM V. CAPITATA	-	-	-	-	-	-	-	-
GOMPHONEMA GRACILE V LANCEOLATA	45	-	22	60	-	22	90	45
GOMPHONEMA GRACILE V NAVICULOIDES	-	-	-	15	-	-	-	22
GOMPHONEMA INTRICATUM V PUMILA	-	-	-	-	22	-	45	22
GOMPHONEMA MONTANUM V SUBCLAVATA	-	-	-	30	-	-	-	-
GOMPHONEMA PARVULUM	-	22	22	34	22	134	80	87
MELOSIRA AMBIGUA	322	80	22	45	182	810	-	22
MELOSIRA DISTANS	41	88	-	15	-	90	102	-
MELOSIRA GRANULATA	-	22	-	-	22	88	22	-
MELOSIRA GRANULATA V ANGUSTISSIMA	47	-	-	-	-	-	-	-
NAVICULA [illegible]	-	-	-	-	-	-	-	-
NAVICULA CAPITATA	-	82	-	15	-	-	-	-
NAVICULA CRYPTOCEPHALA V INTERMEDIA	-	-	-	-	-	-	11	-
NAVICULA CRYPTOCEPHALA V VENETA	101	-	-	42	-	94	137	102
NAVICULA DECUSSIS	-	-	-	-	-	-	73	-
NAVICULA [illegible]		-	-	-	-	87	-	-
NAVICULA LANCEOLATA	-	-	-	-	-	45	-	-
NAVICULA LUZONENSIS	-	-	22	-	-	-	-	-
NAVICULA MENISCULUS V UPSALIENSIS	-	-	-	-	22	-	-	-
NAVICULA MINIMA	132	47	22	-	185	-	-	-
NAVICULA MUTICA	40	-	-	-	-	-	-	-
NAVICULA PUPULA	-	-	-	-	-	-	-	-
NAVICULA PUPULA V. ELLIPTICA	81	-	-	-	22	44	22	-
NAVICULA [illegible]	40	-	22	-	-	-	-	22
NAVICULA RADIOSA V TENELLA	-	-	-	-	-	-	-	-
NAVICULA RHYNCHOCEPHALA V GERMAINII	-	-	-	-	-	-	-	-
NAVICULA SCHROETERI V ESCAMBIA	-	-	-	-	-	-	-	-
NAVICULA CF SIMULA	-	-	-	-	-	-	-	-
NAVICULA [illegible]	82	-	-	-	-	87	-	-
NAVICULA TENERA	-	-	-	10	-	-	27	-
NAVICULA [illegible]	40	-	-	-	22	-	-	22
NAVICULA TRIDENTULA	-	-	-	-	-	87	-	-
NAVICULA SP 7	-	-	-	-	-	-	-	-
NAVICULA SP 8	-	-	-	-	-	-	-	-
NITZSCHIA ACICULARIS	-	-	44	-	-	90	-	44
NITZSCHIA [illegible]	-	-	-	-	-	-	-	-
NITZSCHIA DISSIPATA	80	-	-	-	-	-	-	-
NITZSCHIA DENTICULA	45	-	-	15	-	87	34	42
NITZSCHIA FONTICOLA	-	-	-	-	-	-	-	-
NITZSCHIA KUETZINGIANA	274	50	45	45	-	224	50	111
NITZSCHIA IGNORATA	-	-	-	-	-	-	-	22
NITZSCHIA LINEARIS	-	-	-	-	-	-	-	-
NITZSCHIA MICROCEPHALA	40	-	-	-	-	-	-	-
NITZSCHIA PALEA	80	-	-	12	-	-	22	22
NITZSCHIA RECTA	-	-	-	-	-	-	-	-
NITZSCHIA SP 1	-	-	22	-	22	50	-	22
NITZSCHIA SP 4	-	-	-	-	-	-	-	-
NITZSCHIA SP 2	-	-	-	-	-	-	80	-
NITZSCHIA SP 9	-	-	-	-	-	-	-	-
NITZSCHIA SINUATA V TABELLARIA	80	-	-	-	-	44	-	-
NITZSCHIA TRYBLIONELLA V VICTORIAE	-	-	-	-	-	22	-	-
OPEPHORA MARTYI	-	-	-	-	-	-	-	-
PINNULARIA BRAUNII	-	-	-	-	-	-	-	-
RHOICOSPHENIA CURVATA	-	-	-	-	22	-	-	-
STEPHANODISCUS ASTRAEA	-	-	-	-	-	-	-	-
STEPHANODISCUS SP 1	81	22	77	-	87	112	11	22
SURIRELLA OVATA	-	-	-	-	-	22	-	-
SYNEDRA ACUS	-	-	81	-	-	-	-	-
SYNEDRA PULCHELLA	-	80	-	-	-	-	-	-
SYNEDRA DELICATISSIMA	1720	1005	1018	400	22	437	842	420
SYNEDRA RUMPENS	-	-	-	-	-	-	22	-
SYNEDRA ULNA	-	-	-	-	-	-	274	-
SYNEDRA ULNA V DANICA	156	404	824	122	-	201	-	400
TABELLARIA FENESTRATA	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	33082	27293	20019	14406	24051	20414	5779	36702
NUMBER OF TAXA	36	24	22	31	21	27	15	21

TABLE B-4 (CONTINUED).

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATION:							
	41	42	[illegible]	********	********	********	********	********
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES SP. A	226	67	136	*****	*****	*****	*****	*****
ACHNANTHES EXIGUA V HETEROVALVA	-	-	-	*****	*****	*****	*****	*****
ACHNANTHES LANCEOLATA V DUBIA	16	-	67	*****	*****	*****	*****	*****
ACHNANTHES MINUTISSIMA	10268	10316	10374	*****	*****	*****	*****	*****
ACHNANTHES NOLLII	-	-	76	*****	*****	*****	*****	*****
AMPHIPLEURA PELLUCIDA	-	-	-	*****	*****	*****	*****	*****
AMPHORA OVALIS V PEDICULUS	-	-	-	*****	*****	*****	*****	*****
AMPHORA OVALIS V LIBYCA	-	-	-	*****	*****	*****	*****	*****
AMPHORA PERPUSILLA	88	-	-	*****	*****	*****	*****	*****
AMPHORA SP. 1	-	-	-	*****	*****	*****	*****	*****
ANOMOEONEIS VITREA	100	66	40	*****	*****	*****	*****	*****
CALONEIS BACILLUM	-	-	-	*****	*****	*****	*****	*****
COCCONEIS PLACENTULA V EUGLYPTA	801	-	66	*****	*****	*****	*****	*****
CYCLOTELLA MENEGHINIANA	-	-	-	*****	*****	*****	*****	*****
CYCLOTELLA STELLIGERA	46	67	-	*****	*****	*****	*****	*****
CYCLOTELLA SP. 6	66	-	-	*****	*****	*****	*****	*****
CYCLOTELLA SP. 3	-	-	-	*****	*****	*****	*****	*****
CYMBELLA AFFINIS	100	66	136	*****	*****	*****	*****	*****
CYMBELLA DELICATULA	-	-	-	*****	*****	*****	*****	*****
CYMBELLA LAEVIS	-	-	-	*****	*****	*****	*****	*****
CYMBELLA MICROCEPHALA	916	66	876	*****	*****	*****	*****	*****
CYMBELLA SINUATA	46	-	67	*****	*****	*****	*****	*****
CYMBELLA TUMIDA	-	-	-	*****	*****	*****	*****	*****
CYMBELLA VENTRICOSA	64	66	88	*****	*****	*****	*****	*****
CYMBELLA SP. 2	66	-	-	*****	*****	*****	*****	*****
DIPLONEIS OVALIS	-	-	-	*****	*****	*****	*****	*****
DIPLONEIS SP. A	-	-	-	*****	*****	*****	*****	*****
FRAGILARIA CAPUCINA	418	276	664	*****	*****	*****	*****	*****
FRAGILARIA CONSTRUENS N	435	276	67	*****	*****	*****	*****	*****
FRAGILARIA CONSTRUENS V VENTER	67	67	-	*****	*****	*****	*****	*****
FRAGILARIA CROTONENSIS	-	-	-	*****	*****	*****	*****	*****
FRAGILARIA PINNATA	169	205	90	*****	*****	*****	*****	*****
FRAGILARIA VAUCHERIAE	66	-	-	*****	*****	*****	*****	*****
GOMPHONEMA APICATUM	-	-	-	*****	*****	*****	*****	*****
GOMPHONEMA ANGUSTATUM V PRODUCTA	66	66	-	*****	*****	*****	*****	*****
GOMPHONEMA AUGUR	88	66	67	*****	*****	*****	*****	*****
GOMPHONEMA CONSTRICTUM V. SUBCAPITATA	-	-	-	*****	*****	*****	*****	*****
GOMPHONEMA GRACILE V LANCEOLATA	-	-	-	*****	*****	*****	*****	*****
GOMPHONEMA GRACILE V NAVICULOIDES	-	-	-	*****	*****	*****	*****	*****
GOMPHONEMA INTRICATUM V PUMILA	320	-	66	*****	*****	*****	*****	*****
GOMPHONEMA MONTANUM V SUBCLAVATA	-	-	-	*****	*****	*****	*****	*****
GOMPHONEMA PARVULUM	-	-	-	*****	*****	*****	*****	*****
MELOSIRA AMBIGUA	61	-	-	*****	*****	*****	*****	*****
MELOSIRA DISTANS	76	88	-	*****	*****	*****	*****	*****
MELOSIRA GRANULATA N	-	-	-	*****	*****	*****	*****	*****
MELOSIRA GRANULATA V ANGUSTISSIMA	-	-	-	*****	*****	*****	*****	*****
NAVICULA ARVENSIS	-	-	-	*****	*****	*****	*****	*****
NAVICULA CAPITATA	-	-	-	*****	*****	*****	*****	*****
NAVICULA CRYPTOCEPHALA V INTERMEDIA	67	-	-	*****	*****	*****	*****	*****
NAVICULA CRYPTOCEPHALA V VENETA	110	66	66	*****	*****	*****	*****	*****
NAVICULA DECUSSIS	-	-	-	*****	*****	*****	*****	*****
NAVICULA HEUFLERI V LEPTOCEPHALA	-	-	-	*****	*****	*****	*****	*****
NAVICULA LANCEOLATA	88	-	-	*****	*****	*****	*****	*****
NAVICULA LUZONENSIS	-	-	-	*****	*****	*****	*****	*****
NAVICULA MENISCULUS V UPSALIENSIS	-	-	-	*****	*****	*****	*****	*****
NAVICULA MINIMA	805	88	65	*****	*****	*****	*****	*****
NAVICULA MUTICA	-	-	-	*****	*****	*****	*****	*****
NAVICULA PUPULA	66	-	-	*****	*****	*****	*****	*****
NAVICULA PUPULA V. ELLIPTICA	-	-	-	*****	*****	*****	*****	*****
NAVICULA PYGMAEA	-	-	-	*****	*****	*****	*****	*****
NAVICULA RADIOSA V TENELLA	-	-	-	*****	*****	*****	*****	*****
NAVICULA RHYNCHOCEPHALA V GERMANII	-	-	-	*****	*****	*****	*****	*****
NAVICULA SCHROETERI V ESCAMBIA	-	-	-	*****	*****	*****	*****	*****
NAVICULA CF. SIMULA	-	88	-	*****	*****	*****	*****	*****
NAVICULA SUBHAMULATA	-	-	-	*****	*****	*****	*****	*****
NAVICULA TENERA	-	-	-	*****	*****	*****	*****	*****
NAVICULA THIENEMANNII	66	-	-	*****	*****	*****	*****	*****
NAVICULA TRIDENTULA	-	-	87	*****	*****	*****	*****	*****
NAVICULA SP. 3	66	-	88	*****	*****	*****	*****	*****
NAVICULA SP. 6	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA ACICULARIS	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA [illegible]	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA DISSIPATA	65	-	-	*****	*****	*****	*****	*****
NITZSCHIA FONTICOLA	66	66	116	*****	*****	*****	*****	*****
NITZSCHIA FONTICOLA	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA KUETZINGIANA	134	66	88	*****	*****	*****	*****	*****
NITZSCHIA IGNORATA	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA LINEARIS	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA MICROCEPHALA	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA PALEA	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA RECTA	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA SP. 1	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA SP. 4	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA SP. 6	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA SP. 9	-	-	-	*****	*****	*****	*****	*****
NITZSCHIA SINUATA V TABELLARIA	66	-	-	*****	*****	*****	*****	*****
NITZSCHIA TRYBLIONELLA V VICTORIAE	-	-	-	*****	*****	*****	*****	*****
OPEPHORA MARTYI	-	-	-	*****	*****	*****	*****	*****
PINNULARIA BRAUNII	-	-	-	*****	*****	*****	*****	*****
RHOICOSPHENIA CURVATA	67	-	-	*****	*****	*****	*****	*****
STEPHANODISCUS ASTRAEA	-	-	-	*****	*****	*****	*****	*****
STEPHANODISCUS SP. 1	64	-	67	*****	*****	*****	*****	*****
SURIRELLA OVATA	46	67	-	*****	*****	*****	*****	*****
SYNEDRA ACUS	-	-	-	*****	*****	*****	*****	*****
SYNEDRA PULCHELLA	-	-	-	*****	*****	*****	*****	*****
SYNEDRA DELICATISSIMA	611	66	618	*****	*****	*****	*****	*****
SYNEDRA RUMPENS	-	-	58	*****	*****	*****	*****	*****
SYNEDRA ULNA	-	-	-	*****	*****	*****	*****	*****
SYNEDRA ULNA V DANICA	58	66	867	*****	*****	*****	*****	*****
TABELLARIA FENESTRATA	88	-	-	*****	*****	*****	*****	*****
TOTAL NUMBER OF ORGANISMS	17816	11661	21061	******	******	******	******	******
NUMBER OF TAXA	[illegible]	[illegible]	26	*****	*****	*****	*****	*****

TABLE B-5
VAAP PERIPHYTON ARTIFICIAL SUBSTRATE, AUGUST 12 - SEPTEMBER 7, 1975

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATION							
	A	31	C1	C2	32	22	NO [illegible]	B
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES SP A	30	22	45	52	-	65	22	22
ACHNANTHES LANCEOLATA N	-	-	-	-	-	-	-	-
ACHNANTHES LANCEOLATA V DUBIA	-	-	-	-	-	87	-	-
ACHNANTHES MINUTISSIMA	8421	60920	39836	22316	13557	21835	15796	21842
ACHNANTHES NOLLII	91	45	27	44	245	275	254	-
AMPHIPLEURA PELLUCIDA	-	-	-	-	-	-	-	-
AMPHORA OVALIS P PEDICULUS	-	-	-	-	-	-	-	-
AMPHORA OVALIS V LIBYCA	-	-	-	-	-	-	-	-
AMPHORA PERPUSILLA	-	-	-	-	-	-	-	-
AMPHORA SP 1	-	-	-	-	-	-	22	-
ANOMOEONEIS VITREA	30	-	-	22	44	90	-	573
COCCONEIS PLACENTULA V EUGLYPTA	-	-	-	-	-	-	-	22
CYCLOTELLA MENEGHINIANA	30	42	-	-	-	-	22	-
CYCLOTELLA STELLIGERA	305	941	160	44	112	107	100	22
CYCLOTELLA SP 2	-	-	-	-	-	22	-	-
CYMBELLA AFFINIS	-	90	44	91	255	136	213	29
CYMBELLA DELICATULA	-	-	-	-	-	-	-	-
CYMBELLA LAEVIS	-	67	22	274	67	64	-	-
CYMBELLA MICROCEPHALA	91	44	-	156	45	90	155	306
CYMBELLA TUMIDA	-	55	-	140	22	-	-	-
CYMBELLA VENTRICOSA	10	-	-	-	-	-	22	-
DIPLONEIS OCULATA	-	-	-	-	22	-	-	-
DIPLONEIS OVALIS	-	-	-	-	-	-	-	-
DIPLONEIS SP A	-	-	-	-	-	22	-	-
FRAGILARIA CAPUCINA	182	45	-	476	115	329	229	900
FRAGILARIA CONSTRUENS N	10	-	-	-	-	-	-	22
FRAGILARIA CONSTRUENS V VENTER	-	-	22	-	-	-	-	-
FRAGILARIA CROTONENSIS	-	-	-	22	45	-	22	49
FRAGILARIA PINNATA	-	-	-	-	-	22	-	-
FRAGILARIA VAUCHERIAE	-	-	-	-	-	22	-	-
GOMPHONEMA ABBREVIATUM	-	-	45	-	-	-	-	-
GOMPHONEMA ACUMINATUM V CORONATA	-	-	-	-	-	-	-	-
GOMPHONEMA APICATUM	-	-	-	22	-	-	-	-
GOMPHONEMA ANGUSTATUM V PRODUCTA	-	-	-	-	-	-	-	22
GOMPHONEMA AUGUR	-	4[illegible]	-	22	-	113	45	22
GOMPHONEMA CONSTRICTUM V. SUBCAPITATA	-	-	-	-	-	-	-	-
GOMPHONEMA GRACILE & LANCEOLATA	-	-	-	-	-	-	-	90
GOMPHONEMA INTRICATUM V PUMILA	-	-	44	-	-	67	-	-
GOMPHONEMA PARVULUM	-	-	22	-	-	-	-	22
MELOSIRA AMBIGUA	91	225	22	-	91	95	95	87
MELOSIRA DISTANS	-	-	-	40	31	-	-	80
MELOSIRA GRANULATA N	15	-	-	-	22	46	-	67
MELOSIRA GRANULATA V ANGUSTISSIMA	-	-	-	-	45	-	22	-
NAVICULA CAPITATA	-	22	-	-	-	-	-	-
NAVICULA CONTENTA V BICEPS	-	-	-	-	-	-	-	-
NAVICULA CRYPTOCEPHALA V INTERMEDIA	15	-	-	-	47	-	-	-
NAVICULA CRYPTOCEPHALA V VENETA	30	-	-	22	142	67	127	-
NAVICULA DICEPHALA	-	-	-	-	-	-	-	-
NAVICULA GRACILIS	-	-	-	-	-	-	-	-
NAVICULA [illegible]	45	-	-	-	-	-	-	-
NAVICULA HEUFLERI V LEPTOCEPHALA	-	45	-	22	-	-	-	-
NAVICULA LUZONENSIS	-	-	-	-	-	-	-	-
NAVICULA MENISCULUS & UPSALIENSIS	-	-	-	-	-	22	-	-
NAVICULA MINIMA	30	-	-	-	22	-	-	-
NAVICULA MUTICA	-	-	-	-	-	-	22	-
NAVICULA PUPULA V. ELLIPTICA	-	-	-	-	-	-	-	-
NAVICULA PYGMAEA	-	45	-	-	-	-	-	-
NAVICULA RADIOSA V TENELLA	-	-	-	-	-	-	-	-
NAVICULA RHYNCHOCEPHALA V GERMAINI	-	2[illegible]	-	-	-	-	-	-
NAVICULA [illegible]	-	-	-	42	-	-	-	-
NAVICULA THIENEMANNII	30	22	-	-	22	-	-	-
NAVICULA TRIDENTULA	-	-	-	-	-	-	-	22
NITZSCHIA ACICULARIS	-	-	-	-	-	-	-	44
NITZSCHIA AMPHIBIA	-	-	-	-	-	-	-	-
NITZSCHIA DENTICULA	15	45	-	91	44	90	-	22
NITZSCHIA KUETZINGIANA	106	95	22	-	112	27	255	22
NITZSCHIA MICROCEPHALA	-	24	-	-	22	-	-	-
NITZSCHIA PALEA	45	92	-	-	-	22	-	-
NITZSCHIA SP 8	-	-	-	-	-	-	-	-
NITZSCHIA SINUATA V TABELLARIA	-	-	-	-	-	-	-	22
OPEPHORA MARTYI	-	-	-	-	-	-	-	-
PINNULARIA BRAUNII	-	-	-	-	-	-	-	-
STEPHANODISCUS ASTRAEA	-	55	-	-	-	-	-	-
STEPHANODISCUS SP 1	33	24	-	42	42	90	196	22
SURIRELLA OVATA	-	-	-	-	-	-	-	-
SURIRELLA ROBUSTA	-	-	-	-	-	-	-	-
SYNEDRA PULCHELLA	-	-	-	22	-	-	-	-
SYNEDRA DELICATISSIMA	30	-	-	274	45	-	45	991
SYNEDRA ULNA	76	93	-	251	92	22	91	112
TABELLARIA FENESTRATA	-	-	22	-	-	-	-	-
UNSPECIFIED IN MASTER FILE								
UNSPECIFIED TAXON	-	-	-	-	400	-	-	-
TOTAL NUMBER OF ORGANISMS	7736	67463	77171	29716	15044	24551	18647	24040
NUMBER OF TAXA	22	29	14	42	24	26	27	29

TABLE B-5(CONTINUED).

TAXONOMIC CLASSIFICATION	NUMBER OF ORGANISMS AT STATIONS							
	F1	F2	U1	U2	A1	A2	V2	********
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES SP	170	45	22	113	117	874	297	*****
ACHNANTHES LANCEOLATA	-	-	22	-	-	-	-	*****
ACHNANTHES LANCEOLATA V DUBIA	-	-	-	40	44	22	251	*****
ACHNANTHES MINUTISSIMA	10449	17250	83119	37060	20951	15102	20383	*****
ACHNANTHES NOLLII	-	69	22	455	-	-	57	*****
AMPHIPLEURA PELLUCIDA	40	-	22	22	22	22	-	*****
AMPHORA OVALIS V PEDICULUS	-	-	-	-	22	-	-	*****
AMPHORA OVALIS V LIBYCA	-	-	22	-	-	-	22	*****
AMPHORA PERPUSILLA	-	-	-	-	-	-	45	*****
AMPHORA SP 1	-	-	-	-	-	-	-	*****
ANOMOEONEIS VITREA	22	930	192	291	1390	801	90	*****
COCCONEIS PLACENTULA V EUGLYPTA	137	135	81	-	-	-	-	*****
CYCLOTELLA MENEGHINIANA	-	-	-	-	-	-	90	*****
CYCLOTELLA STELLIGERA	90	44	60	45	67	190	134	*****
CYCLOTELLA SP 2	-	-	-	-	-	-	-	*****
CYMBELLA AFFINIS	22	-	22	909	320	200	408	*****
CYMBELLA DELICATULA	-	-	-	22	-	-	-	*****
CYMBELLA LAEVIS	-	22	-	113	40	-	40	*****
CYMBELLA MICROCEPHALA	-	67	270	500	917	1000	1000	*****
CYMBELLA TUMIDA	-	80	22	61	-	-	-	*****
CYMBELLA VENTRICOSA	-	-	-	-	30	60	60	*****
DIPLONEIS OCULATA	-	-	-	-	-	-	-	*****
DIPLONEIS OVALIS	-	22	-	-	-	-	-	*****
DIPLONEIS SP A	-	-	-	-	-	-	-	*****
FRAGILARIA CAPUCINA	20	927	412	350	909	200	220	*****
FRAGILARIA CONSTRUENS V [illegible]	-	-	-	92	112	820	412	*****
FRAGILARIA CONSTRUENS V VENTER	-	-	-	22	135	410	220	*****
FRAGILARIA CROTONENSIS	-	40	22	22	-	-	-	*****
FRAGILARIA PINNATA	-	-	-	113	251	825	814	*****
FRAGILARIA VAUCHERIAE	-	-	-	-	22	-	-	*****
GOMPHONEMA ABBREVIATUM	-	-	-	-	-	-	-	*****
GOMPHONEMA ACUMINATUM V CORONATA	-	22	-	-	-	-	-	*****
GOMPHONEMA APICATUM	-	22	-	-	22	-	-	*****
GOMPHONEMA ANGUSTATUM V PRODUCTA	90	134	80	-	22	-	-	*****
GOMPHONEMA AUGUR	-	-	-	90	67	-	-	*****
GOMPHONEMA CONSTRICTUM V. CAPITATA	-	-	22	-	-	-	-	*****
GOMPHONEMA GRACILE V LANCEOLATA	-	113	-	90	-	-	22	*****
GOMPHONEMA INTRICATUM V PUMILA	810	22	40	-	65	-	-	*****
GOMPHONEMA PARVULUM	81	66	-	-	-	-	-	*****
MELOSIRA AMBIGUA	93	45	45	22	90	851	801	*****
MELOSIRA DISTANS	-	-	-	89	130	102	110	*****
MELOSIRA GRANULATA [illegible]	-	82	-	-	-	26	22	*****
MELOSIRA GRANULATA V ANGUSTISSIMA	-	-	-	-	-	-	22	*****
NAVICULA CAPITATA	-	-	-	-	-	-	44	*****
NAVICULA CONTENTA V BICEPS	-	-	-	-	29	-	-	*****
NAVICULA CRYPTOCEPHALA V INTERMEDIA	-	-	-	-	40	82	40	*****
NAVICULA CRYPTOCEPHALA V VENETA	-	200	180	67	113	44	323	*****
NAVICULA DICEPHALA	-	-	-	-	22	-	-	*****
NAVICULA GRACILIS	-	22	-	-	-	-	-	*****
NAVICULA CF HEUFLERI	-	-	-	-	-	-	-	*****
NAVICULA HEUFLERI V LEPTOCEPHALA	-	-	-	22	-	-	-	*****
NAVICULA LUZONENSIS	-	-	-	-	22	-	-	*****
NAVICULA MENISCULUS V UPSALIENSIS	-	-	-	-	-	-	-	*****
NAVICULA MINIMA	-	-	44	22	60	113	113	*****
NAVICULA MUTICA	-	-	-	-	-	-	-	*****
NAVICULA PUPULA V. ELLIPTICA	20	-	-	-	-	-	22	*****
NAVICULA PYGMAEA	-	-	-	-	22	-	-	*****
NAVICULA RADIOSA V TENELLA	-	-	-	-	-	-	22	*****
NAVICULA RHYNCHOCEPHALA V GERMAINI	-	-	-	-	-	-	-	*****
NAVICULA [illegible]	-	-	-	-	-	-	22	*****
NAVICULA [illegible]	-	-	-	-	44	22	-	*****
NAVICULA TRIPUNCTATA	-	22	-	-	29	67	22	*****
NITZSCHIA ACICULARIS	82	-	82	22	65	60	-	*****
NITZSCHIA AMPHIBIA	-	-	-	-	-	-	26	*****
NITZSCHIA DENTICULA	-	12	67	22	90	130	113	*****
NITZSCHIA KUETZINGIANA	40	-	22	44	67	140	440	*****
NITZSCHIA MICROCEPHALA	-	-	-	-	-	-	81	*****
NITZSCHIA PALEA	-	-	-	-	22	-	-	*****
NITZSCHIA SP A	-	-	-	-	-	22	22	*****
NITZSCHIA SINUATA V TABELLARIA	22	-	-	44	45	67	100	*****
OPEPHORA MARTYI	-	-	-	-	-	-	22	*****
PINNULARIA BRAUNII	-	-	-	-	-	22	-	*****
STEPHANODISCUS ASTRAEA	-	-	-	22	-	20	-	*****
STEPHANODISCUS SP 1	40	-	-	55	67	130	67	*****
SURIRELLA OVATA	-	-	-	-	-	-	22	*****
SURIRELLA ROBUSTA	-	-	-	-	84	-	-	*****
SYNEDRA PULCHELLA	-	-	-	-	-	-	-	*****
SYNEDRA DELICATISSIMA	22	909	900	120	637	60	667	*****
SYNEDRA ULNA	-	102	700	10	44	-	41	*****
TABELLARIA FENESTRATA	-	-	-	-	-	-	-	*****
UNSPECIFIED IN MASTER FILE								
UNSPECIFIED TAXON	-	-	-	-	-	-	-	*****
TOTAL NUMBER OF ORGANISMS	21074	26110	87044	61944	87627	[illegible]	20201	******
NUMBER OF TAXA	18	20	29	22	40	40	41	*****

TABLE B-6

PRESENCE-ABSENCE DATA FOR FILAMENTOUS ORGANISMS COLLECTED FROM VAAP ARTIFICIAL SUBSTRATES, JUNE-JULY 4-WEEK INCUBATION PERIOD, 1975, LAKE CHICKAMAUGA, TENNESSEE

Species	A	B-1	B-2	C-1	F-2	S	T-1	X-2
Cyanophyceae								
Microcoleus lynbyaccous				X		X		
Oscillatoria lutea								X
Oscillatoria submembranceae		X						
Schizothrix arenaria					X			
Schizothrix calcicola		X	X	X	X		X	X
Spirulina subsala			X					X
Chlorophyceae								
Chaetopeltis sp.							X	
Choleochaete spp.		X		X	X		X	
Cylindrocapsa geminella						X	X	
Mougeotia spp.		X	X		X		X	X
Oedogonium sp. 1	X	X	X			X	X	X
Ulothrix spp.					X		X	
Ciliophora (stalked protozoans)								
Opisthostyla sp.				X			X	
Vorticella sp.		X					X	X
Total No. Autotrophic Species	1	5	4	3	5	3	7	5
Total No. Heterotrophic Species	0	0	1	1	0	0	2	1
Total No. of Filamentous Species	1	5	5	4	5	3	9	6

TABLE B-7

PRESENCE-ABSENCE DATA FOR FILAMENTOUS ORGANISMS
COLLECTED FROM SELECTED VAAP ARTIFICIAL SUBSTRATES
AUGUST-SEPTEMBER 4-WEEK INCUBATION PERIOD
1975, LAKE CHICKAMAUGA, TENNESSEE

Species	A	B-1	C-1	F-2	S	T-1	X-2
Cyanophyceae							
Anabaena sp.						X	
Microcoleus lynbyaceous			X				
Oscillatoria lutea		X					
Oscillatoria submembranceae	X				X	X	
Schizothrix arenaria			X	X			
Schizothrix calcicola	X	X		X			X
Spirulina subsala							X
Chlorophyceae							
Aphanochaete polychaete	X						
Bulbochaete sp.					X		
Choleochaete spp.	X	X		X			
Cylindrocapsa geminella			X				
Mougeotia spp.		X	X	X	X	X	X
Oedogonium sp. 1	X	X		X	X	X	X
Oedogonium lautummiarum	X						
Stigeoclonium attenuatum		X		X			
Stigeoclonium tenue			X				
Ulothrix spp.		X		X		X	
Ciliophora (stalked protozoans)							
Opisthostyla sp.		X			X		
Rhabdostyla sp.		X					
Thuricolopsis sp.	X						
Thuricola sp.	X		X				
Vorticella sp.	X	X			X	X	X
Total No. of Autotrophic Species	6	7	5	7	4	5	4
Total No. of Heterotrophic Species	3	9	1	0	2	1	1
Total No. of Filamentous Species	9	10	6	7	6	6	5

TABLE B-8
VAAP NATURAL SUBSTRATE DIATOMS (RAW COUNTS), JUNE, 1975

Bacillariophyta (Diatoms)	T-2	X-2	A	B-1	S	F-2
ACHNANTHES LANCEOLATA N	1	-	2	1	1	-
ACHNANTHES LANCEOLATA V DUBIA	-	-	3	-	1	3
ACHNANTHES MINUTISSIMA	220	302	28	157	255	1216
ACHNANTHES SP 1	-	1	1	1	-	-
AMPHORA SP 1	-	-	-	-	-	1
ANOMOEONEIS VITREA	-	54	-	-	-	2
CALONEIS BACILLUM	1	-	-	-	-	-
CALONEIS SP	-	-	1	-	-	-
COCCONEIS PLACENTULA V LINEARIS	4	-	1	2	-	1
COCCONEIS PLACENTULA V EUGLYPTA	2	-	-	2	-	-
CYCLOTELLA STELLIGERA	-	3	-	1	1	1
CYMBELLA AFFINIS	-	-	-	2	-	8
CYMBELLA DELICATULA	-	-	-	-	-	1
CYMBELLA VENTRICOSA	3	8	-	2	-	8
CYMBELLA PROSTATA	5	-	-	-	-	63
CYMBELLA MICROCEPHALA	7	44	2	2	-	1
CYMBELLA LAEVIS	-	-	-	-	-	2
CYMBELLA TUMIDA	1	-	-	3	-	7
CYMBELLA SP 1	1	15	-	-	-	-
DIPLONEIS SMITHII	-	-	-	-	1	-
DIPLONEIS SP A	-	-	-	-	-	1
FRUSTULIA VULGARE	-	-	-	1	-	-
FRAGILARIA CONSTRUENS V VENTER	-	1	-	-	-	-
FRAGILARIA CROTONENSIS	-	1	-	-	-	-
FRAGILARIA PINNATA	2	2	-	-	-	3
FRAGILARIA VAUCHERIAE	6	-	-	-	-	5
GOMPHONEMA ACUMINATUM V MONTANUM	1	1	-	-	3	-
GOMPHONEMA GRACILE V LANCEOLATA	1	-	-	9	1	-
GOMPHONEMA MONTANUM V SUBCLAVATA	-	-	-	-	2	1
GOMPHONEMA PARVULUM	1	1	-	1	1	3
GOMPHONEMA SP 1	-	1	-	3	2	-
GOMPHONEMA SP 2	9	-	-	3	2	-
MELOSIRA DISTANS	3	-	-	-	-	-
MELOSIRA GRANULATA N	1	8	1	-	4	6
MELOSIRA VARIANS	-	1	1	-	-	-
NAVICULA AURICULATA	1	-	-	-	-	-
NAVICULA CRYPTOCEPHALA V INTERMEDIA	2	-	1	-	-	2
NAVICULA CRYPTOCEPHALA V VENETA	8	3	-	6	6	62
NAVICULA LANCEOLATA	1	-	-	-	-	-
NAVICULA MENISCULUS V UPSALIS	-	-	-	-	-	1
NAVICULA MINIMA	1	-	-	-	-	-
NAVICULA MUTICA	-	-	1	-	-	-
NAVICULA PUPULA	2	-	-	-	-	1
NAVICULA PUPULA V RECTANGULARIS	-	-	-	-	-	2
NAVICULA SALINARIUM V INTERMEDIA	2	-	-	-	-	1
NAVICULA VIRIDULA	1	-	-	-	-	-
NAVICULA SP 1	-	-	-	-	-	1
NAVICULA SP 2	-	1	3	2	1	-
NAVICULA SP 5	-	-	-	-	-	1
NAVICULA SP 6	-	-	-	1	-	-
NITZSCHIA AMPHIBIA	2	1	3	-	3	4
NITZSCHIA DENTICULA	78	104	-	-	-	20
NITZSCHIA KUTZINGIANA	-	-	-	-	1	-
NITZSCHIA PALEA	1	-	-	-	-	-
NITZSCHIA SP 1	1	-	-	-	-	-
NITZSCHIA SINUATA V TABELLARIA	64	15	-	-	-	99
NITZSCHIA TRYBLIONELLA V VICTORIAE	-	-	-	-	-	-

TABLE B-8 (Continued)

Bacillariophyta (Diatoms)	T-2	X-2	A	B-1	S	F-2
STEPHANODISCUS ASTRAEA	-	1	-	-	1	3
STEPHANODISCUS SP 1	1	-	-	-	-	3
SURIRELLA OVATA	1	-	-	-	-	-
SYNEDRA PULCHELLA	-	-	1	-	-	1
SYNEDRA DELICATISSIMA	-	-	-	-	1	-
SYNEDRA RUMPENS V FAMILARIS	2	1	1	2	-	-
SYNEDRA ULNA	7	-	-	-	-	4
TABELLARIA FENESTRATA	1	-	-	-	-	-
UNIDENTIFIED TAXA						
UNIDENTIFIED SPECIES 1	-	-	-	1	-	-
TOTAL NUMBER OF ORGANISMS	445	569	51	202	287	1538
NUMBER OF TAXA	36	22	16	20	18	34

TABLE B-9

RELATIVE ABUNDANCE OF DOMINANT TO COMMON VAAP ARTIFICIAL SUBSTRATE DIATOM SPECIES - JUNE 11-25, 1975

Station	Species	Density (Cells/mm^2)	Percent Relative Abundance
	Achnanthes minutissima	420	59.3
	Nitzschia palea	105	14.8
	Nitzschia cf. capitellata	60	8.5
A	Synedra rumpens	30	4.2
	Gomphonema intricatum v. pumila	22	3.1
	Gomphonema parvulum	15	2.1
	Other species	56	7.9
	Total	708	99.9*
	Achnanthes minutissima	24,815	88.9
	Fragilaria capucina	940	3.4
B-1	Synedra rumpens	396	1.4
	Synedra ulna	297	1.1
	Other species	1,454	5.2
	Total	27,902	100
	Achnanthes minutissima	15,277	82.4
	Fragilaria capucina	970	5.2
B-2	Synedra rumpens	312	1.7
	Synedra ulna	304	1.6
	Other species	1,668	9.0
	Total	18,531	99.9*
	Achnanthes minutissima	5,687	93.0
C-1	Gomphonema intricatum v. pumila	93	1.5
	Fragilaria capucina	54	0.8
	Other species	282	4.6
	Total	6,116	99.9*
	Achnanthes minutissima	10,410	82.0
	Fragilaria capucina	863	6.8
C-2	Synedra rumpens	342	2.7
	Gomphonema intricatum v. pumila	205	1.6
	Cocconeis placentula v. euglypta	152	1.2
	Other species	718	5.7
	Total	12,690	100
	Achnanthes minutissima	13,218	97.6
D-1	Fragilaria capucina	75	0.5
	Other species	247	1.8
	Total	13,540	99.9*

TABLE B-9 (CONTINUED)

Station	Species	Density (Cells/mm^2)	Percent Relative Abundance
D-2	Achnanthes minutissima	7,760	90.5
	Achnanthes nollii	195	2.3
	Synedra rumpens	90	1.0
	Other species	532	6.2
	Total	8,577	100
F-1	Achnanthes minutissima	1,083	80.9
	Gomphonema parvulum	79	5.9
	Synedra ulna	32	2.4
	Cymbella affinis	30	2.2
	Synedra rumpens	25	1.8
	Other species	90	6.7
	Total	1,339	99.9*
F-2	Achnanthes minutissima	3,287	57.3
	Navicula cryptocephala v. veneta	358	6.2
	Synedra ulna	274	4.8
	Cymbella prostata	212	3.7
	Fragilaria vaucheriae	175	3.0
	Gomphonema parvulum	166	2.9
	Cymbella ventricosa**	105	1.8
	Other species	1,160	20.2
	Total	5,737	99.9*
S	Achnanthes minutissima	10,995	94.0
	Gomphonema parvulum	314	2.7
	Fragilaria capucina	118	1.0
	Other species	271	2.3
	Total	11,698	100
T-1	Achnanthes minutissima	10,907	90.8
	Gomphonema parvulum	274	2.3
	Fragilaria capucina	244	2.0
	Gomphonema gracile v. lanceolata	106	0.9
	Other species	476	4.0
	Total	12,007	100
T-2	Achnanthes minutissima	18,891	91.4
	Nitzschia denticula	827	4.0
	Fragilaria capucina	144	0.7
	Other species	802	3.9
	Total	20,664	100

TABLE B-9 (CONTINUED)

Station	Species	Density (Cells/mm^2)	Percent Relative Abundance
	Achnanthes minutissima	16,956	93.7
U-1	Fragilaria capucina	220	1.2
	Other species	916	5.1
	Total	18,092	100
	Achnanthes minutissima	16,746	86.5
	Fragilaria capucina	668	3.4
X-1	Cymbella microcephala	332	1.7
	Anomoeneis vitrea	236	1.2
	Other species	1,385	7.2
	Total	19,367	100
	Achnanthes minutissima	5,788	85.4
	Fragilaria capucina	173	2.6
X-2	Synedra delicatissima	167	2.5
	Anomoeneis vitrea	151	2.2
	Cymbella microcephala	70	1.0
	Other species	430	6.3
	Total	6,779	100
	Achnanthes minutissima	5,170	75.7
	Cymbella affinis	228	3.3
	Cymbella microcephala	221	3.2
Y-1	Navicula cryptocephala v. veneta	174	2.5
	Nitzschia denticula	136	2.0
	Gyrosigma attenuatum	106	1.6
	Other species	793	11.6
	Total	6,828	*99.9

*99.9% relative abundance results from rounding off.

**Cymbella ventricosa = Cymbella minuta.

TABLE B-10

RELATIVE ABUNDANCE OF DOMINANT TO COMMON VAAP ARTIFICIAL SUBSTRATE DIATOM SPECIES - JUNE 11 - JULY 10, 1975

Station	Species	Density (Cells/mm^2)	Percent (%) Relative Abundance
A	Achnanthes minutissima	5,614	88.7
	Nitzschia palea	273	4.3
	Synedra rumpens	97	1.5
	Other species	344	5.4
	Total	6,328	99.9*
B-1	Achnanthes minutissima	73,102	86.7
	Melosira ambigua	1,651	2.0
	Nitzschia denticula	1,055	1.2
	Synedra rumpens	733	0.9
	Other species	7,617	9.1
	Total	84,158	99.9*
B-2	Achnanthes minutissima	84,345	91.6
	Fragilaria capucina	2,202	2.4
	Melosira ambigua	1,284	1.4
	Other species	4,199	4.6
	Total	92,030	100.0
C-1	Achnanthes minutissima	54,039	93.2
	Cocconeis placentula v. euglypta	618	1.1
	Gomphonema intricatum v. pumila	585	1.0
	Other species	2,737	4.7
	Total	57,979	100.0
D-1	Achnanthes minutissima	60,772	89.3
	Achnanthes nollii	1,551	2.3
	Cymbella affinis	700	1.0
	Synedra ulna v. danica	650	0.9
	Other species	4,400	6.5
	Total	68,073	100.0
D-2	Achnanthes minutissima	32,766	88.1
	Achnanthes nollii	791	2.1
	Cymbella laevis	446	1.2
	Cymbella microcephala	378	1.0
	Cymbella prostata	377	1.0
	Other species	2,424	6.5
	Total	37,182	99.9*

Table B-10 (Continued)

Station	Species	Density (Cells/mm²)	Percent (%) Relative Abundance
F-2	Achnanthes minutissima	42,404	83.1
	Navicula cryptocephala v. veneta	1,617	3.2
	Achnanthes nollii	1,616	3.2
	Cymbella affinis	550	1.0
	Other species	4,857	9.5
	Total	51,044	100.0
S	Achnanthes minutissima	45,709	92.8
	Gomphonema parvulum	1,032	2.1
	Other species	2,529	5.1
	Total	49,270	100.0
T-1	Achnanthes minutissima	28,499	88.6
	Melosira ambigua	585	1.8
	Navicula cf. minima	413	1.3
	Navicula cryptocephala v. veneta	343	1.1
	Other species	2,320	7.2
	Total	32,160	100.0
X-2	Achnanthes minutissima	52,317	87.7
	Cymbella microcephala	2,271	3.8
	Anomoeoneis vitrea	1,410	2.4
	Synedra delicatissima	378	0.6
	Other species	3,249	5.4
	Total	59,625	99.9*
Y-2	Achnanthes minutissima	16,080	76.5
	Cymbella affinis	917	4.3
	Achnanthes nollii	710	3.4
	Navicula cryptocephala v. veneta	665	3.2
	Navicula minima	607	2.9
	Other species	2,032	9.7
	Total	21,011	100.0

*99.9% total relative abundance results from rounding off.

TABLE B-11

RELATIVE ABUNDANCE OF DOMINANT TO COMMON VAAP ARTIFICIAL SUBSTRATE DIATOM SPECIES - AUGUST 12-26, 1975

Station	Species	Density (Cells/mm^2)	Percent (%) Relative Abundance
A	Achnanthes minutissima	434	47.9
	Nitzschia kutzingiana	102	11.3
	Nitzschia palea	102	11.3
	Navicula cf. heufleri v. leptocephala	68	7.5
	Melosira granulata	68	7.5
	Melosira ambigua	22	2.4
	Melosira distans	22	2.4
	Synedra delicatissima	22	2.4
	Other species	66	7.3
	Total	906	100.0
B-1	Achnanthes minutissima	14,084	86.1
	Navicula cf. heufleri v. leptocephala	228	1.4
	Gomphonema parvulum	228	1.4
	Melosira ambigua	159	1.0
	Other species	1,661	10.1
	Total	16,360	100.0
B-2	Achnanthes minutissima	9,140	79.1
	Cymbella affinis	470	4.1
	Fragilaria capucina	332	2.9
	Melosira ambigua	274	2.4
	Nitzschia kutzingiama	194	1.7
	Synedra delicatissima	182	1.6
	Other species	964	8.3
	Total	11,556	100.1*
C-1	Achnanthes minutissima	23,031	88.4
	Fragilaria capucina	366	1.4
	Synedra ulna	251	1.0
	Other species	2,386	9.2
		26,034	100.0

TABLE B-11 (Continued)

Station	Species	Density (Cells/mm^2)	Percent (%) Relative Abundance
C-2	Achnanthes minutissima	13,438	85.9
	Synedra delicatissima	397	2.5
	Fragilaria capucina	198	1.3
	Synedra rumpens	198	1.3
	Other species	1,405	9.0
	Total	15,636	100.0
D-1	Achnanthes minutissima	18,970	93.7
	Achnanthes nollii	137	0.7
	Melosira ambigua	136	0.7
	Other species	1,004	4.9
		20,247	100.0
D-2	Achnanthes minutissima	12,766	69.7
	Achnanthes nollii	1,115	6.1
	Fragilaria capucina	1,069	5.8
	Synedra delicatissima	840	4.6
	Synedra ulna	687	3.7
	Fragilaria crotonensis	228	1.2
	Other species	1,619	8.8
	Total	18,324	99.9*
E-1	Achnanthes minutissima	18,997	72.5
	Amphipleura pellucida	825	3.1
	Synedra delicatissima	687	2.6
	Achnanthes nollii	550	2.1
	Synedra ulna v. danica	503	1.9
	Fragilaria capucina	458	1.7
	Other species	4,181	16.0
	Total	26,201	99.9*
E-2	Achnanthes minutissima	27,441	81.0
	Fragilaria capucina	1,514	4.5
	Synedra delicatissima	1,330	3.9
	Achnanthes nollii	504	1.5
	Fragilaria construens	413	1.2
	Other species	2,678	7.9
	Total	33,880	100.0

TABLE B-11 (Continued)

Station	Species	Density (Cells/mm²)	Percent (%) Relative Abundance
"No Wake"	Achnanthes minutissima	33,858	91.0
	Synedra delicatissima	1,009	2.7
	Fragilaria capucina	641	1.7
	Synedra ulna v. danica	504	1.3
	Other species	1,191	3.2
	Total	37,203	99.9*
"F-Buoy"	Achnanthes minutissima	6,766	65.0
	Synedra delicatissima	1,719	16.5
	Synedra ulna v. danica	825	7.9
	Achnanthes nollii	389	3.7
	Fragilaria capucina	206	2.0
	Other species	510	4.9
	Total	10,415	100.0
S	Achnanthes minutissima	15,304	90.1
	Fragilaria capucina	488	2.9
	Synedra delicatissima	320	1.9
	Cymbella microcephala	167	0.9
	Other species	707	4.2
	Total	16,986	100.0
F-1	Achnanthes minutissima	17,525	94.8
	Melosira ambigua	182	1.0
	Other species	784	4.2
	Total	18,491	100.0
T-2	Achnanthes minutissima	15,346	74.1
	Fragilaria capucina	1,697	8.2
	Synedra delicatissima	687	3.3
	Melosira ambigua	618	3.0
	Synedra ulna v. danica	251	1.2
	Nitzschia kutzingiana	228	1.1
	Other species	1,887	9.1
		20,714	100.0

TABLE B-11 (Continued)

Station	Species	Density (Cells/mm^2)	Percent (%) Relative Abundance
U-1	Achnanthes minutissima	3,187	55.2
	Synedra delicatissima	642	11.1
	Fragilaria capucina	401	6.9
	Synedra ulna	377	6.5
	Cymbella affinis	148	2.6
	Navicula cryptocephala v. venta	137	2.3
	Other species	883	15.3
	Total	5,775	99.9*
U-2	Achnanthes minutissima	22,871	85.4
	Fragilaria capucina	1,398	5.2
	Synedra delicatissima	458	1.7
	Synedra ulna v. danica	389	1.4
	Other species	1,666	6.2
	Total	26,782	99.9*
X-1	Achnanthes minutissima	12,295	69.8
	Cymbella microcephala	916	5.2
	Fragilaria construens	435	2.5
	Fragilaria capucina	412	2.3
	Synedra delicatissima	411	2.3
	Cymbella affinis	320	1.8
	Anomoeoneis vitrea	320	1.8
	Other species	2,505	14.2
	Total	17,614	99.9*
X-2	Achnanthes minutissima	12,318	88.0
	Fragilaria capucina	274	2.0
	Fragilaria construens	274	2.0
	Other species	1,125	8.0
	Total	13,991	100.0
Y-2	Achnanthes minutissima	18,374	87.3
	Fragilaria capucina	664	3.2
	Synedra delicatissima	412	1.9
	Synedra ulna v. danica	251	1.2
	Cymbella microcephala	228	1.1
	Other species	1,122	5.3
	Total	21,051	100.0

*Total relative abundances slightly below or above 100% are due to rounding off.

TABLE B-12

RELATIVE ABUNDANCE OF DOMINANT TO COMMON VAAP ARTIFICIAL SUBSTRATE DIATOM SPECIES - AUGUST 12 - SEPTEMBER 7, 1975

Station	Species	(Cells/mm^2)	Percent (%) Relative Abundance
A	Achnanthes minutissima	6,421	83.0
	Cyclotella stelligera	305	3.9
	Fragilaria capucina	152	2.0
	Nitzchia kutzingiana	106	1.4
	Achnanthes nollii	91	1.2
	Other species	663	8.5
	Total	7,738	100.0
B-1	Achnanthes minutissima	40,809	95.6
	Cyclotella stelligera	641	1.5
	Other species	1,215	2.8
	Total	42,665	99.9*
C-1	Achnanthes minutissima	36,634	98.5
		537	1.5
	Total	37.171	100.0
C-2	Achnanthes minutissima	22,916	90.8
	Fragilaria capucina	596	2.4
	Synedra delicatissima	320	1.3
	Cymbella laevis	274	1.1
	Other species	1,128	4.5
	Total	25,234	100.1*
D-2	Achnanthes minutissima	13,557	85.6
	Achnanthes nollii	298	1.9
	Cymbella affinis	205	1.3
	Other species	1,784	11.2
		15,844	100.0
NW	Achnanthes minutissima	17,754	90.8
	Fragilaria capucina	229	1.2
	Achnanthes nollii	205	1.0
	Nitzchia kutzingiana	205	1.0
	Other species	1,150	5.9
		19,543	99.9*

TABLE B-12 (continued)

Station	Species	(Cells/mm²)	Percent (%) Relative Abundance
E-2	Achnanthes minutissima	21,838	90.7
	Cymbella microcephala	687	2.9
	Fragilaria capucina	228	0.9
	Other species	1,328	5.5
	Total	24,081	100.0
S	Achnanthes minutissima	21,242	86.8
	Synedra delicatissima	871	3.6
	Fragilaria capucina	664	2.7
	Anomoeoneis vitra	573	2.3
	Cymbella microcephala	366	1.5
	Other species	758	3.1
	Total	24,474	100.0
T-1	Achnanthes minutissima	19,498	92.8
	Gomphonema intricatum v. pumila	619	2.9
	Achnanthes sp. A	159	0.8
	Other species	740	3.5
	Total	21,016	100.0
T-2	Achnanthes minutissima	17,250	85.7
	Synedra delicatissima	550	2.7
	Fragilaria capucina	527	2.6
	Anomoeoneis vitrea	435	2.1
	Navicula cryptocephala v. venta	205	1.0
	Other species	1,168	5.8
	Total	20,135	99.9*
U-1	Achnanthes minutissima	20,117	88.9
	Synedra delicatissima	504	2.2
	Fragilaria capucina	412	1.8
	Synedra ulna	366	1.6
	Other species	1,241	5.5
	Total	22,640	100.0

TABLE B-12 (Continued)

Station	Species	(Cells/mm²)	Percent (%) Relative Abundance
U-2	Achnanthes minutissima	37,460	91.1
	Cymbella microcephala	549	1.3
	Cymbella affinis	504	1.2
	Achnanthes nollii	458	1.1
	Fragilaria capucina	366	0.9
	Other species	1,757	4.3
	Total	41,094	99.9*
X-1	Achnanthes minutissima	24,201	80.6
	Anomoeneis vitrea	1,352	4.5
	Cymbella microcepha	917	3.0
	Fragilaria capucina	587	1.9
	Synedra delicatissima	503	1.7
	Cymbella affinis	320	1.1
	Other species	2,147	7.2
	Total	30,027	100.0
X-2	Achnanthes minutissima	15,162	72.5
	Cymbella microcephala	1,008	4.8
	Fragilaria construens	824	3.9
	Fragilaria pinnata	825	3.9
	Fragilaria construens v. venter	412	2.0
	Fragilaria capucina	297	1.4
	Achnanthes sp. A	274	1.4
	Other species	2,103	10.1
	Total	20,905	100.0
Y-2	Achnanthes minutissima	22,389	76.4
	Cymbella microcephala	1,284	4.4
	Fragilaria pinnata	619	2.1
	Melosira ambigua	481	1.6
	Nitzschia kutzingiana	458	1.6
	Cymbella affinis	458	1.6
	Fragilaria construens	412	1.4
	Synedra delicatissima	320	1.1
	Other species	2,870	9.8
	Total	29,291	100.0

*Total relative abundances slightly above or below 100% are due to the effect of rounding off.

TABLE B-13

MEAN DIATOM CELL DENSITIES (CELLS/MM^2) FOR VAAP ARTIFICIAL SUBSTRATES INCUBATED FOR 2- AND 4-WEEK INTERVALS JUNE - JULY, 1975, LAKE CHICKAMAUGA, TENNESSEE

Stations		2-Week* Incubation Interval June 11-25, 1975	4-Week** Incubation Period June 11 - July 10, 1975
A		708	6,328
B-1		27,902	84,158
B-2	Waconda Bay	18,531	92,030
C-1		6,116	57,979
C-2		12,690	L***
D-1		13,540	68,073
D-2		8,577	37,182
F-1	Offshore	1,339@	51,044
F-2		5,737	
S		11,698	49,270
T-1	Reference Bay A	12,007	32,160
T-2		20,664	L***
U-1		18,092	L***
U-2		L***	L***
X-1		19,367	L***
X-2		6,779	59,625
Y-1		6,828	L***
Y-2		L***	21,011

*Means developed from 3 replicates
**Means developed from 2 replicates
@Station found washed ashore
L***Station lost or vandalized

TABLE B-14

MEAN DIATOM CELL DENSITIES (CELLS/MM^2) FOR VAAP ARTIFICIAL SUBSTRATES INCUBATED FOR 2- AND 4-WEEK INTERVALS AUGUST - SEPTEMBER, 1975, LAKE CHICKAMAUGA, TENNESSEE

Stations	2-Week Incubation Interval* August 12-26, 1975	4-Week Incubation Interval* August 12-Sept. 7, 1975
A	906	7,738
B-1	16,360	42,665
B-2	11,556	L**
C-1 Waconda Bay	26,034	37,171
C-2	15,636	25,234
D-1	20,247	L**
D-2	18,324	15,844
No Wake	37,203	
E-1	26,201	L**
E-2	33,880	24,081
F-1 Offshore	L**	L**
F-2	L**	19,543
F-Buoy	10,415	
S	16,986	24,474
T-1 Reference Bay A	18,491	21,016
T-2	20,714	20,135
U-1	5,775	22,640
U-2	26,782	41,094
X-1	17,614	30,027
X-2 Huss Lowe Slough	13,991	20,905
Y-1	L**	L**
Y-2	21,051	29,291

*Means developed from 2 replicates
L**Lost or vandalized station

TABLE B-15

SHANNON-WEAVER SPECIES DIVERSITY INDICES ($\bar{H}$) FOR
VAAP ARTIFICIAL SUBSTRATE DIATOMS, JUNE - JULY
2- AND 4-WEEK INCUBATION PERIODS, LAKE CHICKAMAUGA, TENNESSEE

Stations		2-Week* Incubation Period June 11-25, 1975	4-Week** Incubation Period June 11-July 10, 1975
A		1.49	0.62
B-1		0.64	0.83
B-2	Waconda	0.64	0.52
C-1	Bay	0.44	0.45
C-2		0.91	L***
D-1		0.17	0.66
D-2		0.59	0.71
F-1	Offshore	0.93	0.97
F-2		2.07	
S		0.34	0.45
T-1	Reference	0.54	0.70
T-2	Bay A	0.49	L***
U-1		0.42	L***
X-1	Huss	0.78	L***
X-2	Lowe	0.81	0.67
Y-1	Slough	1.28	L***
Y-2		L***	1.20

*3 replicates pooled.
**2 replicates pooled.
L***Lost or vanaalized station.

TABLE B-16

SHANNON-WEAVER SPECIES DIVERSITY INDICES ($\bar{H}$) FOR VAAP ARTIFICIAL SUBSTRATE DIATOMS, AUGUST - SEPTEMBER 2- AND 4-WEEK INCUBATION PERIODS, LAKE CHICKAMAUGA, TENNESSEE

Stations		2-Week* Incubation Period August 12-26, 1975	4-Week* Incubation Period August 12-September 9, 1975
A		1.83	0.91
B-1		0.85	0.29
B-2	Waconda	1.10	L**
C-1	Bay	0.74	0.11
C-2		0.82	0.53
D-1*		0.43	L**
D-2		1.39	0.82
No Wake		0.51	0.55
E-1		1.49	L**
E-2		1.00	0.55
F-1	Offshore	L**	L**
F-2		L**	0.55
F Buoy		1.26	
S	Reference	0.56	0.69
T-1	Bay A	0.34	0.42
T-2		1.27	0.78
U-1		1.89	0.63
U-2		0.78	0.55
X-1		1.54	1.03
X-2	Huss	0.69	1.34
Y-1	Lowe	L**	L**
Y-2	Slough	0.71	1.26

*2 replicates pooled.
L**Lost or vandalized station.

TABLE B-17

SHANNON-WEAVER SPECIES DIVERSITY INDICES, SHANNON EVENNESS VALUES, AND TOTAL NUMBER OF SPECIES FOR NATURAL SUBSTRATE DIATOMS, JUNE, 1975, LAKE CHICKAMAUGA, TENNESSEE

Station	Shannon-Weaver Index ($\bar{H}$)	Shannon Evenness Values (J)	Total Numbers of Species
A	1.85	0.669	16
B-1 Waconda	0.13	0.337	20
F-2 Bay	0.99	0.280	34
S Reference	0.64	0.222	18
T-2 Bay A	1.84	0.512	36
X-2 Huss Lowe Slough	1.59	0.510	22

TABLE B-18

COMPARISONS OF DIATOM CELL DENSITY ESTIMATES (CELLS/MM^2)
FOR NATURAL AND ARTIFICIAL SUBSTRATES COLLECTED
DURING JUNE, 1975, LAKE CHICKAMAUGA

Station		Natural Substrates (Cells/mm^2) June, 1975	Artificial Substrates (Cells/mm^2) June 2-Week Incubation	Artificial Substrates (Cells/mm^2) June-July 4-Week Incubation
A		920	708	6,328
B-1	Waconda	14,540	27,902	84,158
F-2	Bay	11,510	5,737	1,044
S	Reference	6,260	11,698	49,270
T-2	Bay A	17,620	20,664	32,168*
X-2	Huss Lowe Slough	10,185	6,779	59,625

*Represents cells/mm^2 for Station T-1; T-2 was lost during the 4-week incubation period.

TABLE B-19

TRANSECT MEAN PERIPHYTON BIOMASS, CHLOROPHYLL a AND AUTOTROPHIC INDICES, JUNE - JULY SURVEY, 2-WEEK INCUBATIONS*

Station or Transect	Chlorophyll a (mg/M^2)	Organic Biomass (gm/M^2)	Autotrophic Index
A	4*	0.67	167
B Waconda	24	3.5	146
C Bay	35	1.9	54
D	17	1.4	82
E	22	-	-
F Offshore	-	1.5	-
S Reference	12	2.1	175
T Bay	14	2.9	207
U A	-	1.5	-
X Huss Lowe	-	2.0	-
Y Slough	13	1.3	100

*Raw data in Tables B-23 and B-27.

TABLE B-20

TRANSECT MEAN PERIPHYTON BIOMASS, CHLOROPHYLL a AND AUTOTROPHIC INDICES, JUNE - JULY SURVEY, 4-WEEK INCUBATIONS*

Station or Transect	Chlorophyll a (mg/M^2)	Organic Biomass (gm/M^2)	Autotrophic Index
A	2.5	0.9	360
B Waconda	38	3.6	95
C Bay	23	1.2	52
D	18	2.7	150
F Offshore	21	1.3	62
S Reference	12	1.1	92
T Bay A	23	1.5	65
X Huss Lowe	2	2.0	1000
Y Slough	12	1.2	100

*Raw data in Tables B-24 and B-28.

TABLE B-21

TRANSECT MEAN PERIPHYTON BIOMASS, CHLOROPHYLL a, AND AUTOTROPHIC INDICES, AUGUST - SEPTEMBER SURVEY 2-WEEK INCUBATIONS*

Station or Transect		Chlorophyll a (mg/M^2)	Organic Biomass (gm/M^2)	Autotrophic Index
B	Waconda	19	2.8	147
C	Bay	8	-	-
D		18	2.5	138
S	Reference	25	3.1	124
T	Bay A	15	2.2	147
X	Huss Lowe	16	1.6	100
Y	Slough	18	2.0	111

*Raw data in Tables B-25 and B-29.

TABLE B-22

TRANSECT MEAN PERIPHYTON BIOMASS, CHLOROPHYLL a AND AUTOTROPHIC INDICES, AUGUST - SEPTEMBER SURVEY, 4-WEEK INCUBATIONS*

Station or Transect	Chlorophyll a (mg/M^2)	Organic Biomass (gm/M^2)	Autotrophic Index
A Waconda	3	0.7	233
B Bay	25	3.8	152
C	29	1.4	48
S Reference	23	1.5	65
T Bay A	19	1.0	53
X Huss Lowe	7	1.4	200
Y Slough	13	1.2	92

*Raw data in Tables B-26 and B-30.

TABLE B-23

RAW CHLOROPHYLL a RESULTS JUNE
2 WEEK INCUBATIONS

Station	Replicate Results (mg/m^2)		
	1	2	3
A	3.7	5.2	-
B-1	19	27	-
B-2	26	-	-
C-1	35	35	-
D-1	16	24	-
D-2	13	15	-
No Wake	8	-	-
E-2	6	15	44
S	12		
T-1	14	-	-
Y-1	8	12	-
Y-2	16	16	-

TABLE B-24

RAW CHLOROPHYLL a RESULTS - JUNE
4 WEEK INCUBATIONS

Station	Replicate Results (mg/m^2)				
	1	2	3	4	5
A	2.8	1.8	2.8	2.6	-
B-1	47	49	-	-	-
B-2	47	28	13	47	38
C-1	21	29	19	23	-
D-1	14	7	24	23	22
F-2	23	19	-	-	-
No Wake	34	-	-	-	-
S	14	10	11	-	-
T-1	22	36	18	28	12
X-2	4	2	2	1	-
Y-2	10	13	13	-	-

TABLE B-25

RAW CHLOROPHYLL a RESULTS - AUGUST
2 WEEK INCUBATIONS

Station	Replicate Results (mg/m^2)		
	1	2	3
B-1	19	-	-
C-1	7	-	-
C-2	9	-	-
D-1	17	17	21
S	25	21	29
T-2	15	-	-
U-1	6	10	-
X-2	14	19	15
Y-1	23	18	20
Y-2	13	16	-

TABLE B-26

RAW CHLOROPHYLL a RESULTS - AUGUST
4 WEEK INCUBATIONS

Station	Replicate Results (mg/m²)				
	1	2	3	4	5
A	3	-	-	-	-
B-1	25	-	-	-	-
C-1	17	31	26	-	-
C-2	32	36	28	33	-
S	30	24	21	19	-
T-1	20	17	-	-	-
T-2	20	-	-	-	-
U-1	18	17	-	-	-
X-1	7	6	16	7	-
X-2	7	11	6	2	1
Y-2	10	13	16	-	-

TABLE B-27

RAW ORGANIC BIOMASS DATA - JUNE
2 WEEK INCUBATIONS

Station	Replicate Results (gm/m^2)				
	1	2	3	4	5
A	0.75	0.96	0.21	0.48	0.96
B-1	6.2	3.0	5.0	2.1	3.1
B-2	3.0	3.3	4.0	2.6	2.4
C-1	0.69	1.2	0.64	0.85	1.3
C-2	3.4	3.3	2.8	2.8	2.3
D-1	1.7	1.7	2.1	1.7	1.3
D-2	0.85	1.5	0.75	1.4	1.1
F-1	1.3	1.0	1.1	-	-
F-2	2.1	2.2	1.4	1.2	1.5
No Wake	2.7	2.6	2.9	2.8	3.1
S	2.4	2.2	2.1	2.6	1.1
T-1	3.6	2.5	2.6	1.7	2.7
T-2	4.3	2.7	2.7	3.0	3.0
U-1	3.9	1.7	1.1	1.7	-
U-2	1.1	0.75	1.4	0.80	1.3
X-1	2.6	2.1	3.3	3.4	2.6
X-2	1.3	0.53	1.7	1.4	0.91
Y-1	3.1	1.3	1.6	1.2	2.1
Y-2	0.85	0.59	0.43	0.48	-

TABLE B-28

RAW ORGANIC BIOMASS DATA - JUNE
4 WEEK INCUBATIONS

Stations	Replicate Results (gm/m^2)		
	1	2	3
A	1.3	0.80	0.59
B-1	2.6	3.3	6.7
B-2	3.6	1.7	-
C-1	1.1	1.5	1.1
D-1	1.1	1.8	1.2
D-2	5.3	2.7	4.3
F-2	0.53	1.0	2.3
S	0.80	1.3	1.3
T-1	1.2	0.69	2.7
X-2	2.1	1.3	2.6
Y-2	0.75	0.85	2.0

TABLE B-29

RAW ORGANIC BIOMASS DATA - AUGUST
2 WEEK INCUBATIONS

Station	Replicate Results (gm/m^2)		
	1	2	3
B-1	3.1	2.9	2.4
D-1	1.3	4.6	1.6
S	3.1	-	-
T-1	1.7	2.1	1.8
T-2	2.7	2.7	2.5
U-1	2.8	2.8	2.3
U-2	3.0	1.6	3.0
X-2	0.48	2.5	1.8
Y-2	2.4	2.3	1.2

TABLE B-30

RAW ORGANIC BIOMASS RESULTS - AUGUST
4 WEEK INCUBATIONS

Station	Replicate Results (gm/m^2)				
	1	2	3	4	5
A	0.70	0.82	0.58	-	-
B-1	3.8	-	-	-	-
C-1	1.5	-	-	-	-
C-2	1.3	1.6	1.0	-	-
S	1.5	1.0	1.6	1.5	1.9
T-1	0.80	0.81	0.79	-	-
T-2	1.6	-	-	-	-
X-1	1.4	-	-	-	-
Y-2	1.0	1.4	-	-	-

TABLE B-31

AUTOTROPHIC INDEX DATA
CALCULATED FROM MEAN CHLOROPHYLL a
AND MEAN ORGANIC BIOMASS RESULTS

Station	June Trip	
	2 Week Incubation	4 Week Incubation
A	167	356
B-1	170	88
B-2	120	77
C-1	54	52
D-1	85	76
D-2	79	
S	175	94
T-1	187	65
Y-1	166	80
Y-2	37	120
X-2	-	1000

Station	August Trip	
	2 Week Incubation	4 Week Incubation
A	-	2333
B-1	147	152
B-2	-	-
C-1		61
C-2		41
D-1	139	-
D-2	-	-
S	124	-
T-1	-	
T-2	175	

Table B-31 (Continued)

Station	August Trip	
	2 Week Incubation	4 Week Incubation
U-1	-	-
U-2	-	-
X-1	-	-
X-2	100	-
Y-1	-	-
Y-2	100	-

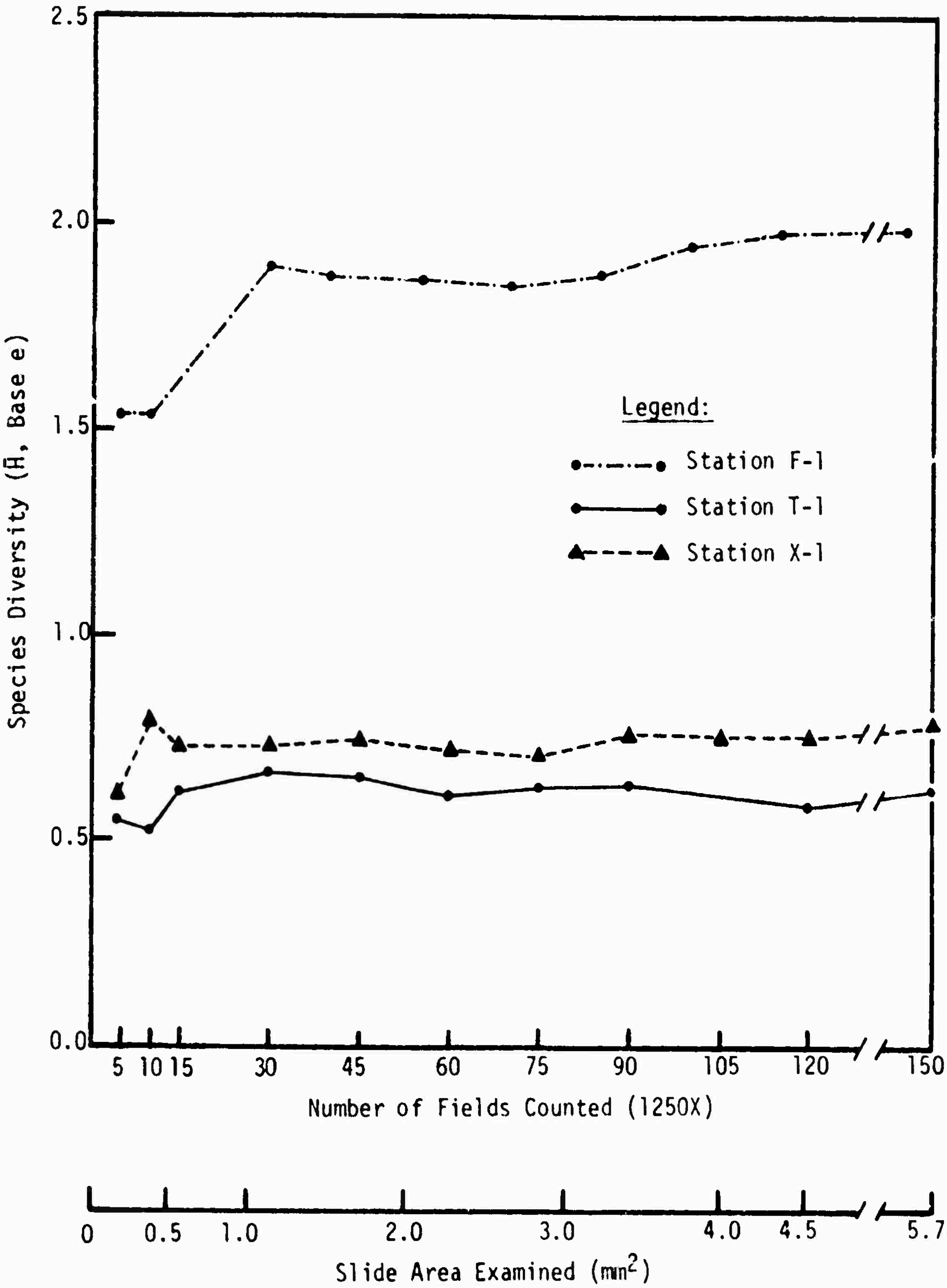


FIGURE B-1. THE EFFECTS OF INCREASING SAMPLE SIZE ON DIATOM SPECIES DIVERSITY IN SUCCESSIVE MICROSCOPIC FIELD COUNTS, VAAP PERIPHYTON DATA FROM STATIONS F-1, T-1, X-1, JUNE 11-25, 1975.

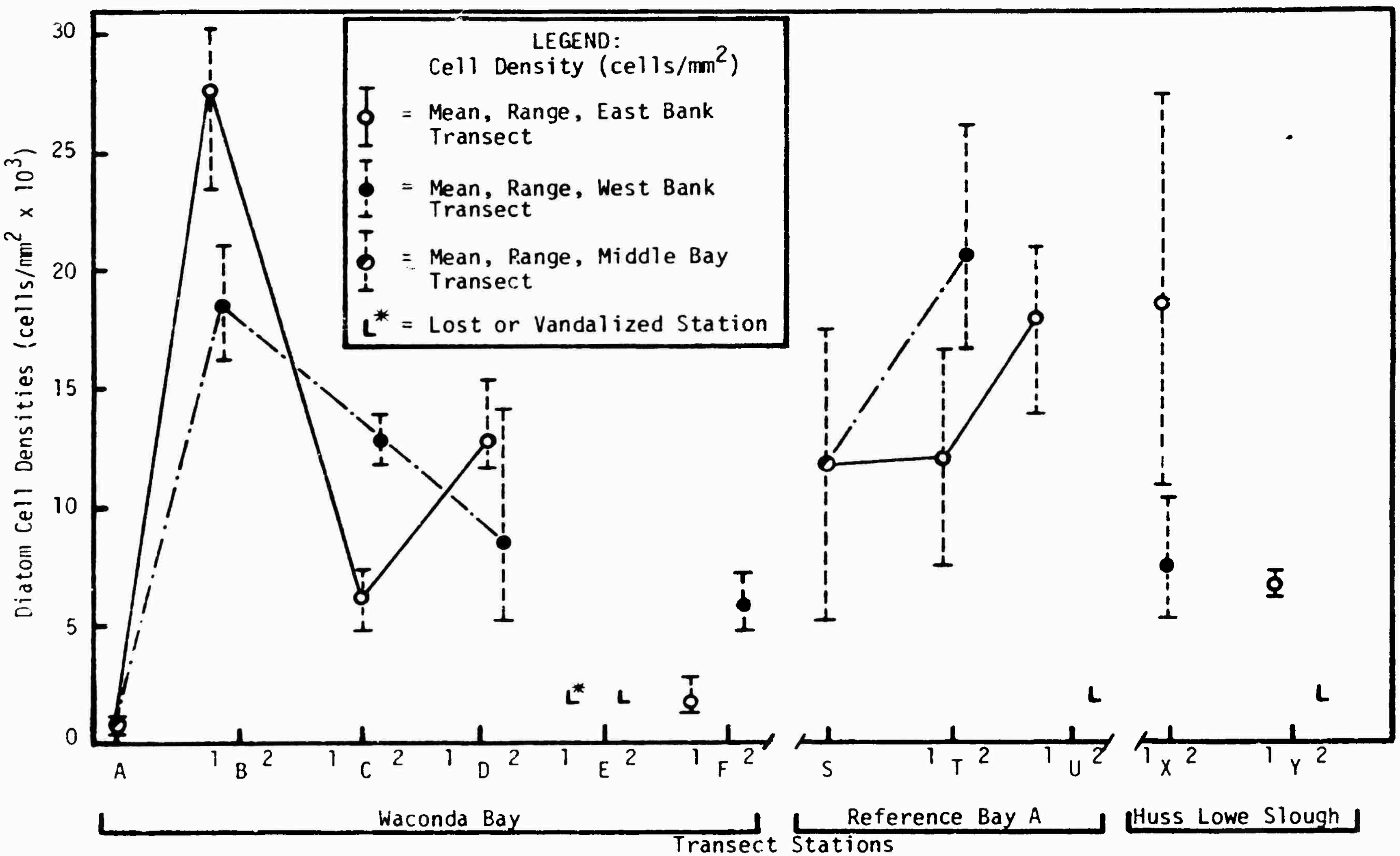


FIGURE B-2. MEANS, RANGES FOR DIATOM CELL DENSITIES (CELLS/MM2) FROM VAAP ARTIFICIAL SUBSTRATES INCUBATED FROM JUNE 11-25, 1975, LAKE CHICKAMAUGA, TENNESSEE.

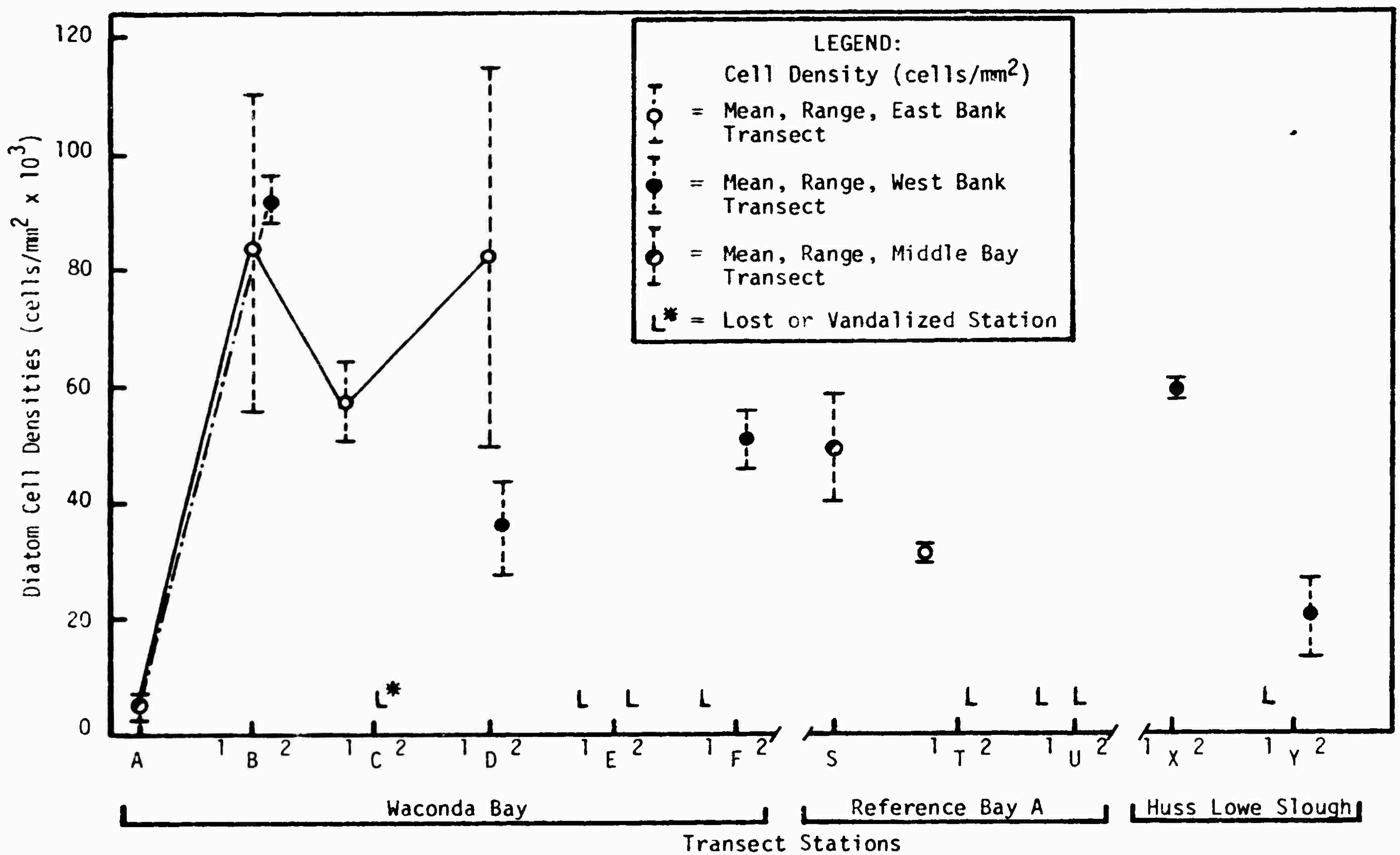


FIGURE B-3. MEANS, RANGES FOR DIATOM CELL DENSITIES (CELLS/MM^2) FROM VAAP ARTIFICIAL SUBSTRATES INCUBATED FROM JUNE 11-JULY 10, 1975, LAKE CHICKAMAUGA, TENNESSEE.

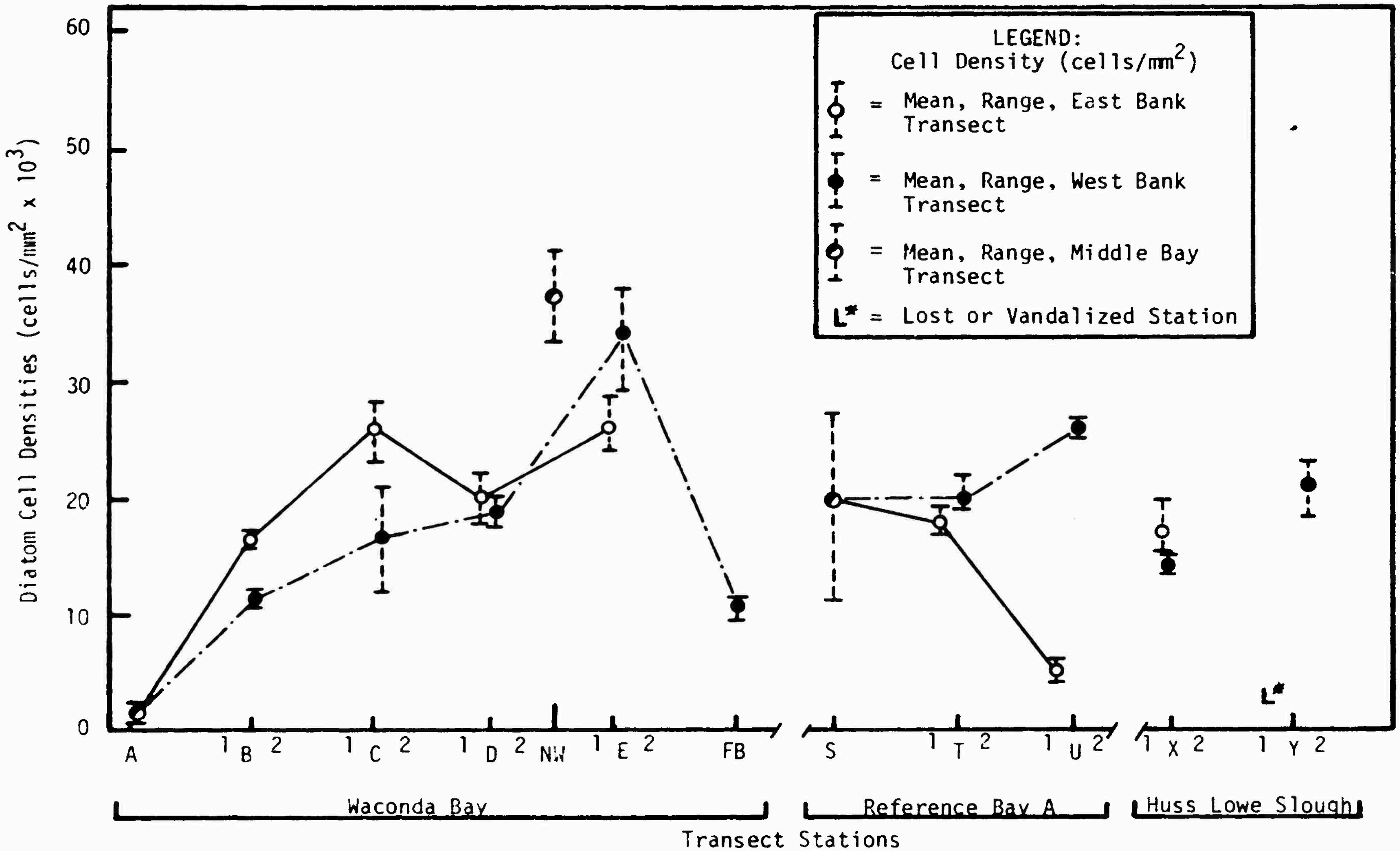


FIGURE B-4. MEANS, RANGES FOR DIATOM CELL DENSITIES (CELLS/MM^2) FROM VAAP ARTIFICIAL SUBSTRATES INCUBATED FROM AUGUST 12-26, 1975, LAKE CHICKAMAUGA, TENNESSEE

*Transect F, Stations F-1 and F-2, were lost during this sampling period; therefore Stations FB and NW were used as alternate sampling sites.

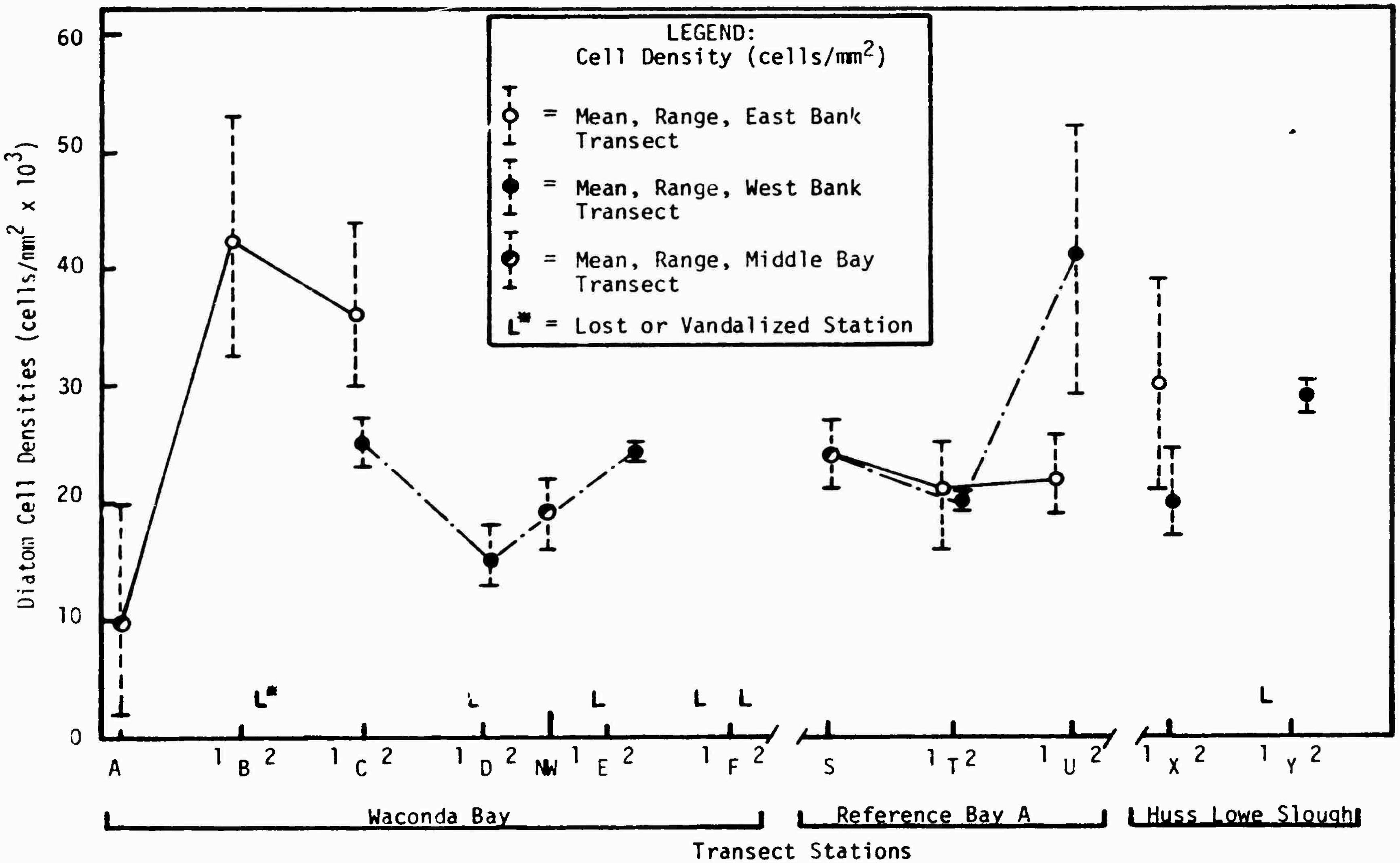


FIGURE B-5. MEAN, RANGES FOR DIATOM CELL DENSITIES (CELLS/MM^2) FROM VAAP ARTIFICIAL SUBSTRATES INCUBATED FROM AUGUST 12-SEPTEMBER 7, 1975, LAKE CHICKAMAUGA, TENNESSEE.

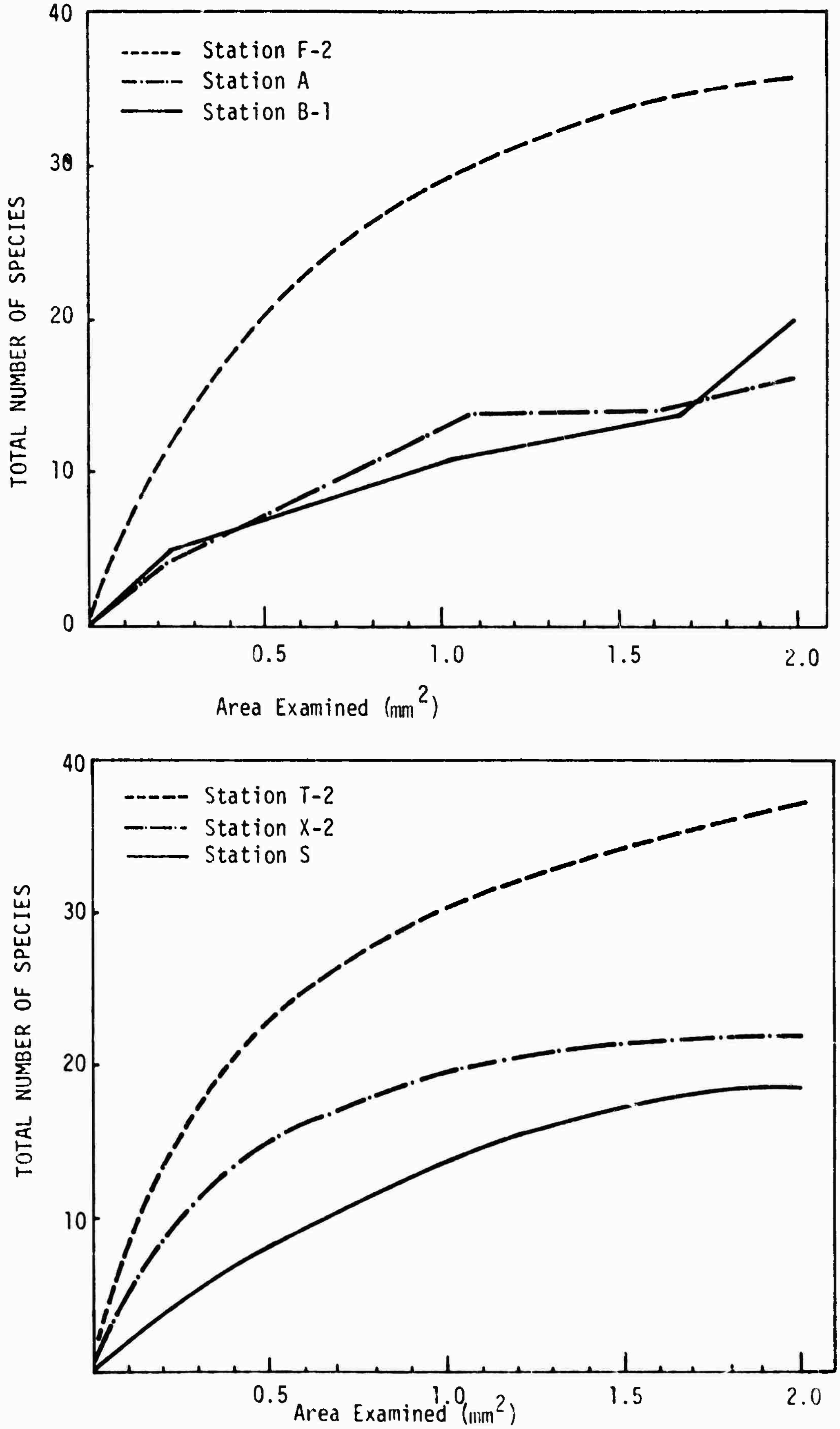


FIGURE B-6. DIATOM SPECIES AREA CURVES FOR VAAP NATURAL SUBSTRATES, LAKE CHICKAMAUGA, TENNESSEE, JUNE, 1975

APPENDIX C

PHYTOPLANKTON

LIST OF TABLES

LIST OF FIGURES

TABLE C-1

TAXONOMIC LIST OF VAAP PHYTOPLANKTON, JUNE 9, 1975

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1
ACHNANTHES SP A	11	90	-	-	68	-	11	-
ACHNANTHES EXIGUA V HETEROVALVE	-	-	-	-	-	-	-	-
ACHNANTHES LANCEOLATA V DUBIA	11	22	-	-	-	-	22	22
ACHNANTHES MINUTISSIMA	6876	33800	6754	15315	17495	15319	3168	22830
ACHNANTHES NOLLII	126	319	388	-	68	44	22	182
AMPHIPLEURA PELLUCIDA	-	-	-	-	-	-	11	90
AMPHORA OVALIS V PEDICULUS	-	-	-	-	-	-	-	22
AMPHORA OVALIS V LIBYCA	11	-	-	-	-	22	11	-
AMPHORA PERPUSSILLA	-	-	-	-	-	-	-	-
AMPHORA SP 1	11	-	-	-	-	-	-	-
ANOMOEONEIS VITREA	-	22	-	90	22	136	11	68
CALONEIS BACILLUM	-	22	-	-	-	-	-	-
COCCONEIS PLACENTULA V EUGLYPTA	-	-	-	-	91	91	34	-
CYCLOTELLA MENEGHINIANA	-	22	-	-	-	22	-	-
CYCLOTELLA STELLIGERA	22	-	22	-	22	22	11	-
CYCLOTELLA SP 2	-	-	-	-	-	-	-	-
CYCLOTELLA SP 3	-	-	-	-	-	-	-	-
CYMBELLA AFFINIS	34	67	22	60	-	68	147	228
CYMBELLA DELICATULA	-	-	22	-	-	-	-	-
CYMBELLA SINUATA	-	-	-	-	22	45	-	-
CYMBELLA VENTRICOSA	-	-	-	30	-	68	-	91
CYMBELLA MICROCEPHALA	11	-	45	167	22	68	22	44
CYMBELLA LAEVIS	-	22	-	-	-	-	34	-
CYMBELLA TUMIDA	-	22	-	-	-	-	22	-
CYMBELLA SP 2	-	-	-	-	-	-	-	-
DIPLONEIS OVALIS	-	-	-	-	-	22	-	-
DIPLONEIS SP A	-	-	-	-	-	22	-	-
FRAGILARIA CAPUCINA	379	640	206	489	-	1694	397	1396
FRAGILARIA CONSTRUENS N	103	-	-	15	-	-	-	-
FRAGILARIA CONSTRUENS V VENTER	-	-	-	-	-	-	-	-
FRAGILARIA CROTONENSIS	11	-	45	-	-	44	-	67
FRAGILARIA PINNATA	57	-	-	-	-	-	-	114
FRAGILARIA VAUCHERIAE	-	-	22	-	-	-	11	22
GOMPHONEMA ACUMINATUM V MONTANUM	-	22	-	-	-	-	-	22
GOMPHONEMA ANGUSTATUM V PRODUCTA	-	-	-	15	45	-	33	-
GOMPHONEMA AUGUR	22	113	-	30	-	91	33	-
GOMPHONEMA CONSTRICTUM V. SUBCAPITATA	-	-	-	-	-	-	-	-
GOMPHONEMA GRACILE V LANCEOLATA	11	-	22	60	-	22	79	45
GOMPHONEMA GRACILE V NAVICULOIDES	-	-	-	15	-	-	-	22
GOMPHONEMA INTRICATUM V PUMILA	-	-	-	-	22	-	45	22
GOMPHONEMA MONTANUM V SUBCLAVATA	-	-	-	30	-	-	-	-
GOMPHONEMA PARVULUM	-	22	22	30	22	136	45	67
MELOSIRA AMBIGUA	80	90	22	45	182	617	-	22
MELOSIRA DISTANS	23	68	-	15	-	90	102	-
MELOSIRA GRANULATA N	-	22	-	-	22	68	22	-
MELOSIRA GRANULATA V ANGUSTISSIMA	11	-	-	-	-	-	-	-
NAVICULA ARVENSIS	-	-	-	-	-	-	-	-
NAVICULA CAPITATA	-	22	-	15	-	-	-	-
NAVICULA CRYPTOCEPHALA V INTERMEDIA	-	-	-	-	-	-	11	-
NAVICULA CRYPTOCEPHALA V VENETA	46	-	-	45	-	90	135	182
NAVICULA DECUSSIS	-	-	-	-	-	-	33	-
NAVICULA HEUFLERI V LEPTOCEPHALA	-	-	-	-	-	67	-	-
NAVICULA LANCEOLATA	-	-	-	-	-	45	-	-
NAVICULA LUZONENSIS	-	-	22	-	-	-	-	-

TABLE C-1 (Continued)

NAVICULA MENISCULUS V UPSALIS	-	-	-	-	22	-	-	-
NAVICULA MINIMA	34	67	22	-	159	-	-	-
NAVICULA MUTICA	11	-	-	-	-	-	-	-
NAVICULA PUPULA	-	-	-	-	-	-	-	-
NAVICULA PUPULA V. ELLIPTICA	23	-	-	-	22	44	22	-
NAVICULA PYGMAEA	11	-	22	-	-	-	-	22
NAVICULA RADIOSA V TENELLA	-	-	-	-	-	-	-	-
NAVICULA RHYNCOCEPHALA V GERMANI	-	-	-	-	-	-	-	-
NAVICULA SIMPLEX	-	-	-	-	-	-	-	-
NAVICULA SUBHAMULATA	11	-	-	-	-	67	-	-
NAVICULA SYMMETRICA	-	-	-	-	-	-	-	-
NAVICULA TENERA	-	-	-	15	-	-	22	-
NAVICULA THIENEMANNII	11	-	-	-	22	-	-	22
NAVICULA TRIDENTULA	-	-	-	-	-	67	-	-
NAVICULA SP 3	-	-	-	-	-	-	-	-
NAVICULA SP 6	-	-	-	-	-	-	-	-
NITZSCHIA ACICULARIS	-	-	44	-	-	90	-	44
NITZSCHIA AMPHIBIA	-	-	-	-	-	-	-	-
NITZSCHIA DISSIPATA	11	-	-	-	-	-	-	-
NITZSCHIA DENTICULA	11	-	-	15	-	67	34	45
NITZSCHIA FONTICOLA	-	-	-	-	-	-	-	-
NITZSCHIA KUTZINGIANA	69	90	45	45	-	228	67	113
NITZSCHIA IGNORATA	-	-	-	-	-	-	-	22
NITZSCHIA LINEARIS	-	-	-	-	-	-	-	-
NITZSCHIA MICROCEPHALA	11	-	-	-	-	-	-	-
NITZSCHIA PALEA	11	-	-	15	-	-	22	22
NITZSCHIA RECTA	-	-	-	-	-	-	-	-
NITZSCHIA SP 1	-	-	22	-	22	68	-	22
NITZSCHIA SP 4	-	-	-	-	-	-	-	-
NITZSCHIA SP 5	-	-	-	-	-	-	56	-
NITZSCHIA SP 7	-	-	-	-	-	-	-	-
NITZSCHIA SINUATA V TABELLARIA	22	-	-	-	-	44	-	-
NITZSCHIA TRYBLIONELLA V VICTORIAE	-	-	-	-	-	22	-	-
OPEPHORA MARTYI	-	-	-	-	-	-	-	-
PINNULARIA BRAUNI	-	-	-	-	-	-	-	-
RHOICOSPHENIA CURVATA	-	-	-	-	22	-	-	-
STEPHANODISCUS ASTRAEA	-	-	-	-	-	-	-	-
STEPHANODISCUS SP 1	23	22	22	-	67	113	11	22
SURIRELLA OVATA	-	-	-	-	-	22	-	-
SYNEDRA ACUS	-	-	67	-	-	-	-	-
SYNEDRA PULCHELLA	-	44	-	-	-	-	-	-
SYNEDRA DELICATISSIMA	333	1006	1716	320	22	686	638	457
SYNEDRA RUMPENS	-	-	-	-	-	-	22	-
SYNEDRA ULNA	-	-	-	-	-	-	375	-
SYNEDRA ULNA V DANICA	34	502	823	122	-	251	-	388
TABELLARIA FENESTRATA	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	8482	37138	10397	16998	18461	20682	5741	26737
NUMBER OF TAXA	34	24	22	23	21	37	35	31

TABLE C-1 (Continued)

CRYPTOPHYCEAE	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2
CRYPTOMONAS SP	95	70	89	83	47	124	83	92
CRYPTOMONAS SP 1	-	-	-	-	-	-	19	-
RHODOMONAS SP	83	115	137	92	54	86	115	111
CHLOROPHYCEAE								
CHLOROCOCCALES								
ANKISTRODESMUS FALCATUS	38	73	57	118	51	28	60	15
COELASTRUM MICROPORUM	3	3	-	6	-	3	-	-
CRUCIGENIA TETRAPEDIA	3	-	-	25	3	-	-	-
DICTYOSPHAERIUM PULCHELLUM	-	-	-	-	-	-	-	-
GOLENKINIA PAUCISPINA	-	-	-	-	-	-	-	-
KIRCHNERIELLA CONTORTA	35	-	-	-	12	-	6	60
KIRCHNERIELLA LUNARIS	-	31	19	-	12	-	-	19
KIRCHNERIELLA OBESA	-	-	-	-	-	-	-	-
MICRACTINIUM PUSILLUM	-	12	19	6	9	19	12	19
OOCYSTIS GLOEOCYSTIFORMIS	-	-	-	-	-	-	-	-
PEDIASTRUM BIRADIATUM	3	-	3	-	3	-	3	-
PEDIASTRUM DUPLEX	-	-	-	3	3	-	-	-
PEDIASTRUM SIMPLEX	-	-	-	3	-	-	-	8
PEDIASTRUM TETRAS	-	-	-	-	-	-	3	-
SCENEDESMUS ABUNDANS	-	-	-	-	-	-	-	-
SCENEDESMUS ACUMINATUS	-	-	-	-	-	-	-	-
SCENEDESMUS ARCUATUS	-	-	-	-	-	-	-	-
SCENEDESMUS BERNARDII	-	-	3	-	-	-	-	-
SCENEDESMUS BIJUGA	115	28	115	31	25	44	44	44
SCENEDESMUS DENTICULATUS	-	-	-	3	6	-	-	-
SCENEDESMUS QUADRICAUDA	6	19	19	15	28	9	28	3
SCENEDESMUS SERRATUS	-	-	-	-	-	-	-	-
TETRADESMUS WISCONSINENSE	-	-	-	-	-	-	-	-
TETRAEDRON MINIMUM	92	57	153	22	28	38	51	28
TREUBARIA SETIGERUM	3	6	9	3	9	-	-	6
VOLVOCALES								
CHLAMYDOMONAS SP	150	89	271	131	99	140	166	150
GONIUM FORMOSUM	-	3	-	6	3	3	6	3
PANDORINA CHARKOWIENSIS	-	-	-	-	-	3	3	3
PANDORINA MORUM	-	-	-	-	-	-	-	-
SPHAERELLOPSIS SP	-	25	-	19	35	-	-	-
DESMIDIACEAE								
COSMARIUM PHASEOLUS	-	-	-	-	-	-	-	-
COSMARIUM SP 3	-	-	-	-	-	-	-	-
COSMARIUM SP 4	-	3	-	-	-	-	-	-
EUASTRUM SP	-	-	-	-	-	-	-	-
EUASTRUM SP 1	-	3	3	-	-	-	-	-
STAURASTRUM LEPTOCLADIUM	6	-	12	3	3	-	3	-

TABLE C-1 (Continued)

	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2
XANTHOPHYCEAE								
OPHIOCYTIUM CAPITATUM	-	-	3	-	-	3	-	-
PSEUDOTETRAEDRCN NEGLECTUM	19	12	6	-	6	-	-	-
CHRYSOPHYCEAE								
CENTRITRACTLS DUPIUS	-	-	-	-	-	-	-	-
CHRYSOCOCCUS PUSILLUM	-	-	-	-	-	-	-	-
DINCBRYON BAVARICUM	51	15	67	89	95	105	124	47
DINCBRYON DIVERGENS	92	204	63	1222	758	710	972	383
OCHROMONAS GRANULCSA	-	3	-	-	-	-	-	-
DINOPHYCEAE								
CERATIUM HIRUNDINELLA	-	6	-	-	-	-	-	-
GLENODINIUM ACICULIFERUM	-	-	-	6	-	-	-	-
GLENODINIUM QUADRIDENS	41	-	31	-	6	9	9	9
PERIDINIUM ACICULIFERUM	9	-	15	-	3	-	12	6
PERIDINIUM CUNNINGTONII	-	3	-	-	-	-	-	-
PERIDINIUM INCONSPICUUM	-	22	12	28	35	19	-	9
PERIDINIUM PUSILLUM	44	22	38	19	54	22	35	12
PERIDINIUM TATRICUM	-	3	-	-	-	-	-	-
CYANOPHYCEAE								
CHROOCOCCALES								
COELOSPHAERIUM KUETZINGIANUM	-	-	-	3	15	6	-	-
DACTYLOCOCCOPSIS RAPHIDIOIDES	-	-	-	3	19	-	-	-
GOMPHOSPHAERIA LACUSTRIS	44	76	166	6	22	67	99	92
MERISMOPEDIA GLAUCA	3	-	-	-	-	-	3	-
OSCILLATORIALES								
LYNGBYA MARTENSIANA	-	3	-	-	-	-	-	-
OSCILLATORIA GEMINATA	19	-	38	19	12	22	19	19
RHAPHIDIOPSIS SP	-	-	-	-	-	-	-	-
SPIRULINA LAXISSIMA	41	31	12	41	38	35	54	44
TRICHODESMIUM SP	-	3	-	-	-	-	-	-

TABLE C-1 (Continued)

BACILLARIOPHYTA (DIATOMS)	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2
ACHNANTHES LANCEOLATA N	-	-	3	-	-	-	-	-
ACHNANTHES LANCEOLATA V DUBIA	3	6	6	-	-	6	-	-
ACHNANTHES SP 1	3	-	-	-	-	-	-	-
ASTERIONELLA FORMOSA	-	9	-	-	9	-	-	-
ATTHEYA ZACHARIAS	-	-	-	-	-	-	-	-
COCCONEIS PLACENTULA V EUGLYPTA	9	-	15	-	9	-	3	3
CYCLOTELLA BODANICA	-	-	-	-	-	-	-	-
CYCLOTELLA STELLIGERA	-	3	-	-	-	-	-	-
CYCLOTELLA SP	-	-	-	-	-	-	-	-
CYMBELLA SP	3	3	9	-	6	3	-	-
DIPLONEIS OCULATA	3	-	-	3	-	-	-	-
FRAGILARIA CAPUCINA	-	3	-	15	25	12	15	-
FRAGILARIA CROTONENSIS	6	19	239	105	92	57	163	131
GYROSIGMA SP	-	-	-	-	-	-	-	-
MELOSIRA AMBIGUA	102	179	-	428	156	70	131	99
MELOSIRA DISTANS	188	63	99	441	303	278	156	108
MELOSIRA GRANULATA N	35	12	-	95	19	12	44	-
NAVICULA CAPITATA	-	-	-	-	-	-	-	-
NAVICULA CRYPTOCEPHALA V VENETA	9	-	-	6	-	-	3	12
NAVICULA RHYNCHOCEPHALA	-	-	-	-	-	-	-	-
NAVICULA VIRIDULA	-	-	-	-	-	-	-	-
NAVICULA SP 2	19	12	12	67	3	57	3	6
NAVICULA SP 3	6	-	15	-	3	-	-	-
NAVICULA SP 4	-	-	-	-	-	-	-	-
NITZSCHIA ACICULARIS	22	3	-	9	-	12	19	9
NITZSCHIA PALEA	6	3	-	25	9	15	-	-
RHIZOSOLENIA SP	-	3	9	-	-	-	-	-
SURIRELLA SP	-	-	-	-	-	-	-	-
SYNEDRA ACTINASTROIDES	25	-	9	-	-	15	-	-
SYNEDRA DELICATISSIMA	35	12	9	12	15	-	6	6
SYNEDRA RUMPENS	6	-	3	-	6	6	-	-
SYNEDRA ULNA	12	15	19	3	6	3	15	9
TABELLARIA FENSTRATA	12	22	-	19	12	12	51	-
EUGLENOPHYCEAE								
EUGLENA SP	-	6	3	12	6	3	15	3
TRACHELOMONAS AUSTRALICA	-	-	-	-	-	-	-	-
TRACHELOMONAS CREBEA	9	25	-	6	3	3	-	6
TRACHELOMONAS VOLVOCINA	-	-	6	-	-	-	-	-
TRACHELOMONAS SP II	-	-	-	-	-	-	-	-
TRACHELOMONAS SP III	-	-	-	-	-	-	3	-
TRACHELOMONAS SP IV	3	-	-	-	-	3	9	3
TOTAL NUMBER OF ORGANISMS	1511	1338	1816	3251	2175	2062	2565	1575
NUMBER OF TAXA	44	46	40	42	47	38	39	35

TABLE C-1 (Continued)

	X-1	X-2	Y-1	Y-2
XANTHOPHYCEAE				
OPHIOCYTIUM CAPITATUM	3	-	-	-
PSEUDOTETRAEDRON NEGLECTUM	-	-	-	-
CHRYSOPHYCEAE				
CENTRITRACTUS DUBIUS	-	-	-	-
CHRYSOCOCCUS PUSILLUM	-	-	-	-
DINOBRYON BAVARICUM	-	9	51	63
DINOBRYON DIVERGENS	15	41	118	147
OCHROMONAS GRANULOSA	-	-	-	-
DINOPHYCEAE				
CERATIUM HIRUNDINELLA	-	-	-	-
GLENODINIUM ACICULIFERUM	-	-	-	-
GLENODINIUM QUADRIDENS	-	3	3	-
PERIDINIUM ACICULIFERUM	3	-	-	6
PERIDINIUM CUNNINGTONII	-	-	-	-
PERIDINIUM INCONSPICUUM	6	-	3	6
PERIDINIUM PUSILLUM	3	9	3	19
PERIDINIUM TATRICUM	-	-	9	-
CYANOPHYCEAE				
CHROOCOCCALES				
COELOSPHAERIUM KEUTZINGIANUM	-	-	-	-
DACTYLOCOCCOPSIS RAPHIDIOIDES	-	-	-	12
GOMPHOSPHAERIA LACUSTRIS	38	60	76	159
MERISMOPEDIA GLAUCA	3	6	-	-
OSCILLATORIALES				
LYNGBYA MARTENSIANA	-	-	-	-
OSCILLATORIA GEMINATA	19	9	9	19
RHAPHIDIOPSIS SP	-	-	-	-
SPIRULINA LAXISSIMA	19	38	3	31
TRICHODESMIUM SP	3	-	-	3

TABLE C-1 (Continued)

BACILLARIOPHYTA (DIATOMS)	X-1	X-2	Y-1	Y-2
ACHNANTHES LANCEOLATA N	-	-	3	3
ACHNANTHES LANCEOLATA V DUBIA	12	-	6	-
ACHNANTHES SP I	-	-	-	-
ASTERIONELLA FORMOSA	38	12	12	12
ATHEYA ZACHARIAS	-	-	-	-
COCCONEIS PLACENTULA V EUGLYPTA	3	-	-	6
CYCLOTELLA BODANICA	-	-	-	9
CYCLOTELLA STELLIGERA	-	-	-	-
CYCLOTELLA SP	-	-	-	22
CYMBELLA SP	-	3	-	-
DIPLONEIS OCULATA	3	-	-	-
FRAGILARIA CAPUCINA	9	6	-	25
FRAGILARIA CROTONENSIS	3	99	-	9
GYROSIGMA SP	-	-	-	-
MELOSIRA AMBIGUA	291	191	220	390
MELOSIRA DISTANS	150	134	249	239
MELOSIRA GRANULATA N	9	15	15	9
NAVICULA CAPITATA	-	-	-	-
NAVICULA CRYPTOCEPHALA V VENETA	9	6	-	6
NAVICULA RHYNCHOCEPHALA	-	-	-	3
NAVICULA VIRIDULA	-	-	-	-
NAVICULA SP 2	31	22	9	9
NAVICULA SP 3	3	9	-	-
NAVICULA SP 4	-	-	-	-
NITZSCHIA ACICULARIS	3	6	19	6
NITZSCHIA PALEA	-	-	9	6
RHIZOSOLENIA SP	-	-	-	-
SURIRELLA SP	-	-	-	-
SYNEDRA ACTINASTROIDES	-	6	-	-
SYNEDRA DELICATISSIMA	22	6	9	12
SYNEDRA RUMPENS	-	-	-	9
SYNEDRA ULNA	15	35	15	25
TABELLARIA FENESTRATA	15	6	6	3
EUGLENOPHYCEAE				
EUGLENA SP	-	-	-	22
TRACHELOMONAS AUSTRALICA	-	-	-	-
TRACHELOMONAS CREBEA	-	9	3	3
TRACHELOMONAS VOLVOCINA	3	-	3	-
TRACHELOMONAS SP II	-	-	6	-
TRACHELOMONAS SP III	-	-	12	3
TRACHELOMONAS SP IV	-	-	-	-
TOTAL NUMBER OF ORGANISMS	1450	1366	1306	1929
NUMBER OF TAXA	41	36	38	55

TABLE C-2

TAXONOMIC LIST OF VAAP PHYTOPLANKTON, JUNE 13, 1975

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1
CRYPTOPHYCEAE								
CRYPTOMONAS SP	76	44	105	28	63	31	15	12
CRYPTOMONAS SP 3	-	-	-	-	-	-	-	-
RHODOMONAS SP	47	31	57	25	15	12	15	51
CHLOROPHYCEAE								
CHLOROCOCCALES								
ACANTHOSPHAERA ZACHARIASI	3	9	3	3	6	-	-	-
ACTINASTRUM HANTZSCHII	-	3	-	-	-	-	-	-
ANKISTRODESMUS FALCATUS	47	86	47	51	47	63	63	92
COELASTRUM CAMBRICUM	-	-	-	-	3	-	3	3
COELASTRUM MICROPORUM	-	-	-	22	-	-	12	6
CRUCIGENIA QUADRATA	-	-	15	-	-	9	-	-
CRUCIGENIA TETRAPEDIA	-	3	3	12	-	-	-	-
DICTYOSPHAERIUM PULCHELLUM	-	-	-	3	-	-	-	-
ECHINOSPHAERELLA LIMNETICA	-	-	-	-	-	-	-	-
FRANCEIA DROESCHERI	-	-	-	-	-	-	-	-
GOLENKINIA PAUCISPINA	-	-	-	3	6	9	3	3
KIRCHNERIELLA CONTORTA	-	-	6	12	-	-	25	6
KIRCHNERIELLA LUNARIS	-	-	-	-	-	-	-	-
KIRCHNERIELLA OBESA	-	-	-	-	-	-	12	-
LAGERHEIMIA QUADRISETA	-	-	-	-	-	-	-	-
LAGERHEIMIA SP	-	-	-	-	-	-	-	-
MICRACTINIUM PUSILLUM	9	3	-	6	-	-	6	3
OOCYSTIS GLOEOCYSTIFORMIS	-	-	-	-	-	-	-	-
OOCYSTIS SOLITARIA	-	-	-	-	-	-	-	-
PEDIASTRUM BIRADIATUM	-	-	-	-	-	3	-	-
PEDIASTRUM DUPLEX	3	3	3	-	3	-	6	3
PEDIASTRUM KAWRAISKYI	-	-	-	-	-	-	-	-
PEDIASTRUM OBTUSUM	-	-	-	-	-	3	-	-
PEDIASTRUM SIMPLEX	-	-	3	-	-	-	6	-
SCENEDESMUS ABUNDANS	3	-	6	3	3	-	3	-
SCENEDESMUS ACUMINATUS	-	-	-	-	3	-	-	-
SCENEDESMUS ARCUATUS	-	-	-	-	-	-	-	-
SCENEDESMUS ARMATUS	-	-	-	-	-	-	-	-
SCENEDESMUS BERNARDII	3	25	-	19	3	-	-	-
SCENEDESMUS BIJUGA	15	22	19	25	19	22	38	31
SCENEDESMUS DENTICULATUS	-	3	-	3	-	-	-	-
SCENEDESMUS QUADRICAUDA	25	35	47	41	12	35	28	25
SCENEDESMUS SERRATUS	3	-	-	3	-	-	-	-
SCHROEDERIA SETIGERA	3	-	3	-	-	3	-	-
TETRAEDRON MINIMUM	19	6	6	19	3	15	3	6
TETRAEDRON REGULARE	-	-	-	-	-	-	-	-
TETRAEDRON TRIGONUM	-	-	-	-	6	-	-	-
TETRAEDRON SPP	-	-	-	-	-	-	-	-
TREUBARIA SETIGERUM	-	-	3	-	3	3	3	-
TETRASPORALES								
ELAKATOTHRIX GELATINOSA	-	-	-	-	-	-	6	15
SPHAEROCYSTIS SCHROETERI	-	-	-	-	-	-	-	-

TABLE C-2 (Continued)

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1
VOLVOCALES								
CHLAMYDOMONAS SP	67	79	31	63	51	38	35	28
EUDORINA SP	-	-	3	-	-	-	-	-
GONIUM FORMOSUM	-	-	-	-	-	-	-	-
SPHAERELLOPSIS SP	6	-	-	6	3	-	-	3
DESMIDACEAE								
COSMARIUM SP 3	-	-	-	-	-	-	-	-
COSMARIUM SP 4	-	-	-	-	-	-	-	-
EUASTRUM SP	-	-	-	-	-	-	-	-
STAURASTRUM LEPTOCLADIUM	-	-	-	-	-	-	-	-
STAURASTRUM QUADRICUSPIDATUM	-	-	-	-	-	-	-	-
ZYGNEMATELES								
MOUGEOTIA SPP	-	-	-	-	-	-	-	22
XANTHOPHYCEAE								
OPHIOCYTIUM CAPITATUM	3	-	-	-	-	3	-	-
PSEUDOTETRAEDRON NEGLECTUM	-	-	3	-	3	-	3	-
CHRYSOPHYCEAE								
CHRYSOCOCCUS PUSILLUM	6	19	-	9	9	12	3	6
DINOBRYON BAVARICUM	-	12	-	-	38	9	-	31
DINOBRYON DIVERGENS	-	150	9	38	3	3	31	9
SYNURA SP	12	-	-	-	9	6	-	-
DINOPHYCEAE								
CERATIUM HIRUNDINELLA	-	-	-	-	-	-	-	-
GLENODINIUM ACICULIFERUM	-	-	-	-	-	-	-	-
PERIDINIUM CUNNINGTONII	-	3	-	-	-	-	6	-
PERIDINIUM INCONSPICUUM	28	12	3	6	15	-	-	-
PERIDINIUM PUSILLUM	9	25	41	9	3	-	-	3

TABLE C-2 (Continued)

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1
CYANOPHYCEAE								
CHROOCOCCALES								
APHANOCAPSA DELICATISSIMA	-	-	-	-	6	-	-	-
CHROOCOCCUS DISPERSUS	3	6	-	6	3	3	3	-
COELOSPHAERIUM KEUTZINGIANUM	-	-	-	-	-	-	-	-
DACTYLOCOCCOPSIS ACICULARIS	-	-	-	-	-	-	-	-
DACTYLOCOCCOPSIS RAPHIDIOIDES	-	-	19	-	3	3	6	-
GOMPHOSPHAERIA LACUSTRIS	31	9	12	15	9	-	6	12
MERISMOPEDIA GLAUCA	-	-	-	-	-	-	-	-
MERISMOPEDIA TENUISSIMA	-	-	-	-	-	-	-	3
MICROCYSTIS AERUGINOSA	-	-	9	-	-	-	-	-
OSCILLATORIALES								
ANABAENA SPIROIDES	3	-	-	-	-	-	-	-
OSCILLATORIA GEMINATA	6	-	6	3	3	3	9	-
SPIRULINA LAXISSIMA	22	3	31	6	3	9	15	-
TRICHODESMIUM SP	-	-	-	-	-	3	-	-
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES LANCEOLATA N	19	15	19	-	28	-	9	-
ACHNANTHES LANCEOLATA V DUBIA	-	-	-	6	-	6	-	-
ANOMOEONEIS SP	-	-	3	-	9	-	-	3
ASTERIONELLA FORMOSA	-	3	-	-	12	54	6	-
ATTHEYA ZACHARIAS	-	-	-	-	-	-	-	-
COCCONEIS SP	3	22	19	15	6	-	-	3
CYCLOTELLA STELLIGERA	-	-	3	6	-	-	-	-
CYCLOTELLA SP	-	-	12	-	22	15	12	15
CYMBELLA AFFINIS	-	-	-	-	-	-	-	-
CYMBELLA VENTRICOSA	-	-	-	-	3	-	-	-
CYMBELLA TUMIDA	3	-	-	3	6	-	-	-
CYMBELLA SP	-	-	-	-	-	3	-	-
FRAGILARIA CAPUCINA	15	-	31	28	15	38	-	44
FRAGILARIA CROTONENSIS	-	44	67	102	156	54	22	51
GYROSIGMA SP	-	-	-	-	-	-	-	-
MELOSIRA AMBIGUA	268	409	793	511	300	707	460	294
MELOSIRA DISTANS	303	214	457	271	265	-	172	195
MELOSIRA GRANULATA N	31	25	67	57	60	115	22	92
MELOSIRA GRANULATA V ANGUSTISSIMA	25	-	6	76	-	15	121	70
MELOSIRA VARIANS	-	-	-	-	-	323	-	-
NAVICULA CAPITATA	-	15	-	-	-	-	-	-
NAVICULA CRYPTOCEPHALA	-	6	19	-	-	-	-	-
NAVICULA RHYNCHOCEPHALA	-	67	57	22	31	38	12	6
NAVICULA SP 1	-	-	-	-	15	-	-	-
NAVICULA SP 2	6	-	28	6	-	-	12	-
NAVICULA SP 3	-	12	-	-	-	-	-	-
NAVICULA SP 4	3	-	-	-	-	-	-	-
NAVICULA SP 5	9	-	-	-	-	-	-	-
NITZSCHIA ACICULARIS	38	41	57	25	19	28	47	28
NITZSCHIA PALEA	44	73	108	35	28	22	12	6

TABLE C-2 (Continued)

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1
NITZSCHIA SP 1	-	-	3	-	-	3	-	-
NITZSCHIA SP 2	-	-	-	-	-	3	-	-
RHIZCSOLENIA SF	3	-	-	-	-	-	-	-
STEPHANODISCUS ASTRAEA	-	-	-	-	-	-	-	6
STEPHANODISCUS ASTRAEA V. MINUTULA	-	-	-	-	-	3	-	-
SURIRELLA SP	-	-	6	-	-	-	-	-
SYNEDRA ACTINASTROIDES	19	15	12	-	12	19	12	-
SYNEDRA DELICATISSIMA	3	3	6	6	-	3	3	-
SYNEDRA RUMPENS	3	-	3	-	-	-	-	-
SYNEDRA ULNA	-	6	-	-	12	-	-	-
SYNEDRA ULNA V DANICA	12	-	9	3	-	22	12	12
TABELLARIA FENESTRATA	-	12	25	3	-	-	-	-
T QUADRISEPTATA	-	-	-	-	22	-	-	-
EUGLENOPHYCEAE								
EUGLENA SP	9	9	-	-	-	9	-	3
PHACUS SP 1	-	3	-	-	-	-	-	-
TRACHELOMONAS CREBEA	-	-	3	3	-	6	-	3
TRACHELOMONAS OBLONGA	6	-	-	-	3	-	-	-
TRACHELOMONAS VOLVOCINA	-	-	6	3	-	-	-	-
TRACHELOMONAS SP II	-	-	-	-	-	-	-	-
TRACHELOMONAS SP IV	3	9	12	6	3	-	3	-
UNIDENTIFIED TAXA								
UNIDENTIFIED SPECIES J	-	-	3	-	-	3	-	-
UNIDENTIFIED SPECIES H	-	-	-	-	-	-	-	3
TOTAL NUMBER OF ORGANISMS	1277	1594	2327	1646	1383	1789	1301	1207
NUMBER OF TAXA	46	43	53	47	51	45	43	39

TABLE C-2 (Continued)

CRYPTOPHYCEAE	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2
CRYPTOMONAS SP	35	12	67	99	38	63	31	44
CRYPTOMONAS SP 3	-	-	-	-	-	3	-	-
RHODOMONAS SP	92	12	73	19	54	51	54	28
CHLOROPHYCEAE								
CHLOROCOCCALES								
ACANTHOSPHAERA ZACHARIASI	-	-	-	-	3	-	3	-
ACTINASTRUM HANTZSCHII	-	-	-	-	-	-	-	-
ANKISTRODESMUS FALCATUS	35	76	67	54	28	51	76	86
COELASTRUM CAMBRICUM	3	-	-	-	-	-	-	-
COELASTRUM MICROPORUM	3	9	3	-	3	3	9	3
CRUCIGENIA QUADRATA	-	-	15	-	-	-	-	12
CRUCIGENIA TETRAPEDIA	-	3	-	-	-	-	-	-
DICTYOSPHAERIUM PULCHELLUM	-	-	3	3	-	-	3	-
ECHINOSPHAERELLA LIMNETICA	-	-	-	-	-	-	-	-
FRANCEIA DROESCHERI	-	-	-	-	-	-	-	-
GOLENKINIA PAUCISPINA	3	3	6	3	-	6	9	9
KIRCHNERIELLA CONTORTA	-	-	-	6	-	-	-	-
KIRCHNERIELLA LUNARIS	47	-	-	-	-	-	57	-
KIRCHNERIELLA OBESA	-	-	6	6	-	-	6	-
LAGERHEIMIA QUADRISETA	-	-	-	-	-	-	-	6
LAGERHEIMIA SP	-	-	-	-	6	-	-	-
MICRACTINIUM PUSILLUM	3	6	9	3	-	-	3	-
OOCYSTIS GLOEOCYSTIFORMIS	3	3	-	-	-	-	-	-
OOCYSTIS SOLITARIA	-	-	6	-	-	-	-	-
PEDIASTRUM BIRADIATUM	6	-	-	-	-	-	-	-
PEDIASTRUM DUPLEX	-	-	-	-	-	-	-	-
PEDIASTRUM KAWRAISKYI	3	-	-	-	-	-	-	-
PEDIASTRUM OBTUSUM	-	-	-	-	-	-	-	-
PEDIASTRUM SIMPLEX	-	-	-	3	-	6	-	-
SCENEDESMUS ABUNDANS	3	-	3	-	-	-	-	-
SCENEDESMUS ACUMINATUS	-	-	-	-	-	-	-	-
SCENEDESMUS ARCUATUS	3	-	-	-	-	-	-	-
SCENEDESMUS ARMATUS	3	-	-	3	-	6	9	-
SCENEDESMUS BERNARDII	-	-	-	-	-	-	-	3
SCENEDESMUS BIJUGA	6	25	15	19	25	19	38	19
SCENEDESMUS DENTICULATUS	-	6	9	-	-	-	-	-
SCENEDESMUS QUADRICAUDA	12	15	19	22	15	6	28	31
SCENEDESMUS SERRATUS	3	-	-	-	-	-	-	-
SCHROEDERIA SETIGERA	-	-	6	3	3	-	-	3
TETRAEDRON MINIMUM	12	6	3	3	3	19	22	15
TETRAEDRON REGULARE	-	-	-	-	-	-	-	3
TETRAEDRON TRIGONUM	6	3	3	-	-	-	-	6
TETRAEDRON SPP	-	-	-	-	-	6	-	-
TREUBARIA SETIGERUM	-	-	-	-	-	9	3	-
TETRASPORALES								
ELAKATOTHRIX GELATINOSA	12	3	-	-	3	-	-	6
SPHAEROCYSTIS SCHROETERI	-	-	3	-	-	-	-	-
VOLVOCALES								
CHLAMYDOMONAS SP	25	38	76	54	31	44	19	28
EUDORINA SP	-	-	-	3	3	-	3	-
GONIUM FORMOSUM	-	3	3	-	-	3	-	9
SPHAERELLOPSIS SP	9	-	9	28	12	9	-	6

TABLE C-2 (Continued)

	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2
DESMIDACEAE								
COSMARIUM SP 3	-	-	-	-	-	-	-	-
COSMARIUM SP 4	-	-	-	-	-	-	-	-
EUASTRUM SP	-	-	-	-	-	-	-	-
STAURASTRUM LEPTOCLADIUM	-	-	6	-	-	-	-	-
STAURASTRUM QUADRICUSPIDATUM	-	-	-	-	-	-	-	-
ZYGNEMATALES								
MOUGEOTIA SPP	-	-	-	-	-	-	67	-
XANTHOPHYCEAE								
OPHIOCYTIUM CAPITATUM	3	-	-	-	-	3	-	-
PSEUDOTETRAEDRON NEGLECTUM	-	3	-	-	-	-	3	-
CHRYSOPHYCEAE								
CHRYSOCOCCUS PUSILLUM	3	3	6	76	12	19	12	3
DINOBRYON BAVARICUM	-	38	6	9	35	9	9	3
DINOBRYON DIVERGENS	3	6	19	-	19	3	35	19
SYNURA SP	6	-	-	6	9	12	-	6
DINOPHYCEAE								
CERATIUM HIRUNDINELLA	-	-	-	-	-	-	-	-
GLENODINIUM ACICULIFERUM	-	-	-	-	-	-	-	-
PERIDINIUM CUNNINGTONII	-	-	-	9	6	15	-	-
PERIDINIUM INCONSPICUUM	-	-	9	31	9	-	3	6
PERIDINIUM PUSILLUM	9	-	-	67	12	15	9	6
CYANOPHYCEAE								
CHROOCOCCALES								
APHANOCAPSA DELICATISSIMA	-	6	-	-	-	-	-	6
CHROOCOCCUS DISPERSUS	-	-	-	-	-	-	-	3
COELOSPHAERIUM KUETZINGIANUM	-	-	-	-	-	-	3	-

TABLE C-2 (Continued)

	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2
DACTYLOCOCCOPSIS ACICULARIS	3	-	-	-	-	-	-	-
DACTYLOCOCCOPSIS RAPHIDIOIDES	6	12	19	-	3	-	-	3
GOMPHOSPHAERIA LACUSTRIS	31	19	73	-	22	22	31	28
MERISMOPEDIA GLAUCA	3	3	6	-	-	-	-	-
MERISMOPEDIA TENUISSIMA	9	3	3	-	-	3	-	-
MICROCYSTIS AERUGINOSA	-	-	-	-	-	-	-	-
OSCILLATORIALES								
ANABAENA SPIROIDES	-	-	-	-	-	-	-	-
OSCILLATORIA GEMINATA	6	15	6	3	-	3	9	-
SPIRULINA LAXISSIMA	12	28	12	3	22	12	44	6
TRICHODESMIUM SP	-	-	-	-	-	-	-	-
******************************	******	******	******	******	******	******	******	******
BACILLARIOPHYTA (DIATOMS)								
ACHNANTHES LANCEOLATA N	-	3	-	-	-	3	-	3
ACHNANTHES LANCEOLATA V DUBIA	6	-	-	-	-	-	9	-
ANOMOEONEIS SP	-	-	-	15	-	-	3	-
ASTERIONELLA FORMOSA	-	-	25	3	-	-	19	-
ATTHEYA ZACHARIAS	-	-	-	-	-	-	-	-
COCCONEIS SP	6	-	-	-	-	3	3	3
CYCLOTELLA STELLIGERA	-	-	-	-	-	-	-	-
CYCLOTELLA SP	6	-	6	12	3	-	15	3
CYMBELLA AFFINIS	-	-	-	3	-	-	-	-
CYMBELLA VENTRICOSA	-	-	-	-	-	-	-	-
CYMBELLA TUMIDA	-	-	-	3	-	-	-	-
CYMBELLA SP	-	-	-	-	-	-	-	-
FRAGILARIA CAPUCINA	38	15	6	6	-	6	25	9
FRAGILARIA CROTONENSIS	28	118	-	-	-	-	-	51
GYROSIGMA SP	-	-	-	-	-	-	-	-
MELOSIRA AMBIGUA	278	153	217	268	284	223	303	476
MELOSIRA DISTANS	195	137	115	175	214	159	195	326
MELOSIRA GRANULATA N	159	15	31	47	35	15	54	15
MELOSIRA GRANULATA V ANGUSTISSIMA	-	22	35	25	28	-	31	-
MELOSIRA VARIANS	-	-	-	-	-	-	-	-
NAVICULA CAPITATA	-	-	-	-	-	-	-	-
NAVICULA CRYPTOCEPHALA	-	-	3	3	-	-	6	-
NAVICULA RHYNCHOCEPHALA	6	3	3	9	6	-	6	9
NAVICULA SP I	-	-	-	-	-	-	-	-
NAVICULA SP 2	3	-	6	22	-	-	6	6
NAVICULA SP 3	-	-	-	-	-	-	-	-
NAVICULA SP 4	-	-	-	-	-	-	-	-
NAVICULA SP 5	-	-	-	-	-	-	-	-
NITZSCHIA ACICULARIS	19	12	15	12	6	22	25	9
NITZSCHIA PALEA	38	9	9	22	3	12	19	-
NITZSCHIA SP I	-	-	-	-	-	-	-	-
NITZSCHIA SP 2	-	-	-	-	-	-	-	-
RHIZOSOLENIA SP	-	-	-	-	-	-	-	-
STEPHANODISCUS ASTRAEA	9	-	-	-	3	-	3	-
STEPHANODISCUS ASTRAEA V. MINUTULA	-	-	-	-	-	-	-	-
SURIRELLA SP	-	-	-	-	-	-	-	-

TABLE C-2 (Continued)

	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2
SYNEDRA ACTINASTROIDES	25	-	-	12	9	-	-	6
SYNEDRA DELICATISSIMA	3	-	-	-	3	-	3	12
SYNEDRA RUMPENS	-	-	-	-	-	3	-	-
SYNEDRA ULNA	-	-	-	-	-	6	-	-
SYNEDRA ULNA V DANICA	3	3	19	3	3	-	3	12
TABELLARIA FENSTRATA	6	-	-	12	-	-	22	-
T QUADRISEPTATA	-	-	-	-	-	-	-	-
EUGLENOPHYCEAE								
EUGLENA SP	6	-	6	15	-	-	-	-
PHACUS SP I	-	-	-	-	-	-	-	-
TRACHELOMONAS CREEEA	-	-	-	19	-	-	6	-
TRACHELOMONAS OBLONGA	-	-	-	6	-	-	-	-
TRACHELOMONAS VOLVOCINA	-	-	6	6	-	-	3	-
TRACHELOMONAS SP II	-	-	-	-	-	-	-	6
TRACHELOMONAS SP IV	6	-	-	25	9	-	-	-
UNIDENTIFIED TAXA								
UNIDENTIFIED SPECIES J	-	-	-	-	3	-	3	-
UNIDENTIFIED SPECIES H	-	-	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	1261	849	1071	1258	985	872	1360	1352
NUMBER OF TAXA	53	38	47	48	38	37	50	44

TABLE C-2 (Continued)

	X-1	X-2	Y-1	Y-2
CRYPTOPHYCEAE				
CRYPTOMONAS SP	47	51	79	31
CRYPTOMONAS SP 3	-	-	-	-
RHODOMONAS SP	41	41	86	111
CHLOROPHYCEAE				
CHLOROCOCCALES				
ACANTHOSPHAERA ZACHARIASI	-	-	-	3
ACTINASTRUM HANTZSCHII	-	-	-	-
ANKISTRODESMUS FALCATUS	47	89	28	41
COELASTRUM CAMBRICUM	3	-	-	3
COELASTRUM MICROPORUM	9	3	12	6
CRUCIGENIA QUADRATA	9	12	-	19
CRUCIGENIA TETRAPEDIA	-	-	-	9
DICTYOSPHAERIUM PULCHELLUM	6	-	9	9
ECHINOSPHAERELLA LIMNETICA	-	12	-	-
FRANCEIA DROESCHERI	-	6	-	-
GOLENKINIA PAUCISPINA	19	15	9	3
KIRCHNERIELLA CONTORTA	-	-	-	-
KIRCHNERIELLA LUNARIS	-	-	-	-
KIRCHNERIELLA OBESA	57	22	-	3
LAGERHEIMIA QUADRISETA	-	-	-	-
LAGERHEIMIA SP	-	-	22	25
MICRACTINIUM PUSILLUM	44	25	28	12
OOCYSTIS GLOEOCYSTIFORMIS	-	6	19	9
OOCYSTIS SOLITARIA	-	-	-	-
PEDIASTRUM BIRADIATUM	3	-	3	3
PEDIASTRUM DUPLEX	6	-	-	3
PEDIASTRUM KAWRAISKYI	-	-	3	-
PEDIASTRUM OBTUSUM	-	-	-	-
PEDIASTRUM SIMPLEX	-	-	6	-
SCENEDESMUS ABUNDANS	-	3	3	-
SCENEDESMUS ACUMINATUS	-	-	3	6
SCENEDESMUS ARCUATUS	-	-	-	-
SCENEDESMUS ARMATUS	-	-	-	6
SCENEDESMUS BERNARDII	-	-	-	-
SCENEDESMUS BIJUGA	73	73	73	150
SCENEDESMUS DENTICULATUS	-	-	3	-
SCENEDESMUS QUADRICAUDA	22	9	12	12
SCENEDESMUS SERRATUS	-	-	-	-
SCHROEDERIA SETICERA	-	6	-	6
TETRAEDRON MINIMUM	79	147	156	147
TETRAEDRON REGULARE	-	-	-	-
TETRAEDRON TRIGONUM	-	3	6	-
TETRAEDRON SPP	-	-	-	3
TREUBARIA SETIGERUM	-	9	15	3
TETRASPORALES				
ELAKATOTHRIX GELATINOSA	-	12	-	3
SPHAEROCYSTIS SCHROETERI	-	-	-	-

TABLE C-2 (Continued)

	X-1	X-2	Y-1	Y-2
VOLVOCALES				
CHLAMYDOMONAS SP	73	83	73	70
EUDORINA SP	3	-	-	-
GONIUM FORMOSUM	-	-	-	-
SPHAERELLOPSIS SP	3	-	-	-
DESMIDACEAE				
COSMARIUM SP 3	-	3	-	-
COSMARIUM SP 4	6	6	-	-
EUASTRUM SP	-	-	3	9
STAURASTRUM LEPTOCLADIUM	22	22	12	25
STAURASTRUM QUADRICUSPIDATUM	-	12	-	-
ZYGNEMATELES				
MOUGEOTIA SPP	-	35	3	51
XANTHOPHYCEAE				
OPHIOCYTIUM CAPITATUM	-	-	-	-
PSEUDOTETRAEDRON NEGLECTUM	-	-	-	-
CHRYSOPHYCEAE				
CHRYSOCOCCUS PUSILLUM	-	6	3	3
DINOBRYON BAVARICUM	67	44	108	22
DINOBRYON DIVERGENS	44	15	31	121
SYNURA SP	6	15	-	-
DINOPHYCEAE				
CERATIUM HIRUNDINELLA	-	9	-	-
GLENODINIUM ACICULIFERUM	-	-	-	3
PERIDINIUM CUNNINGTONII	-	-	-	3
PERIDINIUM INCONSPICUUM	6	3	9	3
PERIDINIUM PUSILLUM	12	-	9	-

TABLE C-2 (Continued)

	X-1	X-2	Y-1	Y-2
CYANOPHYCEAE				
CHROOCOCCALES				
APHANOCAPSA DELICATISSIMA	-	22	-	-
CHROOCOCCUS DISPERSUS	-	-	-	-
COELOSPHAERIUM KEUTZINGIANUM	-	-	-	-
DACTYLOCOCCOPSIS ACICULARIS	-	-	-	-
DACTYLOCOCCOPSIS RAPHIDIOIDES	-	-	-	-
GOMPHOSPHAERIA LACUSTRIS	188	220	118	175
MERISMOPEDIA GLAUCA	-	-	3	-
MERISMOPEDIA TENUISSIMA	-	-	3	3
MICROCYSTIS AERUGINOSA	-	-	-	-
OSCILLATORIALES				
ANABAENA SPIROIDES	-	-	3	-
OSCILLATORIA GEMINATA	31	44	22	25
SPIRULINA LAXISSIMA	15	35	19	12
TRICHODESMIUM SP	-	-	-	-
BACILLARIOPHYTA (DIATOMS)				
ACHNANTHES LANCEOLATA N	9	-	-	3
ACHNANTHES LANCEOLATA V DUBIA	-	22	-	-
ANOMOEONEIS SP	3	3	-	3
ASTERIONELLA FORMOSA	-	-	-	-
ATTHEYA ZACHARIAS	-	-	-	3
COCCONEIS SP	3	-	15	6
CYCLOTELLA STELLIGERA	3	-	-	-
CYCLOTELLA SP	35	6	6	44
CYMBELLA AFFINIS	-	-	-	-
CYMBELLA VENTRICOSA	-	-	-	3
CYMBELLA TUMIDA	-	-	-	-
CYMBELLA SP	-	-	-	-
FRAGILARIA CAPUCINA	41	115	54	15
FRAGILARIA CROTONENSIS	60	47	95	140
GYROSIGMA SP	-	-	3	-
MELOSIRA AMBIGUA	166	137	166	147
MELOSIRA DISTANS	287	-	172	217
MELOSIRA GRANULATA N	19	19	41	99
MELOSIRA GRANULATA V ANGUSTISSIMA	15	-	-	-
MELOSIRA VARIANS	-	297	-	-
NAVICULA CAPITATA	-	-	-	-
NAVICULA CRYPTOCEPHALA	-	-	-	-
NAVICULA RHYNCHOCEPHALA	3	-	6	-
NAVICULA SP 1	-	-	-	-
NAVICULA SP 2	-	-	12	-
NAVICULA SP 3	-	-	3	-
NAVICULA SP 4	-	-	-	-
NAVICULA SP 5	-	6	-	-
NITZSCHIA ACICULARIS	3	6	6	15
NITZSCHIA PALEA	-	9	15	6
NITZSCHIA SP 1	-	-	-	6
NITZSCHIA SP 2	-	-	-	-
RHIZOSOLENIA SP	-	-	-	9

TABLE C-2 (Continued)

	X-1	X-2	Y-1	Y-2
STEPHANODISCUS ASTRAEA	9	-	-	22
STEPHANODISCUS ASTRAEA V. MINUTULA	-	-	-	-
SURIRELLA SP	-	-	-	-
SYNEDRA ACTINASTROIDES	-	-	12	-
SYNEDRA DELICATISSIMA	22	38	22	12
SYNEDRA RUMPENS	-	-	-	15
SYNEDRA ULNA	-	-	38	19
SYNEDRA ULNA V DANICA	25	22	-	-
TABELLARIA FENSTRATA	-	-	-	-
T QUADRISEPTATA	-	19	-	-
EUGLENOPHYCEAE				
EUGLENA SP	-	3	-	9
PHACUS SP I	-	-	-	-
TRACHELOMONAS CREBEA	-	-	3	-
TRACHELOMONAS OBLONGA	-	3	-	-
TRACHELOMONAS VOLVOCINA	-	-	-	-
TRACHELOMONAS SP II	-	-	-	-
TRACHELOMONAS SP IV	-	-	3	-
UNIDENTIFIED TAXA				
UNIDENTIFIED SPECIES J	-	-	-	3
UNIDENTIFIED SPECIES H	3	-	-	3
TOTAL NUMBER OF ORGANISMS	1647	1870	1666	1950
NUMBER OF TAXA	45	51	53	61

TABLE C-3

TAXONOMIC LIST OF VAAP PHYTOPLANKTON, AUGUST 11, 1975

CRYPTOPHYCEAE	Y-1	U-1	S	F-1	E-1	C-1	B-1	A
CRYPTOMONAS SP	39	55	79	31	23	239	159	159
RHODOMONAS SP	55	175	191	151	31	31	231	103
CHLOROPHYCEAE								
CHLOROCOCCALES								
ACANTHOSPHAERA ZACHARIASI	-	-	31	-	7	31	47	23
ACTINASTRUM HANTZSCHII	-	-	-	143	-	-	-	-
ANKISTRODESMUS FALCATUS	55	23	47	31	15	47	87	159
COELASTRUM CAMBRICUM	-	-	-	-	-	-	7	-
COELASTRUM MICROPORUM	7	-	-	-	-	7	31	23
COELASTRUM PROBOSCIDEUM	-	-	-	-	7	-	7	-
CRUCIGENIA APICULATA	47	-	31	-	-	-	39	7
CRUCIGENIA TETRAPEDIA	-	15	-	-	-	7	-	-
DICTYOSPHAERIUM PULCHELLUM	15	-	-	7	-	23	39	7
ECHINOSPHAERELLA LIMNETICA	-	-	7	-	-	7	7	-
FRANCEIA DROESCHERI	-	7	-	-	7	15	23	7
GOLENKINIA PAUCISPINA	-	-	15	7	7	15	71	15
KIRCHNERIELLA CONTORTA	-	-	-	-	31	-	31	-
KIRCHNERIELLA LUNARIS	-	-	55	-	-	39	7	-
KIRCHNERIELLA OBESA	55	-	31	31	-	-	-	-
LAGERHEIMIA SP	-	-	-	-	15	7	15	7
MICRACTINIUM PUSILLUM	23	15	-	15	15	55	103	95
OOCYSTIS GLOEOCYSTIFORMIS	23	-	31	-	-	159	-	-
OOCYSTIS SOLITARIA	-	-	-	15	7	-	-	7
PEDIASTRUM DUPLEX	7	-	-	-	-	-	-	-
PEDIASTRUM SIMPLEX	-	-	-	-	-	31	-	15
SCENEDESMUS ABUNDANS	23	-	-	7	23	31	55	47
SCENEDESMUS ACUMINATUS	7	-	-	-	-	7	15	15
SCENEDESMUS BIJUGA	23	15	-	-	-	15	-	31
SCENEDESMUS DENTICULATUS	7	-	15	-	-	15	-	-
SCENEDESMUS QUADRICAUDA	39	55	15	7	7	71	103	63
SCHROEDERIA SETIGERA	-	-	7	-	-	-	-	7
TETRADESMUS WISCONSINENSI	-	-	7	-	-	23	7	-
TETRAEDRON LUNULA	55	7	-	23	-	-	7	-
TETRAEDRON MINIMUM	15	-	7	15	7	39	47	47
TETRAEDRON REGULARE	-	7	-	-	-	-	7	-
TETRAEDRON TRIGONUM	55	15	39	-	7	15	39	15
TREUBARIA SETIGERUM	-	-	7	15	39	79	63	135
TETRASPORALES								
ELAKATOTHRIX GELATINOSA	-	-	7	7	-	-	-	-
SPHAEROCYSTIS SCHROETERI	-	-	-	-	7	15	-	-

TABLE C-3 (Continued)

	Y-1	U-1	S	F-1	E-1	C-1	B-1	A
VOLVOCALES								
CHLAMYDOMONAS SP	103	47	295	103	95	271	255	327
GONIUM FORMOSUM	-	-	15	-	-	-	-	-
SPHAERELLOPSIS SP	7	-	7	-	7	-	-	-
DESMIDACEAE								
CLOSTERIUM SP	-	-	7	-	-	-	-	-
COSMARIUM PHASEOLUS	31	-	-	-	-	7	7	7
EUASTRUM SP	7	7	7	-	-	7	7	-
STAURASTRUM LEPTOCLADIUM	-	7	7	-	-	-	-	7
ZYGNEMATALES								
MOUGEOTIA SPP	-	-	-	-	63	47	-	-
XANTHOPHYCEAE								
OPHIOCYTIUM CAPITATUM	-	-	-	7	-	7	-	-
PSEUDOTETRAEDRON NEGLECTUM	-	-	-	-	-	-	31	-
CHRYSOPHYCEAE								
CHRYSOCOCCUS PUSILLUM	15	23	415	23	31	23	63	95
DINOBRYON BAVARICUM	-	-	311	-	-	-	143	135
SYNURA SP	-	-	-	-	-	-	79	23
DINOPHYCEAE								
CERATIUM HIRUNDINELLA	-	7	-	-	-	-	-	-
GLENODINIUM ACICULIFERUM	7	-	-	-	-	-	-	-
PERIDINIUM CUNNINGTONII	-	-	7	7	-	7	-	-
PERIDINIUM INCONSPICUUM	23	7	39	23	-	7	39	15
PERIDINIUM PUSILLUM	-	7	-	-	7	-	23	7

TABLE C-3 (Continued)

CYANOPHYCEAE	Y-1	U-1	S	F-1	E-1	C-1	B-1	A
CHROOCOCCALES								
APHANOCAPSA DELICATISSIMA	79	71	71	39	7	215	191	79
CHROOCOCCUS DISPERSUS	31	71	111	23	39	71	119	175
CHROOCOCCUS MINUTUS	55	23	31	-	23	31	31	15
COELOSPHAERIUM KEUTZINGIANUM	-	7	-	-	-	23	63	15
DACTYLOCOCCOPSIS ACICULARIS	-	-	-	-	-	-	-	7
DACTYLOCOCCOPSIS RAPHIDIOIDES	-	39	47	7	-	-	23	103
GOMPHOSPHAERIA LACUSTRIS	687	159	151	47	23	95	127	87
MARSSONIELLA SP	-	-	-	-	7	15	-	7
MERISMOPEDIA GLAUCA	-	-	-	-	-	7	-	-
MERISMOPEDIA TENUISSIMA	15	7	7	-	15	31	47	39
OSCILLATORIALES								
ANABAENA SP	7	-	-	-	15	-	-	-
OSCILLATORIA GEMINATA	615	215	247	191	191	839	1119	1015
SPIRULINA LAXISSIMA	967	135	199	175	151	351	431	247
TRICHODESMIUM SP	39	7	-	15	-	-	15	23

BACILLARIOPHYTA (DIATOMS)	Y-1	U-1	S	F-1	E-1	C-1	B-1	A
ACHNANTHES LANCEOLATA V DUBIA	-	-	7	-	-	7	7	31
ANOMOEONEIS SP	15	-	-	7	-	-	-	-
COCCONEIS SP	-	7	15	-	7	39	7	7
CYCLOTELLA SP	39	31	-	23	31	23	23	31
FRAGILARIA CAPUCINA	215	79	63	63	63	127	39	87
FRAGILARIA CROTONENSIS	-	-	7	7	-	15	15	-
MELOSIRA AMBIGUA	15	95	191	31	47	431	223	255
MELOSIRA DISTANS	15	79	23	79	79	135	135	327
MELOSIRA GRANULATA N	-	15	-	-	-	63	79	127
MELOSIRA GRANULATA V ANGUSTISSIMA	-	-	-	-	-	-	-	47
NAVICULA RHYNCHOCEPHALA	-	-	15	-	-	-	23	23
NAVICULA SP 2	-	-	-	-	-	-	-	31
NAVICULA SP 3	-	-	-	-	-	-	-	7
NITZSCHIA ACICULARIS	-	-	-	23	23	39	103	127
NITZSCHIA PALEA	7	-	7	7	15	7	71	103
NITZSCHIA SINUATA V TABELLARIA	-	-	-	-	-	15	15	23
RHIZOSOLENIA SP	-	-	-	-	-	-	63	63
STEPHANODISCUS ASTRAEA V. MINUTULA	7	-	15	-	15	39	23	39
SYNEDRA ACTINASTROIDES	-	-	23	-	47	-	-	95
SYNEDRA DELICATISSIMA	31	23	-	7	15	-	-	15
SYNEDRA RUMPENS	95	-	39	7	23	-	95	63
SYNEDRA ULNA V DANICA	31	7	15	15	7	7	23	23

TABLE C-3 (Continued)

EUGLENOPHYCEAE	Y-1	U-1	S	F-1	E-1	C-1	B-1	A
EUGLENA SP	15	7	7	47	-	63	47	103
PHACUS SP I	-	7	7	-	-	-	-	-
PHACUS SP II	-	-	-	-	-	15	-	-
TRACHELOMONAS CREBEA	15	7	-	23	7	-	23	-
TRACHELOMONAS GIBBEROSA	-	-	-	-	-	-	7	-
TRACHELOMONAS OBLONGA	-	-	-	-	-	-	7	-
TRACHELOMONAS VOLVOCINA	7	7	-	7	-	7	-	-
TRACHELOMONAS SP III	-	-	-	7	-	-	7	-
TRACHELOMONAS SP IV	15	7	15	-	31	7	55	23
UNIDENTIFIED TAXA								
UNIDENTIFIED SPECIES H	-	-	31	-	-	7	-	7
UNSPECIFIED TAXON	-	15	-	-	-	15	-	-
TOTAL NUMBER OF ORGANISMS	3760	1614	3076	1518	1339	4138	5150	5072
NUMBER OF TAXA	48	42	52	42	45	62	66	64

TABLE C-4

TAXONOMIC LIST OF VAAP PHYTOPLANKTON, AUGUST 15, 1975

CRYPTOPHYCEAE	A	B-1	C-1	E-1	F-1	S	U-1	Y-1
CRYPTOMONAS SP	120	128	128	208	288	160	56	32
RHODOMONAS SP	128	40	184	336	640	24	72	48

****

CHLOROPHYCEAE	A	B-1	C-1	E-1	F-1	S	U-1	Y-1
CHLOROCOCCALES								
ACANTHOSPHAERA ZACHARIASI	24	24	8	-	16	24	8	-
ANKISTRODESMUS FRACTUS	32	40	72	24	24	64	64	24
COELASTRUM PROBOSCIDEUM	16	8	-	-	-	8	-	-
COELASTRUM SPHAERICUM	-	-	8	-	-	16	-	24
CRUCIGENIA APICULATA	-	96	8	64	-	-	-	8
CRUCIGENIA QUADRATA	32	-	-	-	-	-	-	-
CRUCIGENIA TETRAPEDIA	-	8	40	32	8	-	-	8
DICTYOSPHAERIUM PULCHELLUM	-	8	16	8	-	16	-	8
ECHINOSPHAERELLA LIMNETICA	32	-	8	8	-	-	-	-
FRANCEIA DROESCHERI	24	32	24	8	-	-	-	-
GOLENKINIA PAUCISPINA	-	-	32	8	-	8	16	-
KIRCHNERIELLA LUNARIS	-	-	-	56	-	-	16	88
KIRCHNERIELLA OBESA	8	32	-	-	-	-	-	-
LAGERHEIMIA SUBSALSA	-	-	-	8	-	-	-	-
LAGERHEIMIA SP	16	-	-	-	-	-	-	-
MICRACTINIUM PUSILLUM	32	24	48	-	16	16	16	24
OOCYSTIS GLOEOCYSTIFORMIS	-	48	24	8	-	-	16	-
OOCYSTIS SOLITARIA	16	8	8	8	-	8	-	-
PEDIASTRUM BIRADIATUM	-	8	8	-	-	-	-	-
PEDIASTRUM DUPLEX	-	-	8	-	-	-	-	-
PEDIASTRUM SIMPLEX	8	8	24	8	-	16	-	16
SCENEDESMUS ABUNDANS	24	40	16	8	16	8	-	8
SCENEDESMUS ACUMINATUS	-	-	8	-	8	-	-	-
SCENEDESMUS BERNARDII	24	8	-	-	-	8	-	-
SCENEDESMUS BIJUGA	8	8	16	16	16	8	8	8
SCENEDESMUS DENTICULATUS	16	-	-	8	8	-	-	-
SCENEDESMUS QUADRICAUDA	80	40	96	16	24	32	24	8
SCENEDESMUS SERRATUS	-	-	16	-	-	-	-	-
SCHROEDERIA SETIGERA	-	-	-	-	-	8	8	8
TETRAEDRON LUNULA	-	-	24	-	-	8	8	32
TETRAEDRON MINIMUM	40	40	40	16	16	8	40	8
TETRAEDRON REGULARE	-	8	-	16	-	-	-	-
TETRAEDRON TRIGONUM	16	8	56	32	48	-	56	48
TREUBARIA SETIGERUM	32	32	40	24	-	-	32	16
TETRASPORALES								
ELAKATOTHRIX GELATINOSA	-	40	-	-	-	-	-	16

TABLE C-4 (Continued)

	A	B-1	C-1	E-1	F-1	S	U-1	Y-1
VOLVOCALES								
CHLAMYDOMONAS SP	344	336	328	224	200	208	112	48
GONIUM FORMOSUM	16	8	-	-	-	16	8	-
PANDORINA CHARKOWIENSIS	8	-	8	-	-	16	-	-
SPHAERELLOPSIS SP	-	-	-	-	-	-	8	32
DESMIDACEAE								
CLOSTERIUM SP	16	-	-	-	8	8	-	-
COSMARIEM PHASEOLUS	8	-	8	-	8	16	48	24
EUASTRUM SP	16	-	-	-	-	-	-	-
STAURASTRUM LEPTOCLADIUM	-	-	-	-	-	-	8	8
ZYGNEMATELES								
MOUGEOTIA SPP	-	-	32	-	72	-	-	136
XANTHOPHYCEAE								
OPHIOCYTIUM CAPITATUM	8	-	-	-	-	-	-	-
PSEUDOTETRAEDRON NEGLECTUM	24	8	16	8	-	8	-	-
CHRYSOPHYCEAE								
CHROMULINA SP	40	-	-	32	8	-	-	8
CHRYSOCOCCUS PUSILLUM	328	160	160	72	40	464	56	-
DINOBRYON BAVARICUM	48	32	24	-	24	56	-	-
DINOBRYON DIVERGENS	-	-	-	-	-	-	-	8
SYNURA SP	16	16	24	-	-	-	-	-
DINOPHYCEAE								
CERATIUM HIRUNDINELLA	-	16	-	-	-	-	-	-
GLENODINIUM ACICULIFERUM	-	8	-	-	8	-	-	8
PERIDINIUM CUNNINGTONII	8	-	48	16	8	96	16	-
PERIDINIUM INCONSPICUUM	24	64	88	8	48	24	32	16
PERIDINIUM PUSILLUM	8	8	-	32	8	-	-	-
PERIDINIUM TATRICUM	-	-	-	-	-	-	8	-

TABLE C-4 (Continued)

CYANOPHYCEAE	A	B-1	C-1	E-1	F-1	S	U-1	Y-1
CHROOCOCCALES								
APHANOCAPSA DELICATISSIMA	56	120	72	8	32	56	8	56
CHROOCOCCUS DISPERSUS	96	32	40	48	8	48	-	8
CHROOCOCCUS MINUTUS	24	48	16	8	8	-	32	56
COELOSPHAERIUM KEUTZINGIANUM	16	16	16	8	8	8	24	8
DACTYLOCOCCOPSIS ACICULARIS	-	8	-	-	-	-	-	-
DACTYLOCOCCOPSIS RAPHIDIOIDES	56	40	32	-	-	-	8	-
GOMPHOSPHAERIA LACUSTRIS	216	208	232	160	160	112	232	240
MERISMOPEDIA GLAUCA	24	32	16	-	-	-	16	32
MERISMOPEDIA TENUISSIMA	32	8	40	48	8	16	-	-
MICROCYSTIS SP	-	8	-	-	-	-	-	-
OSCILLATORIALES								
ANABAENA SPIROIDES	-	8	8	-	-	-	-	-
ANABAENA SP	-	-	-	-	-	-	-	32
OSCILLATORIA GEMINATA	568	632	424	248	208	272	384	448
SPIRULINA LAXISSIMA	256	400	472	144	240	184	344	1024
TRICHODESMIUM SP	-	16	-	-	-	-	16	48

BACILLARIOPHYTA (DIATOMS)	A	B-1	C-1	E-1	F-1	S	U-1	Y-1
ACHNANTHES LANCEOLATA V DUBIA	-	32	8	-	8	8	-	-
ANOMOEONEIS SP	-	40	-	-	-	-	-	32
COCCONEIS SP	8	24	32	16	-	-	-	-
CYCLOTELLA SP	8	48	56	-	16	32	88	-
CYMBELLA AFFINIS	-	-	8	-	-	-	-	-
FRAGILARIA CAPUCINA	48	232	72	112	48	64	128	416
FRAGILARIA CROTONENSIS	8	-	-	-	-	8	-	-
MELOSIRA AMBIGUA	256	240	400	240	8	336	72	-
MELOSIRA DISTANS	288	152	216	112	-	72	-	16
MELOSIRA GRANULATA N	-	24	24	-	72	-	-	24
MELOSIRA VARIANS	-	-	-	-	160	-	72	-
NAVICULA RHYNCHOCEPHALA	32	40	24	-	-	24	-	-
NAVICULA SP 2	-	16	-	-	-	8	-	-
NITZSCHIA ACICULARIS	40	88	32	-	16	-	-	-
NITZSCHIA PALEA	80	144	88	-	24	24	-	-
NITZSCHIA SINUATA V TABELLARIA	24	-	8	-	-	-	-	-
RHIZOSOLENIA SP	24	-	-	-	-	-	-	-
STEPHANODISCUS ASTRAEA V. MINUTULA	16	-	8	-	8	-	-	-
SYNEDRA ACTINASTROIDES	-	-	72	-	32	24	-	-
SYNEDRA DELICATISSIMA	-	-	-	8	-	8	24	24
SYNEDRA RUMPENS	8	24	16	16	16	16	16	48
SYNEDRA ULNA V DANICA	16	8	16	16	8	16	8	104

TABLE C-4 (Continued)

EUGLENOPHYCEAE	A	B-1	C-1	E-1	F-1	S	U-1	Y-1
EUGLENA SP	16	16	48	8	64	88	32	-
PHACUS SP I	-	-	-	-	-	16	-	-
PHACUS SP II	-	8	-	-	-	-	-	-
PHACUS SP IV	-	-	-	-	-	8	-	-
TRACHELOMONAS CREBEA	16	8	16	-	8	64	-	-
TRACHELOMONAS GIBBEROSA	-	-	-	-	-	32	-	-
TRACHELOMONAS OBLONGA	-	-	-	-	-	8	-	-
TRACHELOMONAS VOLVOCINA	24	-	-	8	8	-	-	8
TRACHELOMONAS SP IV	32	56	112	16	24	152	16	-
TRACHELOMONAS SP VI	-	-	-	-	-	8	-	-
UNIDENTIFIED TAXA								
UNIDENTIFIED SPECIES H	-	8	24	-	24	24	16	-
UNSPECIFIED IN MASTER FILE								
UNSPECIFIED TAXON	-	24	-	-	-	-	-	-
UNSPECIFIED TAXON	-	-	-	-	-	-	-	8
TOTAL NUMBER OF ORGANISMS	3928	4200	4344	2536	2776	3088	2272	3352
NUMBER OF TAXA	64	68	67	47	49	57	43	47

TABLE C-5

VAAP PHYTOPLANKTON SHANNON-WEAVER SPECIES
DIVERSITY INDICES, LAKE CHICKAMAUGA
TENNESSEE, JUNE, 1975

Station	6/9	6/10	6/13	Mean
A	3.00	3.00	2.82	2.94
B-1	2.98	2.94	2.84	2.92
B-2	2.99	2.97	2.60	2.85
C-1	3.14	3.14	2.72	3.00
C-2	3.11	3.26	2.87	3.08
D-1	2.91	3.18	2.40	2.83
D-2	3.28	2.97	2.62	2.96
E-1	3.88	3.16	2.75	3.26
E-2	3.16	3.14	2.91	3.07
F-1	3.08	2.99	2.82	2.96
F-2	2.94	3.26	3.05	3.08
S	2.36	NM*	3.02	2.69
T-1	2.64	2.88	2.61	2.71
T-2	2.54	3.13	2.73	2.80
U-1	2.54	NM*	3.06	2.80
U-2	2.75	2.98	2.40	2.71
X-1	2.83	3.17	3.10	3.03
X-2	2.95	2.99	3.19	3.04
Y-1	2.75	3.26	3.25	3.09
Y-2	3.05	3.16	3.24	3.15

*Not measured

TABLE C-6

VAAP PHYTOPLANKTON CELL DENSITIES (CELL/ML)
LAKE CHICKAMAUGA, TENNESSEE, JUNE, 1975

Station	6/9	6/10	6/13	Mean
A	1500	1811	1277	1529
B-1	2886	3342	1594	2607
B-2	3100	2260	2327	2562
C-1	2218	2981	1646	2282
C-2	2471	1545	1383	1800
D-1	1520	1462	1789	1590
D-2	1783	1661	1301	1582
E-1	1564	1810	1207	1527
E-2	1511	2177	1261	1650
F-1	1338	1870	849	1352
F-2	1816	1465	1071	1451
S	3251	NM*	1258	2255
T-1	2175	1930	985	1697
T-2	2062	1428	872	1454
U-1	2565	NM*	1360	1962
U-2	1575	2386	1352	1771
X-1	1450	1757	1647	1618
X-2	1366	1456	1870	1564
Y-1	1306	1261	1666	1411
Y-2	1929	2133	1950	2004

*Not measured

TABLE C-7

VAAP PHYTOPLANKTON, TOTAL NUMBERS OF SPECIES PER STATION, LAKE CHICKAMAUGA, TENNESSEE, JUNE, 1975

Station	6/9	6/10	6/13	Mean
A	40	49	46	45
B-1	53	59	43	52
B-2	52	55	53	53
C-1	50	61	47	53
C-2	57	51	51	53
D-1	42	58	45	48
D-2	42	47	43	44
E-1	38	53	39	43
E-2	44	52	53	50
F-1	46	54	38	46
F-2	40	58	47	48
S	42	NM*	48	45
T-1	47	42	38	42
T-2	38	55	37	43
U-1	39	NM*	50	44
U-2	35	51	44	43
X-1	41	49	45	45
X-2	36	48	51	45
Y-1	38	55	53	49
Y-2	55	56	61	57

*Not measured

TABLE C-8

VAAP PHYTOPLANKTON TOTAL NUMBERS OF SPECIES
PER STATION, LAKE CHICKAMAUGA,
TENNESSEE, AUGUST 1975

Station	8/11	8/12	8/13	8/14	8/15	Mean
A	64		NM*		64	64
B1	66		71		68	68
C1	62		63		67	64
D2	65	76	73	76	52	68
E1	45		48		47	47
F1	42		53		49	48
S	52		52		57	54
T2	52	77	51	61	66	61
U1	42		57		43	47
X1	76	57	71	52	57	61
Y1	48		43		47	46

*Not measured

TABLE C-9

VAAP PHYTOPLANKTON CELL DENSITIES (CELLS/ML)
LAKE CHICKAMAUGA, TENNESSEE, AUGUST 1975

Station	8/11	8/12	8/13	8/14	8/15	Mean
A	5072		NM*		3928	4500
B1	5150		7064		4200	5471
C1	4138		5688		4344	4723
D2	2186	3239	4943	2949	2396	3143
E1	1339		2384		2536	2086
F1	1518		3520		2776	2605
S	3076		3616		3088	3260
T2	3226	2576	2821	4499	4038	3432
U1	1614		2960		2272	2282
X1	3524	4471	4378	4177	3181	3946
Y1	3760		3128		3352	3413

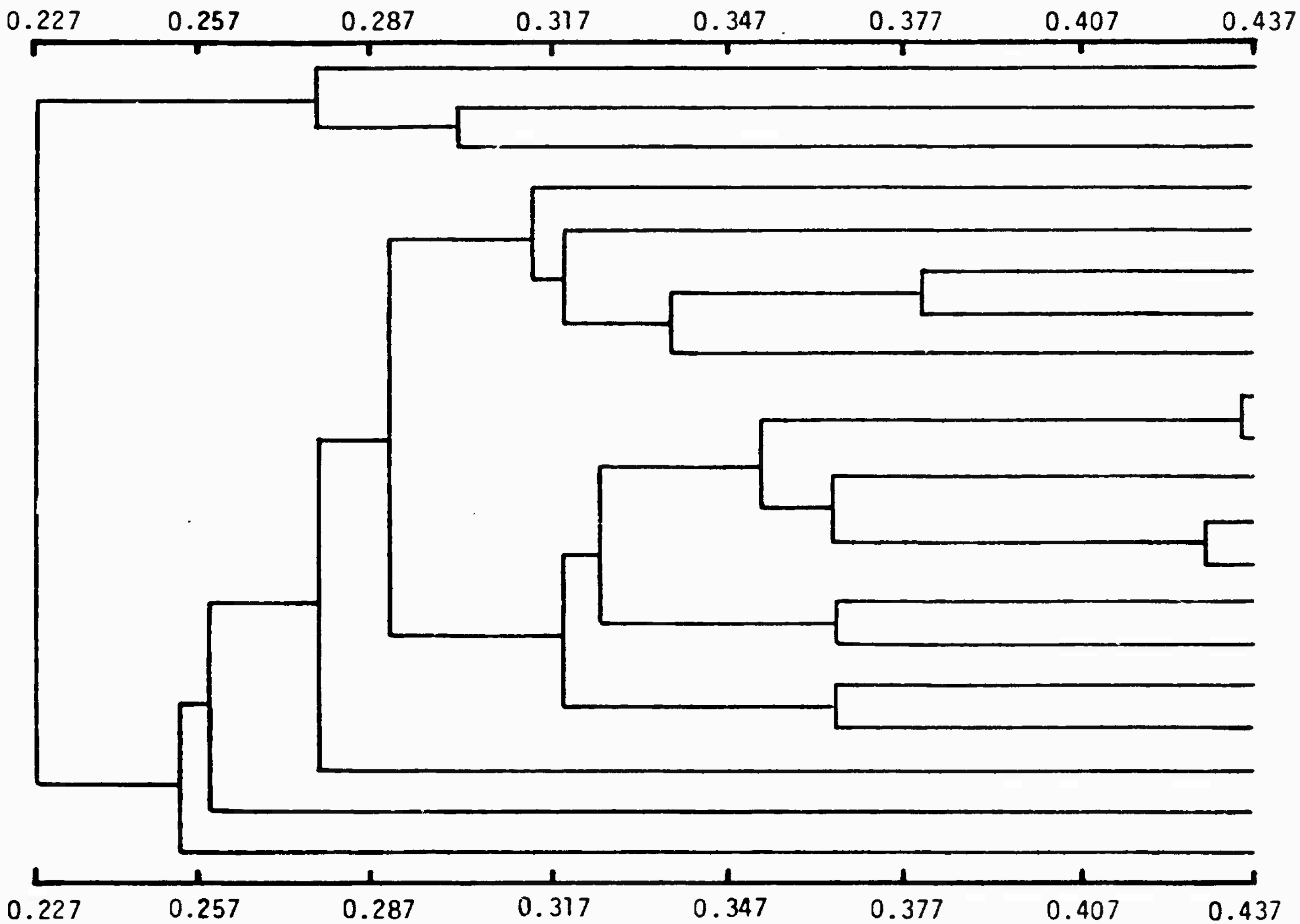
*Not measured

TABLE C-10

VAAP PHYTOPLANKTON SHANNON-WEAVER SPECIES DIVERSITY INDICES, LAKE CHICKAMAUGA, TENNESSEE, AUGUST 1975

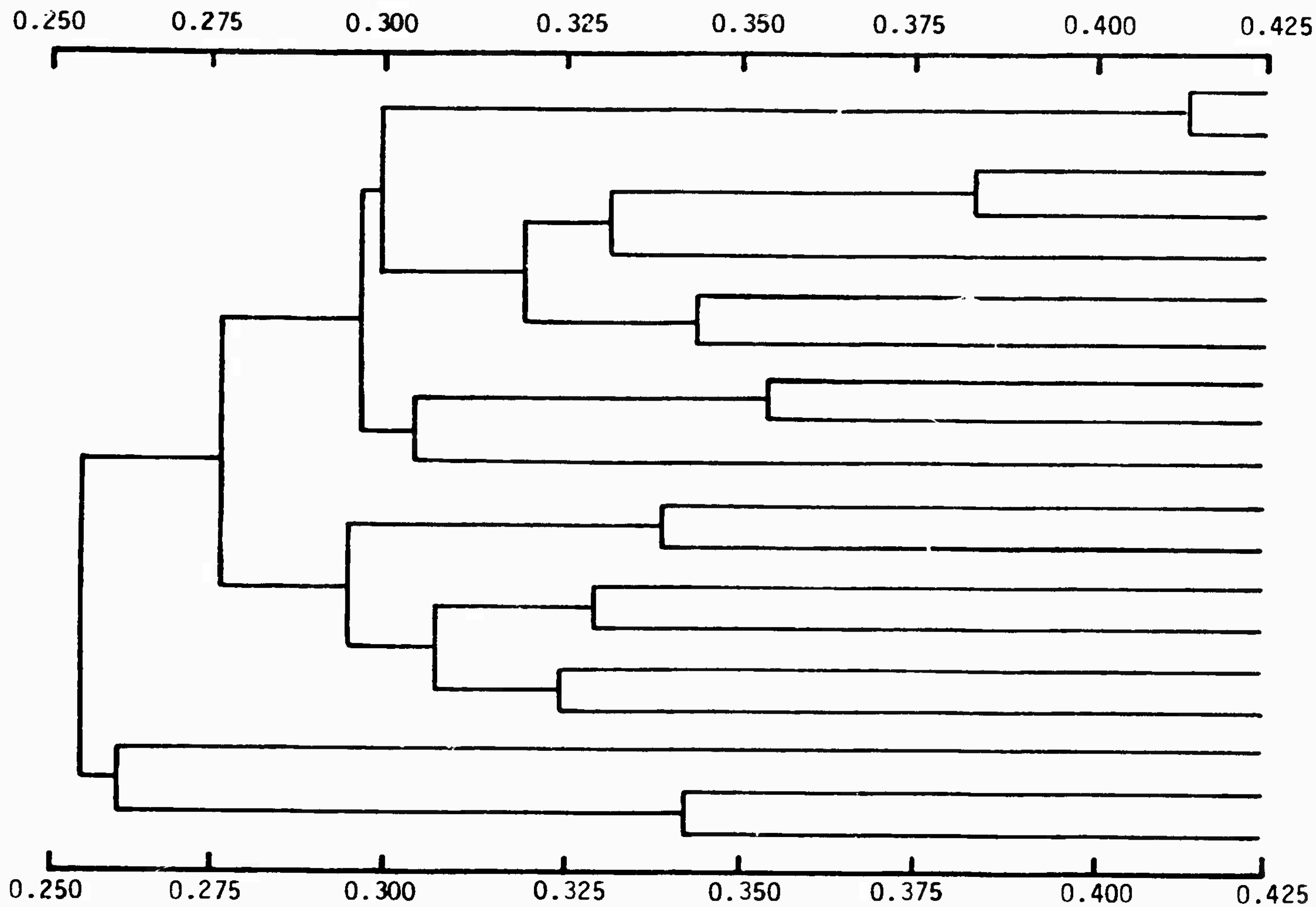
Station	8/11	8/12	8/13	8/14	8/15	Mean
A	3.38		NM*		3.37	3.38
B1	3.39		3.46		3.42	3.42
C1	3.19		3.38		3.47	3.35
D2	3.33	3.53	3.33	3.34	3.20	3.35
E1	3.30		3.00		3.10	3.13
F1	3.15		3.14		2.95	3.08
S	3.17		3.34		3.26	3.26
T2	3.29	3.51	3.20	3.32	3.47	3.36
U1	3.11		3.12		3.06	3.10
X1	2.91	2.92	2.77	2.08	2.58	2.65
Y1	2.67		2.82		2.69	2.73

*Not measured



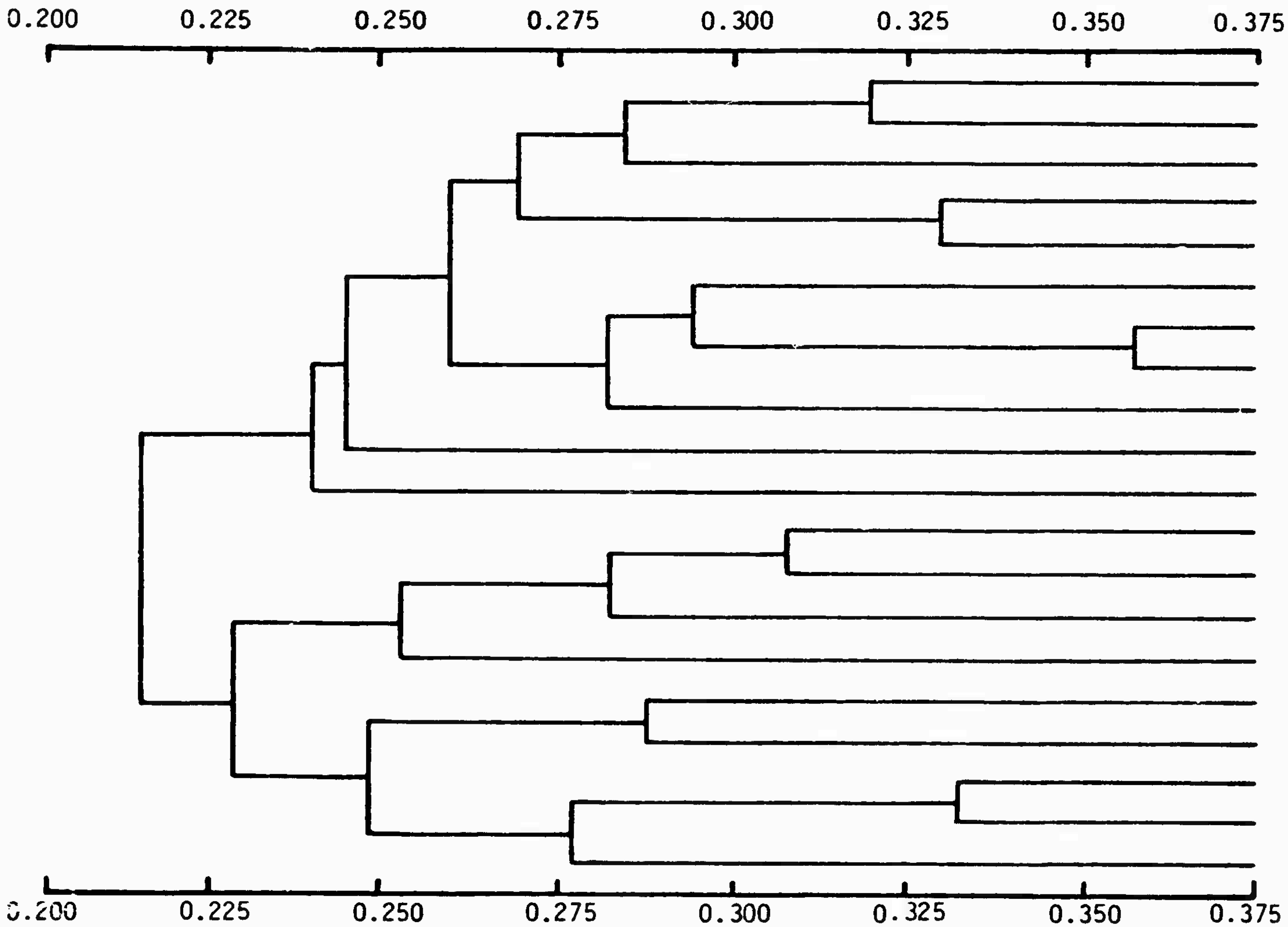
Station	Level
A	0.2790
B-1	0.3010
B-2	0.2266
C-1	0.3137
C-2	0.3210
S	0.3790
T-1	0.3375
Y-2	0.2881
D-1	0.4360
T-2	0.3520
E-1	0.3645
U-1	0.4290
U-2	0.3247
X-2	0.3660
Y-1	0.3195
D-2	0.3640
E-2	0.2780
F-1	0.2590
F-2	0.2549
X-1	

FIGURE C-1. PINKHAM-PEARSON COEFFICIENT OF BIOTIC SIMILARITY FOR VAAP PHYTOPLANKTON, JUNE 9, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.774.



Station	Level
A	0.4140
D-1	0.3005
B-2	0.3840
D-2	0.3330
T-1	0.3193
E-1	0.3450
F-2	0.2963
U-1	[illegible]
X-1	0.3045
Y-2	0.2767
B-1	0.3410
F-1	0.2949
C-1	0.3310
C-2	0.3082
E-2	0.3250
U-2	0.2577
T-2	0.2615
X-2	0.3430
Y-1	

FIGURE C-2. PINKHAM-PEARSON COEFFICIENT OF BIOTIC SIMILARITY FOR VAAP PHYTOPLANKTON, JUNE 10, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.627.



Station	Level
A	0.3200
C-2	0.2845
D-2	0.2695
T-1	0.3300
U-2	0.2593
B-2	0.2960
C-1	0.3580
U-1	0.2823
S	0.2447
B-1	0.2391
D-1	0.2153
E-1	0.3080
X-1	0.2815
Y-2	0.2523
X-2	0.2278
E-2	0.2870
Y-1	0.2480
F-1	0.3330
F-2	0.2765
T-2	

FIGURE C-3. PINKHAM-PEARSON COEFFICIENT OF BIOTIC SIMILARITY FOR VAAP PHYTOPLANKTON, JUNE 13, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.561.

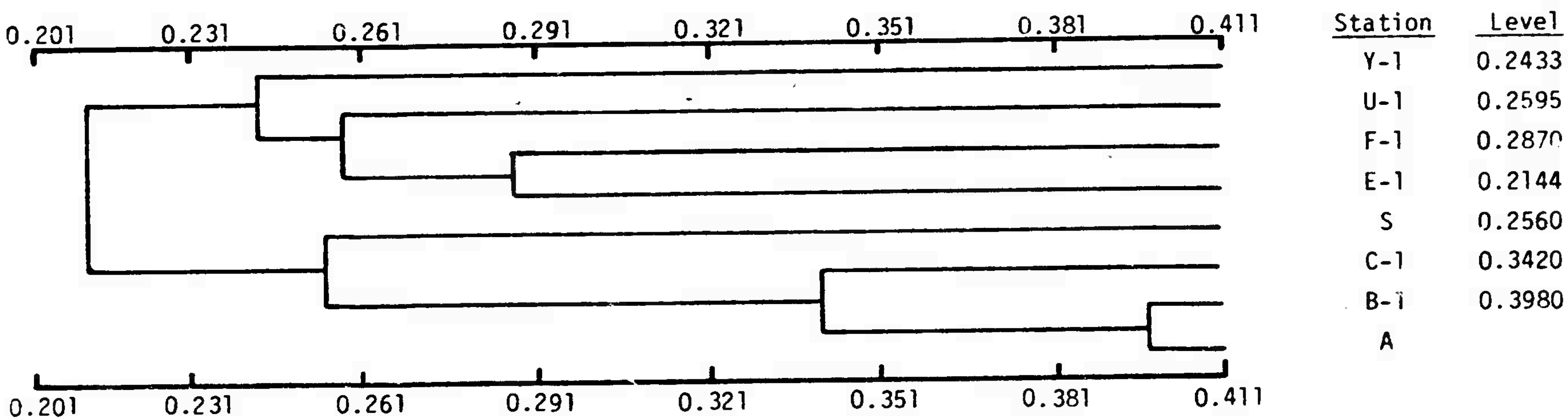


FIGURE C-4. PINKHAM-PEARSON COEFFICIENT OF BIOTIC SIMILARITY FOR VAAP PHYTOPLANKTON, AUGUST 11, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.89.

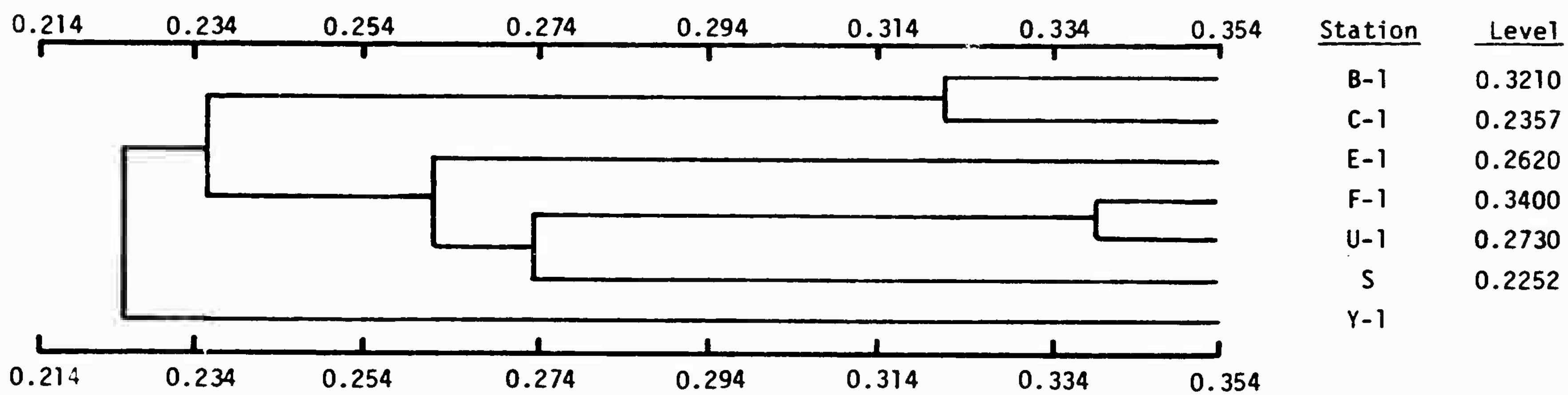
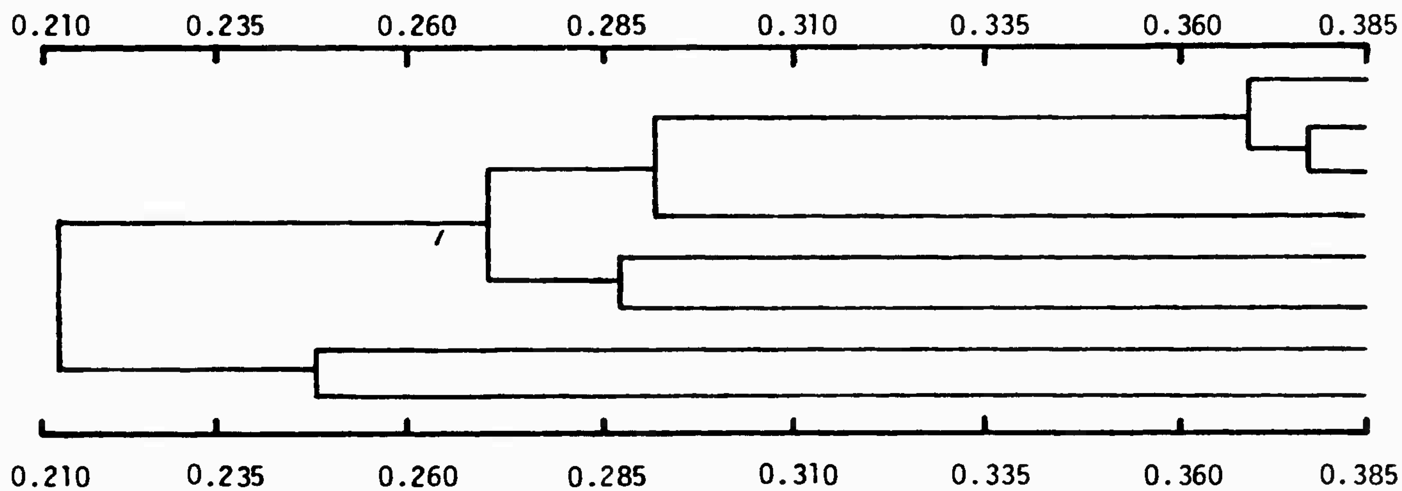


FIGURE C-5. PINKHAM-PEARSON COEFFICIENT FOR BIOTIC SIMILARITY FOR VAAP PHYTOPLANKTON, AUGUST 13, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.746.



Station	Level
A	0.3700
B-1	0.3780
C-1	0.2933
S	0.2690
E-1	0.2880
F-1	0.2150
U-1	0.2470
Y-1	

FIGURE C-6. PINKHAM-PEARSON COEFFICIENT OF BIOTIC SIMILARITY FOR VAAP PHYTOPLANKTON, AUGUST 15, 1975.

APPENDIX D

Computational Methods

LIST OF FIGURES

COMPUTATIONAL METHODS

Community Analysis

Introduction

Biotic components of water quality are generally quantified by one-dimensional diversity indices when single samples or stations are examined, or two-dimensional coefficients of biotic similarity when sample/sample, station/station, or species/species comparisons are undertaken.

Diversity indices are mathematical expressions that describe the distribution of individuals within the community. There are a number of diversity expressions in use. In general, maximum diversity exists if each individual belongs to a different species. Minimum diversity exists if all individuals belong to the same species. An environmental parameter that influences community structure will also modify the diversity index. In cases where environmental stress may occur (such as competition among species, physiochemical limiting factors, or pollution), the community is reduced in the number of species present. Frequently, this reduction in the number of species is accompanied by an increase in the number of individuals of the remaining species, especially in the case of organic pollution. Environmental stress, therefore, tends to reduce the magnitude of diversity indices. One-dimensional diversity indices include the Shannon-Weaver Species Diversity, Evenness, and Simpson's Index of Dominance.

Coefficients of biotic similarity quantify the taxonomic overlap between two samples or stations. Most of these coefficients assume values between 0 and 1, where a value of 0 indicates no species overlap, and a value of 1 implies identical species composition. Morisita's Index of Faunal Affinity and the Pinkham-Pearson's Index of Biotic Similarity are measures of biotic similarity.

In this study data processing subsequent to manual taxonomic identification/confirmation was executed through the IBM 370/OS system at the Northeast Regional Data Center of the State University System of Florida (NERDC). Diversity indices and coefficients of similarity were calculated by proprietary FORTRAN IV routines. The phenograms were generated through application of the NT-SYS Numerical Taxonomy System developed by Rohlf, Kishpaugh and Kirk at Stony Brook (1974).

Shannon-Weaver Species Diversity Index ($\bar{H}$)

The Shannon Weaver Species Diversity Index, $\bar{H}_e$ (Odum, 1971) is defined as:

$$\bar{H}_e = \sum_{i=1}^{t} - \frac{n_i}{N} \ln \frac{n_i}{N}$$

where n_i = total number of organisms persent as species *i*

$$N = \sum_{i=1}^{t} n_i = \text{total number of organisms present in the sample}$$

t = number of taxa present in the sample

$\bar{H}e$ ranges from a minimum of 0.0, occurring when all organisms belong to the same taxon (no diversity), to a maximum of ln N, occurring where each organism present belongs to a unique taxon (maximum diversity).

The Shannon-Weaver Index is commonly expressed to other logarithmic bases, especially base 2 and base 10, and is easily converted by the following expression:

$$\bar{H}_{base_x} = \frac{\bar{H}_e}{\ln x}$$

Evenness (e)

If the organisms of a sample are uniformly distributed among the taxa present, the Shannon-Weaver Index assumes the value, ln t, a condition of perfect evenness in the apportionment of individuals among species. The Index of Evenness, e (Odum, 1971), expresses the actual Shannon-Weaver Index as a fraction of this "ideal" value:

$$e = \frac{\bar{H}_e}{\ln t} \quad \text{(defined for } t > 1\text{)}$$

where $\bar{H}_e$ = actual Shannon-Weaver Species Diversity Index

t = number of taxa present in the sample

Evenness ranges from 0.0 (minimum evenness) to 1.0 (perfect evenness), and the calculated values are independent of the logarithmic base.

Simpson's Index of Dominance

The degree to which numerical dominance of a community is concentrated in one, several, or many species may be quantified by Simpson's Index, c (Odum, 1971):

$$c = \sum_{i=1}^{t} \left(\frac{n_i}{N}\right)^2$$

where n_i = number of individual organisms present as species *i*

$N = \sum_{i=1}^{t} n_i$ = total no. of organisms present in the sample.

t = number of taxa present in the sample

Simpson's Index ranges from 1/N, occurring when each organism represents a unique species (minimum dominance), to 1.0, occurring when all organisms represent the same single species (maximum dominance). In an evenly-dominated community, Simpson's Index assumes the value, 1/t, where t is the number of taxa observed in a sample -- $\bar{H}$ and e, for such a case, assume respective magnitudes of ln t and 1.0. Simpson's Index is therefore inversely related to species diversity and evenness.

Pearson-Pinkham Index of Biotic Similarity (B)

Each of the previously discussed indices ($\bar{H}$, e, and c) quantify community structure with a sacrifice of taxonomic integrity important to paired comparisons between samples or stations. Such indices are incapable of distinguishing samples of similar gross community structure, but unlike taxonomic composition. That is, in computation, the i th species of one sample is not necessarily the same i th species of another sample.

This insensitivity to taxonomic overlap is surmounted by the Pearson-Pinkham Index of Biotic Similarity, B (Pearson and Pinkham, 1974) defined as:

$$B = \frac{1}{t} \sum_{i=1}^{t} \frac{\text{Min}\,(n_{iA}, n_{iB})}{\text{Max}\,(n_{iA}, n_{iB})}$$

where t = number of taxa considered

n_{iA} = number of organisms of species i present at Station A

n_{iB} = number of organisms of species i present at Station B

Min (n_{iA}, n_{iB}) = the minimum value of the pair: n_{iA}, n_{iB}

Max (N_{iA}, n_{iB}) = the maximum value of the pair: n_{iA}, n_{iB}

Biotic similarity is defined only for a paired comparison between two samples or stations. If two samples are characterized by identical taxonomic overlap (all species occur in identical abundance), the calculated index assumes a value of 1.0 (maximum similarity). Two samples possessing no species in common share an index of 0.0 (minimum or no similarity). The number of species considered, t, may include only those species observed in either or both of the two samples, or, if mutual absence is deemed important, may include species not necessarily present in either sample. If mutual absence is considered important, Min (0,0) = 1 and Max (0,0) = 1 in the computation of biotic similarity.

A biotic similarity index, B', between species may be defined on spatial and numerical occurrence by transposition of the axes in the preceding expression of station similarity:

$$B' \equiv \frac{1}{k} \sum_{j=1}^{k} \frac{\mathrm{Min}\ (n_{j1}, n_{j2})}{\mathrm{Max}\ (n_{j1}, n_{j2})}$$

where: k = number of samples or stations considered

n_{j1} = number of organisms of species 1 at Station j

n_{j2} = number of organisms of species 2 at Station j

Min (n_{j1}, n_{j2}) = the minimum value of the pair: n_{j1}, n_{j2}

Max (n_{j1}, n_{j2}) = the maximum value of the pair: n_{j1}, n_{j2}

This index likewise ranges from 0.0 (minimum similarity) to 1.0 (maximum similarity). B' may possess utility for grouping species according to environmental preference or pollution tolerance--that is, it may delineate "indicator organisms."

Phenograms

The quantification of similarity between paired stations, samples, or species by any of the previously-defined coefficients of similarity generates a diagonal matrix containing PC unique elements, where PC is calculated from the expression (Pearson and Pinkham, 1974):

$$PC = \frac{S\ (S - 1)}{2}$$

where: PC = number of unique paired comparisons

S = number of stations, samples, or species being compared

For a study comprising only 25 stations, a similarity matrix of 300 unique elements is produced. Evaluation and presentation of such a voluminous matrix is impractical without computer-aided analysis and graphic models.

Algorithms for clustering similarity matrices into two-dimensional, hierarchic relationships have been developed by numerical taxonomists (Sokal and Sneath, 1963). A technique frequently invoked by ecologists and generally regarded as introducing the least distortion into similarity relationships is the sequential, agglomerative, hierarchic, nonoverlapping clustering method (SAHN) using unweighted pair-groups with arithmetic averaging (UPGMA), described by Sokal and Sneath (1963). The product of this procedure is a branched diagram termed a phenogram (or dendrogram), illustrated below for a study of

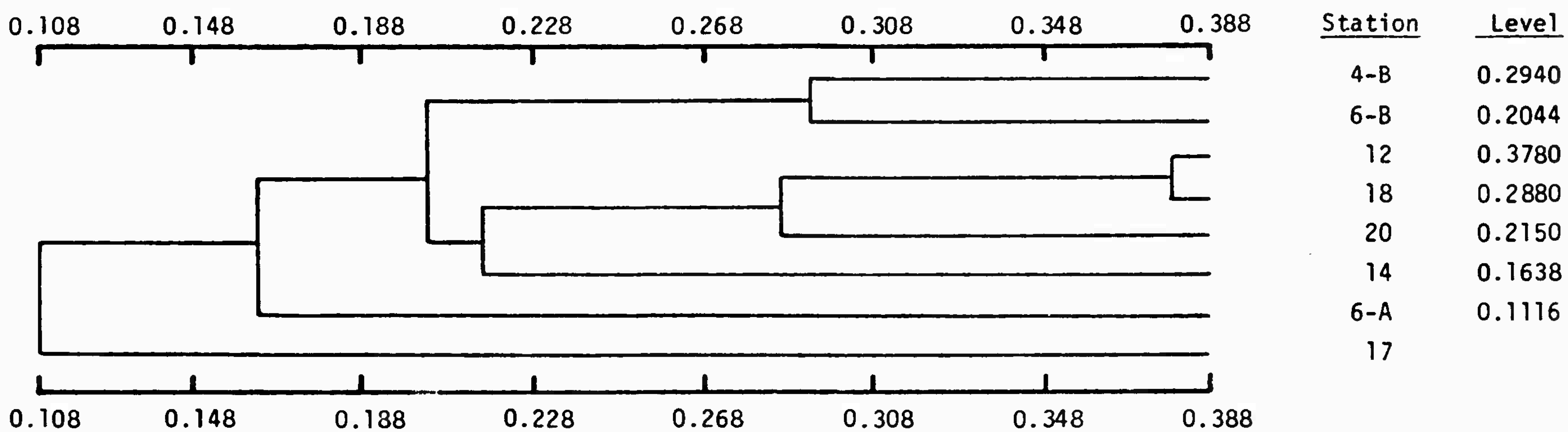


FIGURE D-1. PHENOGRAM OF PERIPHYTON ARTIFICIAL SUBSTRATE, JUNE 11-26, 1975. COPHENETIC CORRELATION COEFFICIENT, 0.927.

diatom populations at six stations in the Holston River. This phenogram, like those contained in the current study, was generated directly by computer using the NT-SYS Numerical Taxonomy Package (Rohlf, Kishpaugh, and Kirk, 1974).

The horizontal scale or abscissa of the phenogram is graduated in the units of the similarity measure upon which the clustering was based -- in this case, the Pearson-Pinkham Biotic Similarity Index (mutual absence unimportant). Points of furcation (branching) between the horizontal stems, representing stations or groups of stations imply that the similarity between the two streams is at the coefficient value shown above the branch on the abscissa. The magnitude of similarity between stems is also shown to the right of the phenogram under the column heading, "Level;" these numbers give the exact similarity level at which each stem (station or group of stations) joins the stem below it. Stems are associated with their respective stations by labels to the right under the column heading "Station."

The magnitude of similarity between any two stations represented on the phenogram will, in general, differ from the corresponding magnitude given in the original similarity matrix. This arises as a consequence of the averaging necessary to recursively agglomerate the separate stations into a single, structured set containing all the stations. In the illustrative phenogram, the level of similarity between Stations 6B and 14 is shown to be 0.2044, whereas, in the original similarity matrix (not shown), the magnitude is given as 0.1720. The phenogram value is the arithmetic average of the original similarity indices of Stations 4B and 6B (the cluster containing Station 6B) respectively paired with Stations 12, 18, 20, and 14 (the cluster containing Station 14).

The degree of distortion resulting from the cluster analysis may be quantified by the cophenetic correlation coefficient, r_{coph}, defined as the product moment correlation coefficient computed between the elements of the original similarity matrix and the corresponding indices implied by the phenogram (Sokal and Sneath, 1963). High values of r_{coph} ($r_{coph} > 0.8$ for fewer than 10 stations) indicate that the distortion introduced by the clustering procedure and depicted by the phenogram has not significantly masked the informational content of the original similarity matrix.

Chemical Water Quality Analysis

Distance Coefficient

The prior discussion has focused upon the numerical measures generally applied to biologic data. A somewhat more generalized approach to paired comparisons between stations, readily extended to the interpretation of chemical data, is the distance measure. The procedure treats stations as points in an n-dimensional hyperspace, where the n coordinates of a station are the values of the n chemical or chemical/biologic parameters considered. Analogous to the biotic similarity coefficients, a matrix of Euclidean distance coefficients is calculated from the expression (Sokal and Sneath, 1963):

$$\Delta_{AB} \equiv \left[\sum_{i=1}^{n} (X_{iA} - X_{iB})^2 \right]^{1/2}$$

where Δ_{AB} = the Euclidean distance between Stations A and B

n = the number of chemical or chemical/biologic parameters considered

X_{iA} = the magnitude of the i th parameter at Station A

X_{iB} = the magnitude of the i th parameter at Station B

Clustering is then executed by grouping together station pairs possessing low distance coefficients, that is, stations close to one another in Euclidean hyperspace.

Difficulty in considering parameters of widely different magnitudes and ranges is overcome by normalization of all parameters to standard variables, Z_{iA}, with zero mean and unit variance.

$$Z_{iA} \equiv \frac{X_{iA} - \bar{X}_i}{S_i}$$

where Z_{iA} = the standardized magnitude of parameter i at Station A

X_{iA} = the measured magnitude of parameter i at Station A

$\bar{X}_i$ = the mean measured magnitude of parameter i (all stations considered)

S_i = the standard deviation of parameter i (all stations considered)

In computation, Z_{iA} and Z_{iB} respectively replace X_{iA} and X_{iB} in the expression for Δ_{AB}.

The magnitude of the Euclidean distance, Δ_{AB}, increases for any pair of stations as the number of parameters considered is increased. To eliminate this dependence, an average distance, d_{AB}, may be calculated (Sokal and Sneath, 1963):

$$d_{AB} \equiv \sqrt{\Delta_{AB}^2/n}$$

where d_{AB} = average distance between Stations A and B

Δ_{AB} = Euclidean distance between Stations A and B

n = number of chemical or chemical/biologic parameters considered.

For standardized, independent, normally-distributed parameters, the expected value of $\underline{d}_{AB}$ converges to $\sqrt{2}$ as $\underline{n}$ approaches infinity, (Sokol and Sneath, 1968).

Biologic Sampling Requirements

Estimation of biologic community structure in natural substrates is confounded by the oft-noted heterogeneity or spatial patchiness of organisms. Sampling of such populations should be conducted so as to provide both an indication of the degree of heterogeneity and some (albeit hypothetical) mean measure of standing crop and structure to allow quantitative comparison of sampling zones or stations.

A biologic community may be considered to possess base population characteristics (density, constituency) governed by gross controlling macrophenonema (i.e. munitions wastes) to which are superposed population variations of lesser magnitude (the apparent random error). The sampling objective is realized when a minimum area or volume is collected such that the error caused by random variations is acceptably small.

In practice, the minimum sampling requirements are generally unknown at the time of collection, unless the investigator has had the benefit of prior studies or preliminary field surveys. If prior information is unavailable, the investigator may choose to bracket the likely requirements and rely upon subsequent detailed laboratory analyses at representative stations to provide that information -- the costs of additional sample collection is usually insignificant relative to the basic expense of a site visit.

One approach to the laboratory determination of minimum sampling requirements is to collect and analyze replicate sets of samples at select stations, each set constituting a unique sampling area or volume. A mean population parameter (diversity, standing crop) may then be plotted against sample area or volume analyzed, bracketed by the calculated standard deviations or confidence limits. Sample size is determined by locating that minimum area or volume where the slope of the plotted data approximates zero and is bracketed by acceptable error limits.

A disadvantage of this procedure is the requirement for collecting and identifying independent replicates of each sample size considered. For an illustrative case, the investigator might collect triplicate sample sets comprised of 1.2, 1.8, 2.3, and 2.9 ft^2 of streambed material if he were studying macrobenthic sampling requirements. These represent a total of 24.6 ft^2 of bottom sediment area and 43 grabs of a 9" x 9¼ (60 lb) Ponar dredge or 98 grabs of a 6" x 6" Ekman dredge, both standard benthic samples. Aside from being physically abusive and expending substantial amounts of costly taxonomic identification time, such a program might require disruption of more substrate area than exists in a particular sampling zone.

A modified procedure, applied to this study, utilized the recombination of subsets of the same sample set to estimate mean Shannon-Weaver diversity for any particular sample size. This allowed the determination of minimum sampling requirements with much greater economy of collection and identification at a sacrifice, however, of precise error limits. For the illustrative case of the prior paragraph, one set of samples totaling 2.9 ft^2 -- 5 hauls of the Ponar or 12 hauls of the petit Ekman dredge could be collected. A plot of mean diversity versus number of dredge hauls (corresponding to varying substrate areas) would be prepared. Mean diversity, $\bar{H}_x$ for x dredge hauls would be calculated as:

$$\bar{H}_x = \sum^{\kappa} H_x^j$$

where $k = c(m,x) = \frac{m!}{x!(m-x)!}$ = the number of combinations of m dredge hauls taken x at a time

m = the total number of dredge hauls collected at a sampling site

H_x^j = the Shannon-Weaver diversity based upon the cumulative taxonomic data of a particular combination, j of x dredge hauls.

Error limits estimated for $\bar{H}x$ are based upon k-1 degrees of freedom. Since k-1 approaches zero as x approaches m, the total number of dredge hauls collected should be somewhat greater than the expected minimum number of dredge hauls required to obtain a reasonably constant estimate of the population diversity.

For macrobenthos both artificial and natural substrate samples were taken. The artificial substrate samplers (Hester-Dendy samplers) were disassembled in the field and preserved on a plate by plate basis. Hence, a replicate consisted of a single plate. For three different sampling sites 15 or 16 plates were counted and tabulated. Utilizing a computer to minimize data processing time, combinations of replicates were pooled utilizing 1, 2, 3, etc. total replicates. Mean pooled Shannon-Weaver values are shown in Figure D-2. In all cases it can be seen that Shannon-Weaver values increased as sample size (total number of replicates pooled) increased up to about seven samples. Addition of more samples to the pool beyond that point had little or no effect on the mean Shannon-Weaver value. Based on these results, seven plates (pooled) were considered to be sufficient to obtain a reasonable estimate of the Shannon-Weaver diversity for the remaining sampling sites.

For macrobenthos in natural substrates the identical procedure was utilized to show that five dredge samples would be sufficient (see Figure D-3).

For diatom populations on artificial substrates (glass slides) this procedure showed five slides to be sufficient (see Figure D-4.)

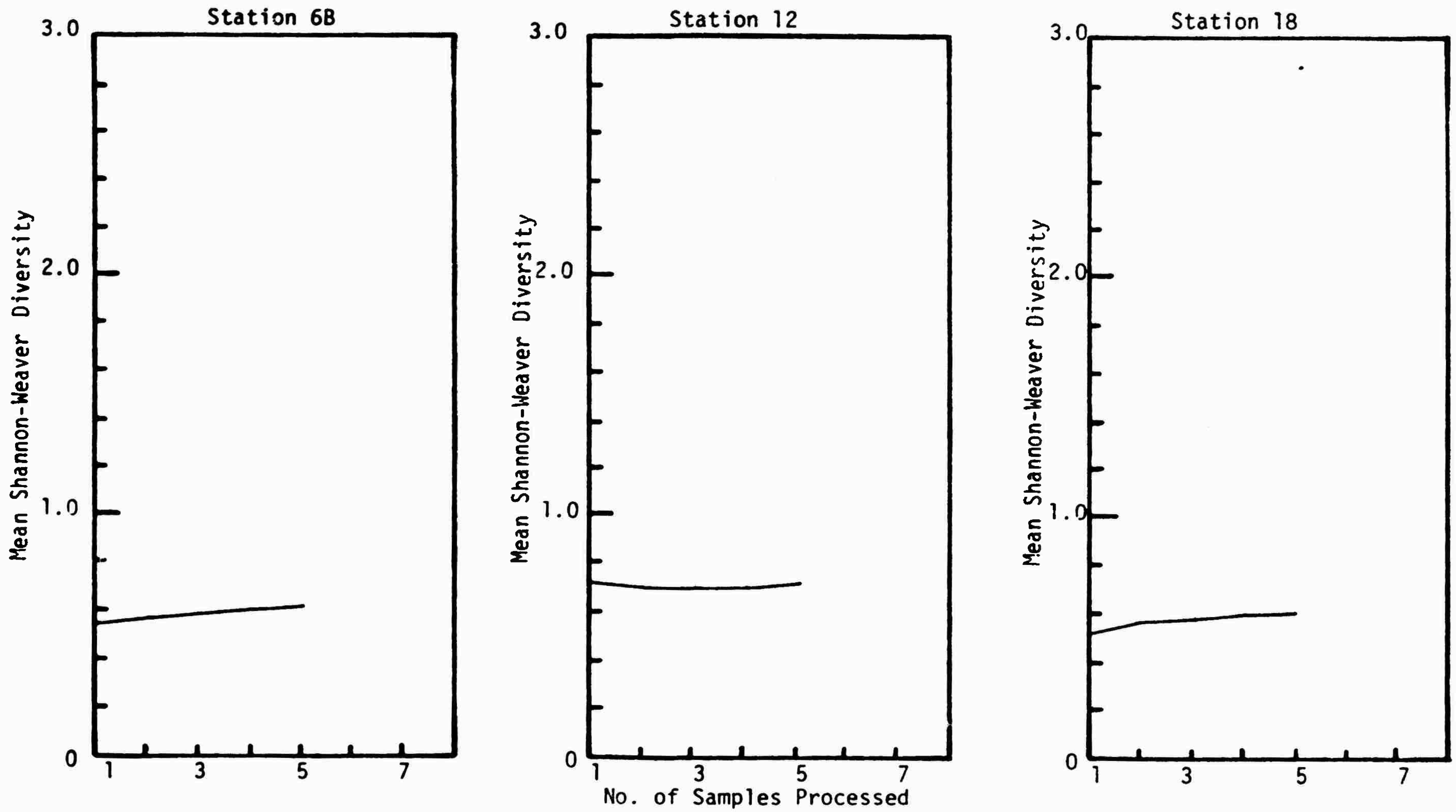


FIGURE D-2. MEAN DIVERSITY - REPLICATE PLOTS OF MACROBENTHOS COLLECTED FROM NATURAL SUBSTRATE DURING THE JUNE STUDY AT HAAP.

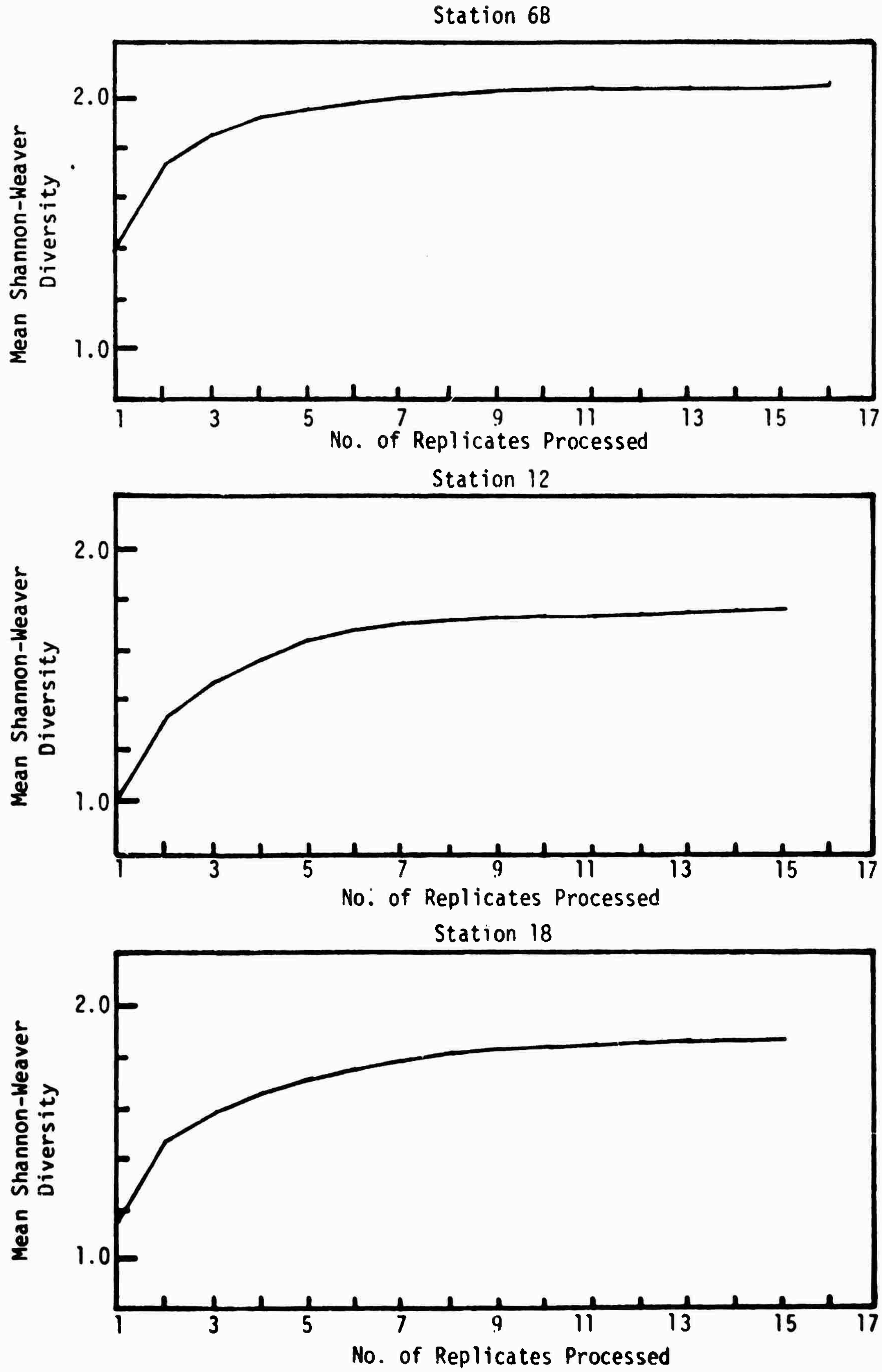


FIGURE D-3. MEAN DIVERSITY - REPLICATE PLOTS OF MACROBENTHOS COLLECTED FROM ARTIFICIAL SUBSTRATE DURING THE JUNE STUDY AT HAAP.

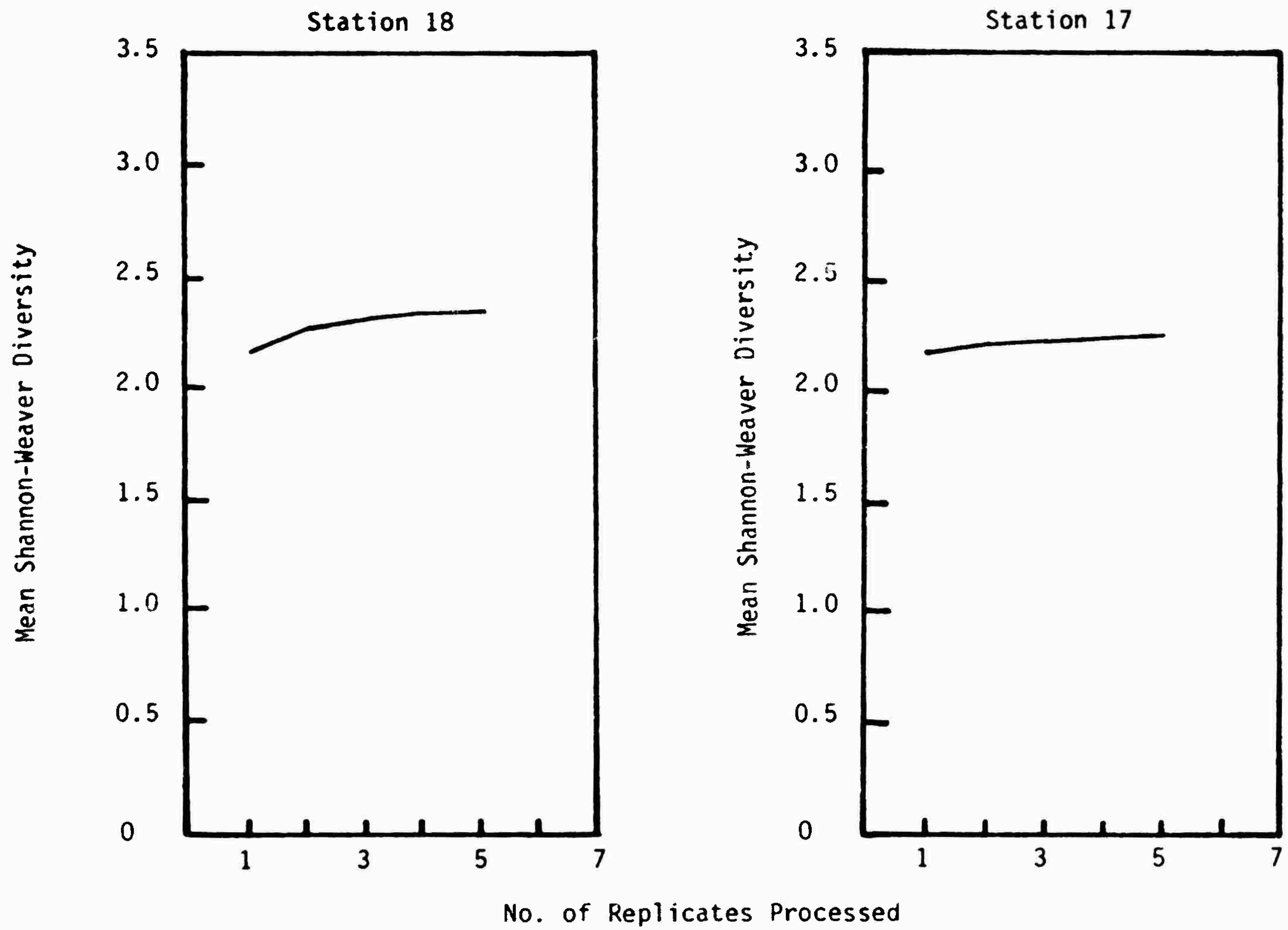


FIGURE D-4. MEAN DIVERSITY - REPLICATE PLOTS OF DIATOMS COLLECTED FROM ARTIFICIAL SUBSTRATE AT THE HAAP SITE AFTER 4-WEEKS INCUBATION - JUNE - JULY 1975

APPENDIX E

SAMPLING MATRICES

LIST OF TABLES

TABLE E-1
SAMPLING PARAMETERS FOR JUNE SURVEY, VOLUNTEER ARMY AMMUNITION PLANT

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2	X-1	X-2	Y-1	Y-2	No Wake
PERIPHYTON																					
Artificial Substrate																					
2-Week Incubation																					
Collected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Analyzed																					
Organisms	3	3	3	3	3	3	5	0	0	3	3	5	3	5	3	0	5	3	3	0	0
Biomass	5	5	5	5	5	5	5	0	0	3	5	5	5	5	4	5	5	5	5	4	5
Chlorophyll	2	2	1	2	0	2	2	0	3	0	0	1	1	0	0	0	0	0	2	2	1
4-Week Incubation																					
Collected	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No	No	No	Yes	No	Yes	Yes
Analyzed																					
Organisms	3	2	2	2	0	2	2	0	0	0	2	2	2	0	0	0	0	2	0	2	0
Biomass	3	3	2	3	0	3	3	0	0	0	3	3	3	0	0	0	0	3	0	3	0
Chlorophyll	4	2	5	4	0	5	0	0	0	0	2	3	5	0	0	0	0	4	0	3	1
Natural Substrate																					
Collected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Analyzed	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No	Yes	No	No	No
MACROINVERTEBRATES																					
Artificial Substrate																					
Collected	18	18	0	6	0	18	18	18	0	0	0	18	13	12	12	0	18	18	6	18	0
Analyzed	7	7	0	6	0	7	17	7	0	0	0	7	7	0	12	0	16	0	6	0	0
Natural Substrate																					
Collected	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0
Analyzed	5	5	3	5	3	5	5	5	3	5	3	5	5	3	5	5	5	3	5	0	0
PLANKTON																					
Collected	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0
Analyzed	3	3	3	3	3	3	3	3	3	3	2	3	3	3	2	3	3	3	3	2	0
CHEMISTRY - WATER																					
Group A	5	5	5	5	5	5	5	5	5	5*	5	5	5	5	5	5	5	5	5	5	0
Solids	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0
Sulfates	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Metals																					
A	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0
B	5	0	0	5	5	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0

*One munitions sample broken in shipment.

TABLE E-1 (CONTINUED)

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2	X-1	X-2	Y-1	Y-2	No Wake
CHEMISTRY - SEDIMENTS Nitrite Nitrogen Total P COD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Volatile Solids Total Solids	2	2	2	2	1	1	2	1	2	2	2	2	1	1	1	2	1	1	1	1	0
Zn, Pb, Cu	2	2	2	2	1	1	2	1	2	2	2	2	1	1	1	2	1	2	1	1	0
TKN	2	2	2	1	1	1	2	1	1	1	1	1	1	1	0	1	1	1	1	1	0
Nitrate Nitrogen	2	2	2	0	1	1	2	1	1	1	1	0	1	1	1	1	1	1	1	1	0
Munitions	1	1	1	1	1	0	1	0	1	0	1	1	1	0	0	1	1	0	0	0	0
Hg	2	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
Mn, Cd, Fe	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	2	1	1	0
Cr^{+6}	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0	1	0	1	0	0	0
Ni	2	1	1	2	1	1	1	1	1	2	1	1	1	1	1	1	2	2	1	1	0

GROUP A

Nitrogen Forms
Total Phosphorus
COD
TOC
Munitions
Alkalinity
Hardness
Chloride
Mercury

METALS A

Cd, Cu
Ni, Zn
Cr

METALS B

Fe
Pb

TABLE E-2
SAMPLING PARAMETERS FOR AUGUST SURVEY, VOLUNTEER ARMY AMMUNITION PLANT

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2	X-1	X-2	Y-1	Y-2	No Wake
PERIPHYTON																					
Artificial Substrate																					
2-Week Incubation																					
Collected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Analyzed																					
Organisms	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	0	2	2
Biomass	0	3	0	0	0	3	0	0	0	0	0	1	3	3	3	3	0	3	0	3	0
Chlorophyll	0	1	0	1	1	3	0	0	0	0	0	3	0	1	2	0	0	3	3	2	0
4-Week Incubation																					
Collected	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Analyzed																					
Organisms	2	2	0	2	2	0	2	0	2	0	0	2	2	0	2	2	2	2	0	2	2
Biomass	3	1	0	1	3	0	0	0	0	0	0	5	3	1	0	0	1	0	0	2	0
Chlorophyll	1	1	0	3	4	0	0	0	0	0	0	4	2	1	2	0	4	5	0	3	0
Natural Substrate																					
Collected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Analyzed	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
MACROINVERTEBRATES																					
Artificial Substrate																					
Collected	18	18	18	18	18	0	18	18	0	18	18	6	18	18	18	18	18	18	18	18	0
Analyzed	7	7	0	7	0	0	7	7	0	6	0	6	7	0	7	0	7	0	7	0	0
Natural Substrate																					
Collected	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0
Analyzed	5	5	0	5	0	5	5	5	0	5	0	5	5	0	0	4	5	0	5	3	0
PLANKTON																					
Collected	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0
Analyzed	2	3	0	3	0	0	5	3	0	3	0	3	0	5	3	0	5	0	3	0	0
CHEMISTRY - WATER																					
Group A	5+	5	5	5	5	5+	5	5	5	5	5+	5	5	5	5	5	5	5	5+	5	0
TOC	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0
Group B	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0
Sulfates	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Cr, Cu, Fe	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Pb, Ni, Zn	5	3	0**	2	2++	0**	0	0	0	2	0	5	0	0	0	0	0	0	5	0	0

*Alternate sampling site "F-Buoy" was utilized for this parameter. **One Ni sample. +One munitions sample broken in shipment. ++No Zn samples.

TABLE E-2 (CONTINUED)

	A	B-1	B-2	C-1	C-2	D-1	D-2	E-1	E-2	F-1	F-2	S	T-1	T-2	U-1	U-2	X-1	X-2	Y-1	Y-2	No Wake
CHEMISTRY - SEDIMENTS Nitrite-Nitrogen Total P COD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0
Volatile Solids Total Solids	2	1	2	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0
TKN Nitrate-Nitrogen	2	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Munitions	1	1	1	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Zn, Pb, Cu Mn, Cd, Fe, Cr^{+6}, Ni	1	1	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1	0	1	0	0
Hg	1	0	1	0	0	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0

GROUP A	GROUP B
Nitrogen	Solids
Phosphorus	Chloride
COD	Hardness
Munitions	
Alkalinity	

TABLE E-3

TIME OF DAY SAMPLED
JUNE TRIP

Station	Date 6/9/75	6/10/75	6/11/75	6/12/75	6/13/75
A	1255	1127	1125	0958	0956
B-1	1315	1142	1144	1019	0944
B-2	1307	1134	1139	1009	0950
C-1	1328	1421	1155	1115	0933
C-2	1337	1433	1115	1124	0927
D-1	1725	1452	1053	1035	0914
D-2	1715	1446	1105	1028	0921
E-1	1735	1504	1044	1058	0907
E-2	1745	1511	1037	1049	0900
F-1	1902	1533	1016	1152	0843
F-2	1852	1523	1027	1140	0851
S	1835	0928	1205	0858	1036
T-1	1824	0953	1219	0914	1023
T-2	1815	0942	1215	0923	1030
U-1	1805	1002	1233	0932	1016
U-2	1755	1100	1227	0943	1011
X-1	1110	1602	0924	1232	0812
X-2	1040	1553	0914	1220	0800
Y-1	1122	1610	0934	1241	0819
Y-2	1132	1619	0944	1253	0825

TABLE E-4

TIME OF DAY SAMPLED
AUGUST TRIP

Station	8/11/75	8/12/75	Date 8/13/75	8/14/75	8/15/75
A	1005	1413	0845	1050	0920
B-1	1020	1425	0903	1032	0938
B-2	1030	1438	0913	1040	0929
C-1	1055	1458	0935	1015	0955
C-2	1105	1445	0925	1000	0945
D-1	1335	1108	1155	0940	1013
D-2	1348	1115	1145	0950	1004
E-1	1405	1055	1130	0928	1032
E-2	1418	1040	1120	0915	1024
F-1	1448	1015	1050	0850	1140
F-2	1433	1028	1105	0905	1130
S	0840	1300	1035	1110	1118
T-1	0900	1315	1015	1122	1108
T-2	0910	1325	1025	1130	1102
U-1	0927	1335	1000	1150	1052
U-2	0940	1348	0950	1140	1042
X-1	1615	0918	1342	1402	0810
X-2	1555	0905	1330	1350	0825
Y-1	1628	0930	1352	1414	0840
Y-2	1540	0850	1315	1424	0852

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