Characterization of Baseline Conditions of the Physical, Chemical and Microbiological Environments in the St. Johns River Estuary

Florida Department of Environmental Regulation
Contract No. SP132

FINAL REPORT

Submitted to:	Mr. Dean Jackman Florida Department of Environmental Regulation 2600 Blair Stone Road Tallahassee, FL 32301
Submitted by:	Dr. Richard H. Pierce Project Manager Ms. L. Kellie Dixon Principal Investigator Water Quality, Sediment and Toxic Metal Analysis Mr. Robert C. Brown Principal Investigator Toxic Organic Substances

Mote Marine Laboratory
1600 City Island Park
Sarasota, FL 34236

Dr. Gary Rodrick
Principal Investigator
Microbiology

University of Florida
Department of Food and Human Nutrition
Gainesville, FL 32601

August 15, 1988

Suggested reference Pierce RH, Dixon LK, Brown RC, Rodrick G. Characterization of baseline conditions of the physical, chemical and microbiological environments in the St. Johns river estuary. FL Dept of Environ Regul. Contract no SP132. Mote Marine Laboratory Technical Report no 128. 110 p plus appendices. (Available from Mote Marine Laboratory Library)

TABLE OF CONTENTS

LIST OF FIGURES

List of Figures, Continued Page

LIST OF TABLES

List of Tables, Continued. Page

List of Tables, Continued

I. PROJECT SUMMARY

Ulcerative Disease Syndrome (UDS) or Ulcerative Mycosis (UM) is a recently described disease of menhaden and other estuarine fish of the eastern coast of the United States. This disease has caused great concern among state and federal marine resource and environmental agencies. Recently, Florida has become a site of special efforts, since an outbreak of UDS has been described in the St. Johns River, near Jacksonville.

The primary etiology of UDS is unclear. However, the major agent of the disease is a degenerative fungus, oomycetes. Even though it has not been established that this organism initiates the disease, the resulting deep necrotic ulcers ultimately cause the demise of the affected fish.

It has been suggested that factors such as pollutants, salinity, and depressed dissolved oxygen (DO) levels predispose fish to infection by the fungus. The purpose of this study was to determine the geographical distribution and concentrations of selected pollutants (organics, metals and nutrients) for determining stresses on affected organisms through the characterization of baseline conditions of the physical, chemical, and microbiological environments in the St. Johns River.

The lower St. Johns River has in recent years been subject to much public and regulatory attention. A review by the Florida Department of Environmental Regulation (FDER) of water quality (Wenzel and McVety, 1986) summarized available information as of that date and indicated that over one third of permitted surface discharges in Duval County were in violation of permit criteria. This county, in addition, contains more than three times the number of discharges than any other Florida county. Stormwater discharges, septic tank and sewer system leachate, as well as wastewater and industrial discharges were all identified as contributory to observed water quality problems in the river.

Tributaries were especially impacted and the above document stated that sediments were considered enriched in many toxic metals in the industrial areas. Of the thirty-one bioassays conducted on discharges by FDER since 1980, metal concentrations were worthy of note in ten. Major tributaries ultimately receiving these discharges were the Broward and Trout Rivers, the Cedar River, and the St. Johns River itself in the downtown area. Of the seven STORET stations inventoried in this region of the river, 45% of 631 water column trace metal concentrations were in violation of Florida Administrative Code, Chapter 17-3 criteria. Nutrient and DO violations were also widely reported.

The state of Florida's 305(b) Water Quality Inventory (Hand, Tauxe and Watts, 1986) has also identified specific areas in the southern part of the basin (Dunns Creek, south of Palatka) impacted by agricultural runoff and sewage treatment plant discharges. Paper mill and other effluents produced poor water quality (for DO and nutrients) in Rice Creek, which enters the St. Johns River north of Palatka. Trout Creek, just south of Green Cove Springs, has experienced elevated nutrients, biochemical oxygen demands, and metal concentrations. Julington Creek and Doctors Lake both receive domestic wastes and increasing amounts of urban runoff. The Ortega River system receives discharges from domestic treatment plants as well as numerous wire, chemical, and paper industries. Much of the Cedar River is classified as poor water quality. Regional sewage treatment and paper industries supply major discharges to the downtown section of the river with concomitant DO problems. The remaining major tributaries, Arlington, Trout and Broward Rivers, and Dunn Creek all receive substantial amounts of domestic and industrial wastes.

Approximately forty stations in the estuarine St. Johns River provided existing STORET data for sediment metals (from 1980-1987, as of November 1987). Median station values indicated that copper, followed by lead and cadmium, were those metals detected at the most number of stations. Unfortunately, aluminum data are absent for these stations, making enrichment determinations from these existing data difficult if not impossible.

Previous studies of petroleum contamination in the St. Johns River were performed in 1982 and 1983 by Boehnke et al. (1983). Relying primarily on aliphatic hydrocarbon data, these studies showed the lower river, from the river mouth to the east end of Blount Island, to be relatively free from petroleum contamination. Select sites from Blount Island upstream to Julington Creek showed moderate to heavy petroleum contamination, especially in sediment near the mouths of the Broward, Trout, and Ortega Rivers, and Julington Creek. More recently, a survey of select polynuclear aromatic hydrocarbons (PNA's) in U.S. estuaries showed the St. Johns River estuary to rank twelfth among the twenty most polluted estuaries studied (NOAA, 1984).

Results from samples collected during 1987 from designated dry (Event 1) and wet (Event 2) seasons (May and September, respectively) and during an apparently wet March in 1988 (Event 3) are reported in this document. Initially, thirty stations were sampled during May 5-7 and again on September 21-23, 1987 for chemical, physical and microbial characterization of water and sediment. A subsequent sampling, conducted during March 21-24, 1988, relocated a majority of the stations for expanded geographical coverage, especially to evaluate specific tributaries. Parametric coverage during all three events was identical. Analyses for baseline characterization was separated into five categories as follows.

1. Sample collection and in situ water quality
    - o Parameters included: salinity, temperature, pH, dissolved oxygen (DO), and Secchi depth
2. Sediment characterization and nutrients
    - o Parameters included: grain size, percent moisture, total organic carbon (TOC), total Kjeldahl nitrogen (TKN), and total phosphorus (TP)
3. Metals in sediment
    - o Metals included: aluminum, cadmium, copper, lead, mercury, and zinc
4. Toxic organic chemicals in sediment
    - o Parameters included: polynuclear aromatic hydrocarbons (PNA), chlorinated hydrocarbon pesticides, polychlorinated biphenyls (PCB), and coprostanol
5. Microbiology of water and sediment
    - o Microbial analyses included: bacteria and select fungi.

In situ water quality data indicated no severely adverse conditions at the time of monitoring, which were all conducted during daylight hours. Although no tidal filters were imposed on any of the samplings, salinity ranged from 35 °/oo near the mouth, to <l °/oo near Palatka during the 1987 samplings and a salt wedge was observed in the river. Conditions were notably fresher during the following March sampling. Dissolved oxygen was adequate at all sites and no extremes of temperature or pH were observed. Light penetration was limited, with Secchi depths between 0.2 and 2.0 meters.

Sediment grain size distribution was site specific, ranging from a gelatinous, highly organic mousse, to a relatively coarse shell hash, with median grain sizes averaging 2.87 phi and ranging from 0.19 to 4.39 phi at the initial thirty stations. Organic carbon content of these sediments ranged from 0.4 to over 90 mgC/g dry weight sediment. A comparison of TOC with % silt-clay was used to provide insight into sediment source material. During the March sampling, when stations emphasizing tributary inputs were selected, overall grain sizes were slightly smaller (median averaging 3.28 phi) and TOC concentrations (1.2 to 174 mg/g C) slightly higher.

Nutrient analysis included total Kjeldahl nitrogen (TKN) and total phosphorus (TP). Nitrogen ranged between 0.02 and 19 mg/g dry sediment. Total phosphorus ranged between 0.04 and 2.57 mg/g of dry sediment. Bulk concentrations of these two parameters also averaged slightly higher in the tributaries. Relationships between TKN, TP, TOC and % silt-clay provided information to identify areas of sediment enriched in nutrients. Comparisons of nutrient concentrations with TOC and % silt-clay indicated that four stations in the upper river exhibited nitrogen enrichment while four stations in the central and lower reaches were enriched in phosphorus.

Sediment metal concentrations were assessed using regression relationships of unpolluted sediment metals with aluminum content. Through this technique, toxic metal pollution was indicated at several sites within the central river region, most notably in the Ortega and Cedar Rivers,and in Big Fishweir and Moncrief Creeks.

Toxic organic substance analysis in surface sediment exhibited elevated concentrations of PNA at select stations in the central and upper St. Johns River. Resituated stations for Event 3 showed considerable PNA contamination in tributaries, indicating that depositional environments within tributaries to the St. Johns River could be zones of pollutant impact for aquatic organisms. Assessment of individual PNA content indicated primarily pyrogenic compounds which enter the river from land drainage areas that are impacted from aeolean deposition. Distribution of the fecal sterol, coprostanol, indicative of sewage-derived material, was similar to that observed for PNA's with the highest concentrations observed in Event 1 and 2 samples in the mid and upper river. Focusing on tributaries, Event 3 stations revealed considerable fecal contamination in tributaries to the mid St. Johns River area.

Moderate levels of Cl-pest were evident throughout, with no preference for tributaries over the River. Most notable was the predominance of op' and pp'-DDT, which has not been allowed for use in almost 20 years. Chlordane, used for termite control around buildings, also was present. These pesticide results indicate that the source would most likely be from buried or contained DDT and chlordane from residential and commercial building environments rather than from agriculture.

Tributaries to the mid-St. Johns River area contained high concentrations of PNA's and coprostanol (sewage-derived sterol) implicating these areas as likely sites for impact to aquatic organisms. Chlorinated pesticides and PCB's also were highest throughout the mid-river section, but these chemicals did not exhibit higher concentrations in the tributaries. PCB concentrations were higher than Cl-pest. Unlike the PNA's and coprostanol, Cl-pest and PCB concentrations did not approach those exhibited in other estuaries considered to be highly polluted through the NS&T Benthic Surveillance (NOAA, 1985).

These results for toxic organics suggest that the primary concern for biological impact would be relative to aromatic hydrocarbon (PNA) contamination, rather than chlorinated pesticides or PCB's, except for one or two areas where all contaminants appear to be alarmingly high.

Other toxic chemicals, such as chlorinated phenols and associated compounds, now should be considered.

Microbiological analyses revealed surprisingly low recoveries of pathogenic bacteria. On these occasions, the most prevalent _Vibrio_ sp. present was _V. parahaemolyticus_, followed by _Aeromonas hydrophila_. Fecal coliforms were also low throughout the water column, with some elevated sediment counts in the mid and upper river. Oomycete fungi were found at the river mouth and at two stations in the mid river area. These were determined to be _Saprolognia_ sp. Characterizations during 1988, from resituated stations to evaluate more of the tributaries, were very similar to the 1987 results except that two forms of _Vibrio vulnificus_ were observed at Station 112. Based on fecal coliform data, tributaries did not appear to contain greater amounts of microorganisms than did the River. The fecal coliform data, however, did not agree with the coprostanol data indicating high levels of sewage-derived material in several tributaries.

Baseline characterization during all samplings revealed a river estuary of acceptable _in situ_ water quality with limited microbiological contamination and notable toxic metal and toxic organic chemical contamination of sediments at specific sites.

II. WATER QUALITY, SEDIMENT CHARACTERIZATION NUTRIENTS, AND METALS

A. INTRODUCTION

One aspect of the baseline characterization of the estuarine portions of the St. Johns River was the collection and analysis of sediment samples for nutrients, grain size and other physical descriptors. Selected stations were further processed for particular metals and toxic organics typically associated with anthropogenic sources of pollution. The analysis of sediments was emphasized in this study to provide estimates of long term conditions or chronic pollution climates. The affinity of many pollutants for fine-grained clays and organic matter dictated the determination of grain size and carbon content in addition to nutrients and metals to allow a multitude of inter-station comparisons. Analyses of three replicates per station were performed to provide reliable characterizations and a range of station variability. Basic in-situ water column information, although not of highest priority during this study due to the pulsed nature of many discharges, was also collected. This report addresses the combined results of the three sampling efforts; Event 1 conducted in early May 1987, Event 2 in late September 1987, and Event 3 in late March 1988.

An estimate of hydrologic conditions across the St. Johns Water Management District during the study period can be depicted by monthly rainfall totals (the average of six stations: Jacksonville Airport, Gainesville, Daytona Beach, Orlando, Melbourne, and Ocala) as compared to long term averages (Figure 1). In 1987, rainfall and, presumably, flows in the St. Johns River, were substantially below normal during April, and consequently the sampling in early May represents a drier than normal dry season. Rainfalls during September, although preceded by several months of below normal totals, were near long term averages recorded for that month. Hydrologic conditions during March, 1988, indicate that rainfall was above average for the month and salinities observed in the River were well below those recorded during previous samplings.

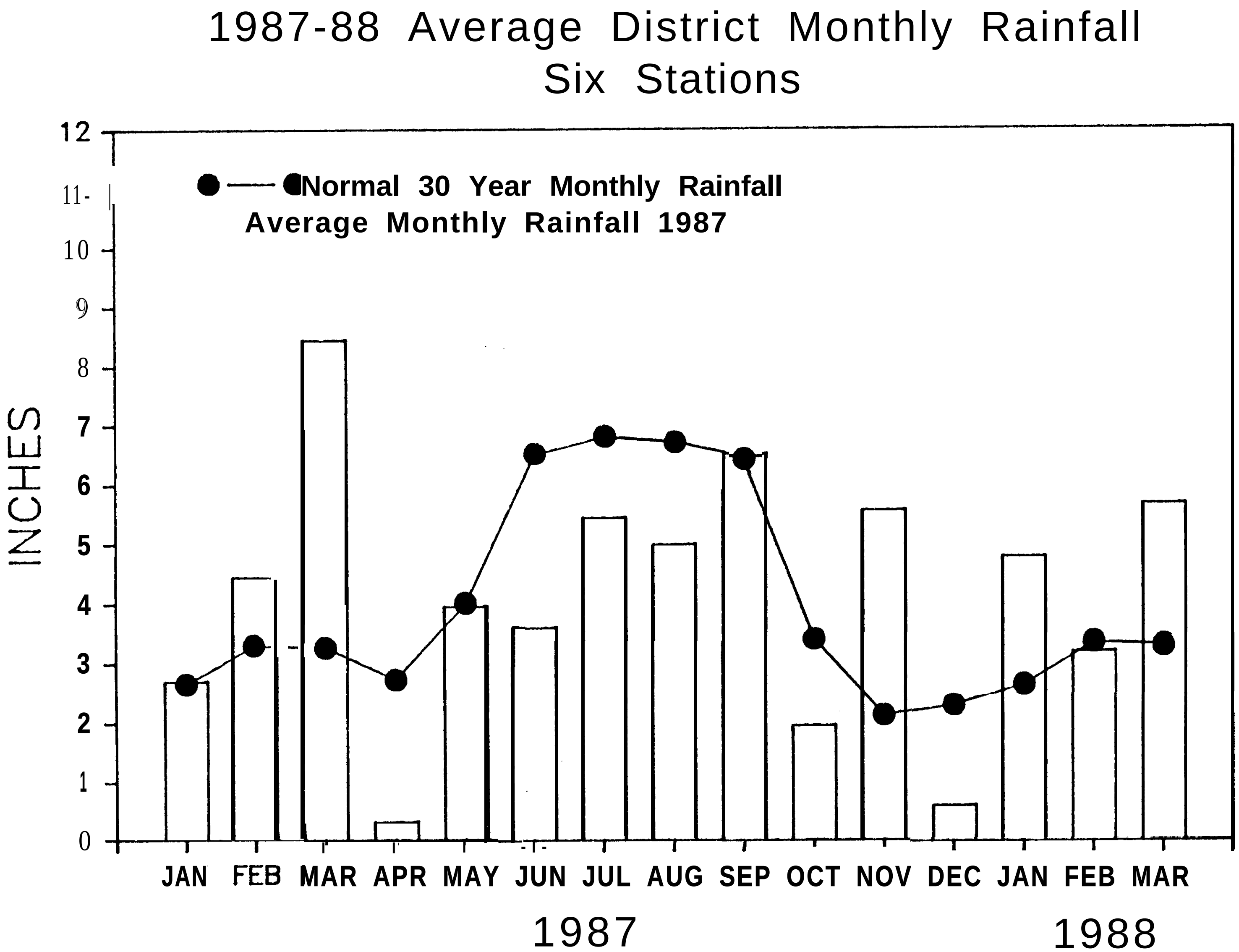


Figure 1. St. Johns Water Management District, District Wide Average Monthly and 1987-88 Monthly Rainfalls.

B. METHODS

1. Sampling

Of the three samplings performed, the initial two consisted of a suite of thirty (30) stations from Mayport to Palatka, a distance of some seventy-five river miles. Each station was visited twice, during the nominal dry and wet seasons of 1987 (May and September, respectively). Stations were selected in the river near the mouths of various tributaries and other locations where non-point discharges or other sources were likely to have had sustained impacts. In addition to focusing on possible non-point sources, locations were also selected based on proximity to known discharges, and to areas being sampled under other UDS programs, specifically those reaches of the river where ichthyofauna were being collected. Repeated sampling of the same locations was expected to provide some measure of temporal variability. Field efforts were conducted on May 5, 6 and 7, 1987 and on September 21, 22, and 23, 1987 by Mote Marine personnel, Ms. Sue Hofmann and Mr. Jay Sprinkel. They were accompanied on May 5 by Dr. Gary Rodrick, Co-PI for microbiological analyses, and on May 6 by Mr. Nick Bruno, FDER, who was observing the field work as FDER's quality assurance representative.

A contract addendum subsequently permitted a third sampling to be conducted during 1988 and at that time the geographic scope of the study was expanded to include roughly 110 miles of the St. Johns River with stations as far up-river as the southern end of Lake George. Areas previously shown to be relatively uncontaminated (near the mouth of the river) were not resampled, and new stations were selected to provide more detailed information on individual tributary inputs by locating most stations outside of the main river channel in more depositional environments. This approach was also expected to quantify areas of relatively higher habitat value for many fish species and one station was situated just north of the Arlington River where local populace and other investigators had recently reported diseased fish (Mr. Dave Snyder, Mr. George Burgess, personal communications).

Thirty-one (31) stations were sampled during this final effort on March 21-24, 1988, of which only three (the mouth of the Trout River, the confluence of Ortega and Cedar Rivers, and upper Julington Creek) had been sampled previously. Other than station locations, however, procedures, personnel, and data collection efforts were identical for all three efforts.

Station locations for all samplings appear in Figures 2 and 3 and Table 1 lists latitude and longitude for each in degrees, minutes, and decimal seconds. Seconds have been calculated and reported to tenths for compatibility with the STORET and other data systems, however, accuracy of these measurements, as estimated from National Oceanic and Atmospheric Administration navigation charts, is approximately +/- 5 seconds at open water stations, and +/- 1 second in restricted areas.

In situ water column determinations included temperature, conductivity, pH, dissolved oxygen (DO), and Secchi depths. Measurements were made at near-surface (upper 25 cm) and near-bottom. Mid-depth measurements were included when overall depth exceeded 3 meters. Calculated salinities were obtained from these data. In situ data were gathered at each station visit.

During each sampling, sediments were collected at all stations. Subsequent to water column measurements and any collection of aqueous microbiological samples, a minimum of three petite ponar grabs were secured at each site. Sediments were deposited in polyethylene trays and the top 5 cm of intact sediment was subsampled with a non-contaminating scoop and placed in polyethylene jars. Acid washed plastic utensils were used to transfer sediments for nutrients, carbon, grain size and metals analyses. Three separate sample containers were collected for these parameters at each site, each container filled from a separate ponar grab in order to provide statistical estimates of the variability associated with each station. Samples were immediately placed and maintained on ice until their receipt at Mote Marine Laboratory and secure storage at 4°C.

Three replicates from each station were analyzed for percent moisture, total Kjeldahl nitrogen, and total phosphorus. Field moist samples were processed for each of these parameters within one week. The dried aliquot from the percent moisture determination was subsequently ground and used for carbon and metals analyses while the remainder of the

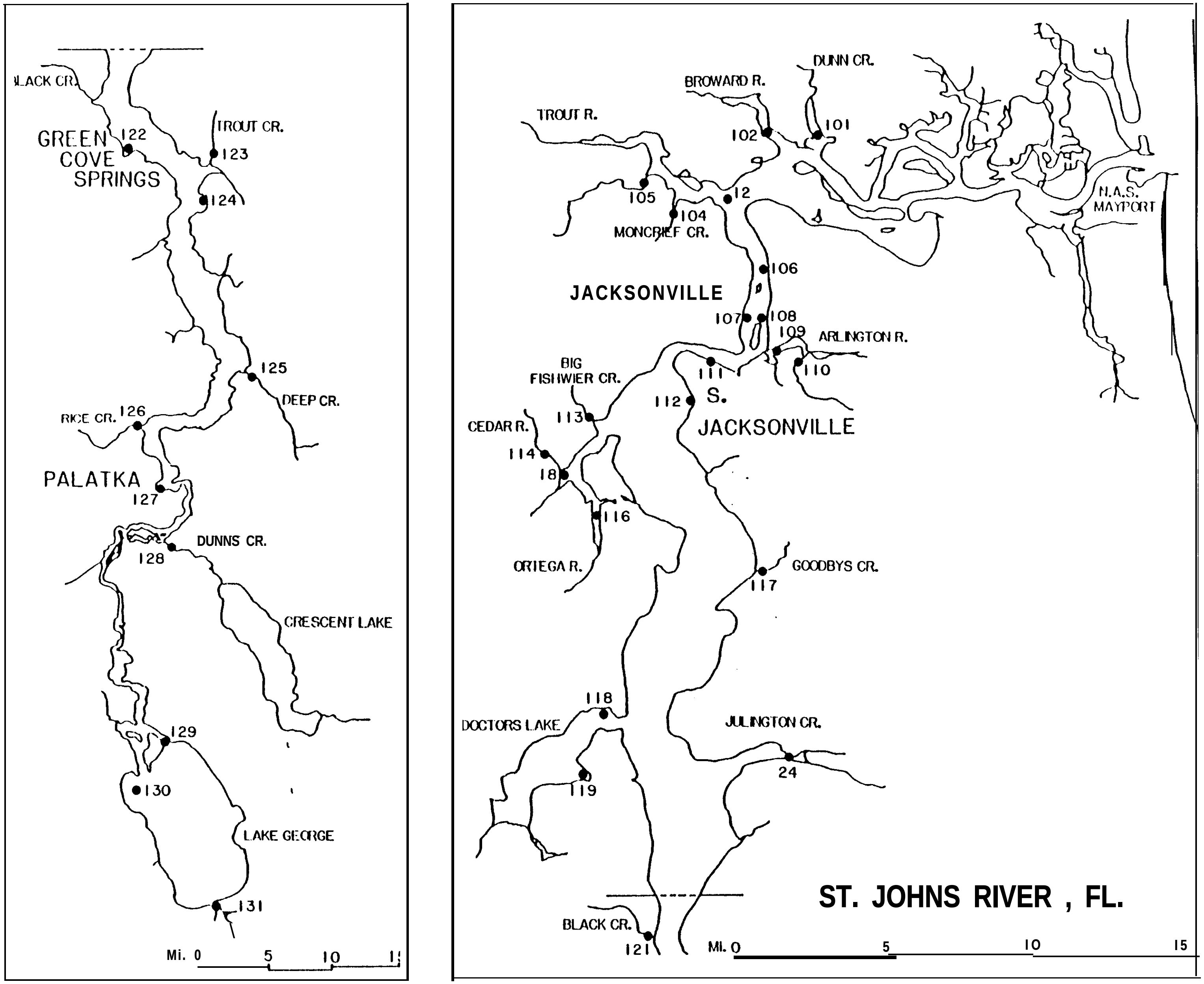


Figure 3. Sampling Locations, St. Johns.River, March 1988.

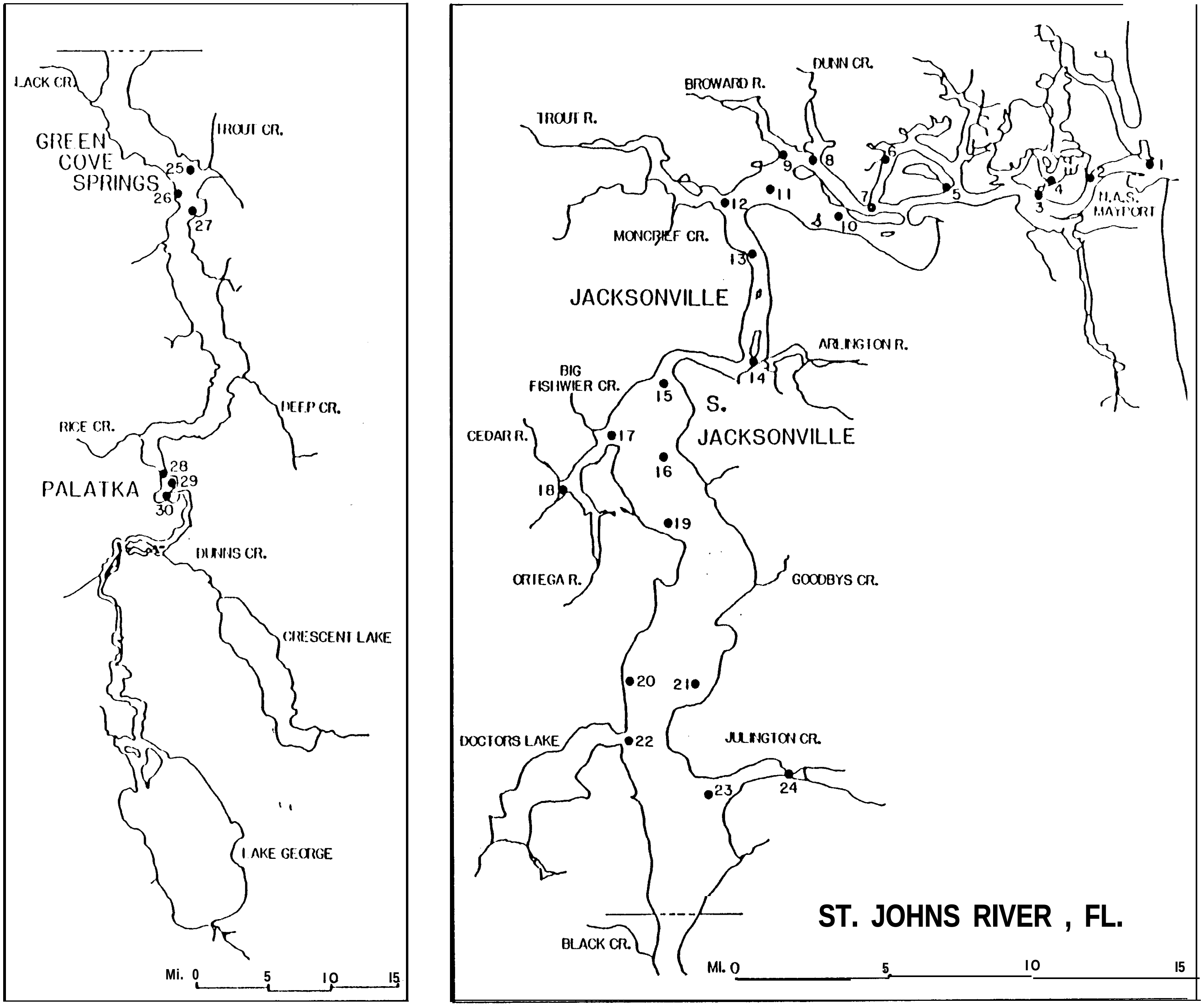


Figure 2. Sampling Locations, St. Johns River, May and September, 1987.

Table 1. Latitude and longitude of station locations, St. Johns River, 1987-88. Units are degrees, minutes, and decimal seconds.

Station	Latitude	Longitude
1	302407.9	812412.1
2	302411.8	812541.2
3	302326.8	812758.9
4	302342.1	812729.8
5	302335.9	813047.2
6	302422.8	813254.7
7	302301.0	813318.5
8	302435.5	813510.2
9	302446.6	813600.8
10	302308.5	813441.5
11	302405.2	813623.8
12	302317.0	813758.9
13	302215.3	813704.5
14	301912.1	813710.2
15	301827.4	814002.3
16	301624.5	814021.9
17	301709.1	814214.3
18	301553.8	814338.9
19	301449.6	814017.9
20	301031.9	814133.8
21	301023.4	814144.9
22	300856.1	813907.1
23	300717.0	813612.2
24	300749.6	813618.6
24	300748.3	813500.0
25	295817.6	813500.0
26	295734.6	813624.8
27	295620.9	813506.7
28	293950.2	813738.2
29	293911.8	813644.0
30	293812.0	813723.3

Table 1. Continued. Latitude and longitude of station locations, St. Johns River, 1987-88. Units are degrees, minutes, and decimal seconds.

Station	Latitude	Longitude
101	302507.3	813458.5
102	302505.9	813626.4
104	302327.0	813943.0
105	302411.9	814036.2
106	302147.8	813647.9
107	302004.9	813736.2
108	302010.2	813649.8
109	301902.0	813644.5
110	301847.5	813543.0
111	301850.8	813826.4
112	301742.9	813917.4
113	301713.0	814232.1
114	301627.4	814357.9
116	301452.8	814230.7
117	301254.1	813717.1
118	300919.6	814233.7
119	300723.5	814302.9
121	300234.6	814236.6
122	295922.8	814016.8
123	295857.4	813359.3
124	295637.2	813427.8
125	294533.9	813145.3
126	294205.2	813859.3
127	293758.7	813756.5
128	293436.5	813723.7
129	292216.9	823728.8
130	291937.1	824003.1
131	291208.1	823417.1

moist sample was frozen until grain size and mercury analyses could be performed.

2. Analytical Methods

Analyses of metals - aluminum, cadmium, copper, lead, mercury and zinc - were only performed on samples from selected stations and again each of the three replicates was separately analyzed to assess station variability. During 1987, fifteen (15) of the thirty stations were so treated and during 1988, sixteen (16) of thirty-one stations were analyzed for metals. The stations analyzed were selected to include the ten stations where microbiological data were collected as well as five or six others to increase spatial coverage, where nitrogen and phosphorus results indicated anomalous conditions, or where water quality problems or industrial discharges had been previously identified.

Analytical procedures employed for total Kjeldahl nitrogen and total phosphorus were from R. H. Plumb, 1981, Procedures for Handling and Chemical Analyses of Sediment and Water Samples, EPA/CE-81-1. Kjeldahl digestion in a block digestor of 0.5-2.0 g of field moist sediment was followed by automated dilution and calorimetric determination of resultant ammonia and ortho-phosphorus via a Technicon AutoAnalyzer II. Samples were quantified against known standards similarly digested and standards were included within each digestion group. The resultant nitrogen and phosphorus concentrations were converted to a dry weight basis using percent moisture values and digested sample weights. Samples were processed within the one week holding time recommended for total Kjeldahl nitrogen in sediments.

Percent moisture was also determined according to the above reference. Samples were dried to a constant weight (weight change of less than 0.5% between subsequent weighings) at 103-105°C. This dried material was subsequently ground and utilized in total organic carbon (TOC) analyses. Although oven drying of samples may result in low TOC values due to the oxidation or volatilization of extremely labile compounds, this method is preferable given the small sample size (0.02 g or less) required for infrared analysis and the varied salt content possible in samples from an estuarine environment.

Total organic carbon was determined after the method of Mills and Quinn (1979) in which 0.01-0.02 g of dried ground sediment is placed in a precombusted ampule and inorganic carbonates are removed with phosphoric acid. After addition of a potassium-persulfate digestion solution, ampules are sparged with oxygen to remove atmospheric and dissolved carbon dioxide, then sealed and digested by autoclaving. Samples were quantified against known standards similarly digested. Instrumental analysis was carried out on an OI TOC Analyzer, calibrated against a certified standard gas mixture, using the infrared detection of carbon dioxide produced from the oxidation of organic carbon compounds in the sample. As a minimum, all samples were processed in duplicate.

Grain size distributions were determined according to the procedures and equations of Folk (1974). Sediments were wet sieved to remove the bulk of the silt-clay size fraction (<0.063 mm in diameter). The coarse and fine fractions were then dried, the coarser disaggregated if necessary and then mechanically sieved through Wentworth whole phi ($-\log_2$ (particle diameter in mm)) intervals or mesh sizes of 2.0, 1.0, 0.5, 0.25, 0.125, and 0.063 mm. The two fractions less than 0.063 mm in diameter were recombined to obtain a total percent silt-clay fraction for the sample. The other fractions were also weighed, individual and cumulative percents determined, and descriptive characteristics such as mean and median grain size, and distribution statistics such as skewness, kurtosis, and sorting coefficient calculated.

Samples for mercury analysis were thawed at room temperature and moist sample aliquots were subjected to an acid-permanganate digestion according to EPA/CE-81-1. Digestion was followed by a cold vapor atomic absorption analysis and samples were quantified against known standards similarly digested. Mercury on a dry weight basis was obtained using the percent moisture values previously determined. The remaining metals, aluminum, cadmium, copper, lead, and zinc were determined by atomic absorption analysis of a $HF-HNO_3-HClO_4$ acid digest of 0.5-1.0 g of dried sediment. This procedure is detailed in the Deepwater Ports Maintenance Dredging and Disposal Manual, FDER.

C. RESULTS

1. In Situ Data

In situ data collected during May and September, 1987, and March, 1988, samplings appear in Appendix A. It should be pointed out that sampling took place over a three to four day period and that *in situ* observations represent neither tidally filtered nor synoptic data. This is particularly apparent when examining salinity data.

During May, 1987, the upstream stations were collected across the time of a predicted low tide, and the fourteen stations at the mouth of the river were sampled across a rising tide, although not necessarily in sequential order. (Collection schedules were modified to allow the most rapid transport of samples for microbiological analyses.) The remaining stations in the central section of the river, from the Arlington River to Julington Creek, were also collected across a predicted low. Within this framework, salinities during this collection effort ranged from 35 to < 1 o/oo and general ranges are depicted in Figure 4. A salt wedge was apparent, particularly between the Trout and Ortega Rivers and saline conditions were essentially absent upstream of the entrance to Doctors Lake. Temperatures between 19°C and 25°C were recorded, the cooler temperatures being observed downstream.

Sampling during May was also conducted between approximately 0700 and 1600 hours EST and at these times, no dissolved oxygen violations were observed. The lowest DOs recorded were between 5 and 6 mg/l and were found at Nichol's Creek, the Broward River, and slightly upstream in Julington Creek (Stations 6, 9, and 24). The average DO gradient was -0.5 mg/l from surface to bottom. Values of pH ranged between 7.40 and 8.26 SU, upstream in Julington Creek and the Ortega River respectively, with the majority of stations falling between 7.90 and 8.10 SU. Secchi depths were typically less than 1.0 m, and were only 0.6 m at Stations 10 and 18, behind Quarantine Island and in the Ortega River.

In situ conditions in the St. Johns River were not drastically different during the September field effort. Although salinities were as much as 9 o/oo higher than during May at a few stations, this fact is difficult to interpret meaningfully in light of differing hydrologic

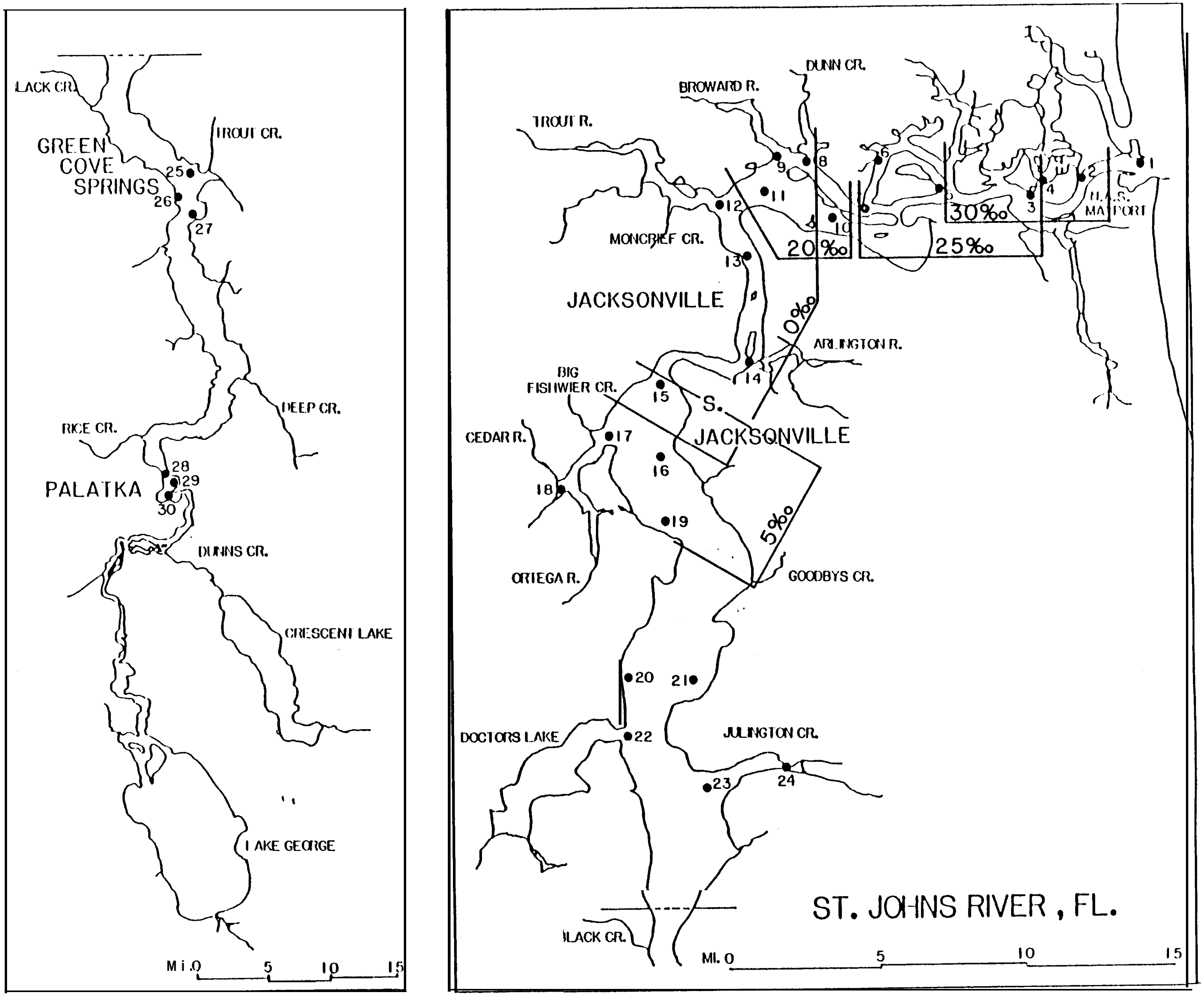


Figure 4. Approximate Salinity Regime, May 1987.

conditions between samplings, predicted tidal heights averaging approximately 2.0 ft higher during September, and the differing tidal phases sampled.

During September, upstream stations were collected across the time of a predicted high tide, in direct contrast to May. The area from Mayport to the Arlington River was sampled across a falling and predicted low tide, and stations in the central section of the river were visited across a predicted high tide. The salt wedge was not as pronounced under these conditions and extended from Blount Island to the Arlington River. Temperatures overall were approximately 5°C warmer, ranging from 27 to over 30°C. Surface to bottom gradients in temperature, averaging 0.4°C during May, were essentially absent during this sampling.

September field efforts were also conducted between 0700 and 1600 EST, and DO concentrations averaged 1.0 mg/l lower than May during this sampling. No values below 4.0 mg/l were recorded, however, but mid-morning concentrations between 4.0 and 5.0 mg/l were observed from Dunn Creek to south of Hendricks Point (Stations 8-15), as well as at the confluence of the Ortega and Cedar Rivers (Station 18). A large portion of these depressed levels, however, is attributable to thermodynamic considerations (warmer, more saline conditions), as percent saturations of DO were comparable between these samplings, averaging 84% in May and 81% in September. Surface to bottom DO gradients were comparable to May data and again averaged about 0.5 mg/l lower at the bottom of the water column. Values of pH ranged over a broader interval, 7.20-8.20 SU, with highest values observed at the Palatka stations. Transparencies, as measured by Secchi depths, were higher overall during September, with half of the stations above 1.0 m. Secchi depths of only 0.5 meters, however, were recorded at Stations 10, 18, and 21.

A direct comparison of salinity during the March, 1988, sampling with the previous work is misleading even with reference to river miles and the upstream shift of all stations. Stations during this effort were positioned to selectively emphasize tributary inputs and were, therefore, located outside of the main channel in areas were salinities were expected to be reduced even under identical hydrological conditions. In addition, as previously stated, no tidal filters were imposed as the major purpose of the study was to examine sediments for chronic impacts.

Those stations in the lower river, however, which were resampled (Stations 12 and 18) both exhibited substantially lower salinities during March, 1988, than during prior visits. Although the hours of this sampling were generally across predicted high tides, the highest salinity observed was only 2.6 °/oo, located in the Ribault River. This may indicate that precipitation observed on the river during this sampling was part of a basin-wide phenomena, and consistent with the high monthly rainfall totals recorded. Surface to bottom salinity gradients were negligible in all areas, averaging less than 1 °/00 at all stations.

Water column temperatures during March, 1988, were the coldest of the three episodes, averaging near 16°C. The lowest value recorded was 13.48°C at the bottom of the Deep Creek station (Station 105) and the thermal gradient at this location was over 5°C in a depth of 3.5 meters. Values of pH ranged from 6.09 to 8.32 SU with the lowest value occurring in Black Creek. Averages near 7.40 SU were obtained for this suite of stations and no particular spatial pattern was apparent in the data.

Dissolved oxygen concentrations in March were higher than previously seen, between 5.2 and 11.6 mg/l, due in part to decreased water temperatures, and no violations of state criteria were observed. Average DO concentration of the tributaries sampled was near 9 mg/l. Surface to bottom gradients were typically absent. The lowest value observed, 5.2 mg/l, was at the bottom of the water column in Trout Creek, Station 123. Percent saturations averaging near 93% also indicated that oxygen demands in the river were lower at this time than previously observed.

Transparency of the water column was markedly lower in the tributaries than in the areas sampled during 1987. Some portion of this reduction in clarity may be attributable to the high rainfall and presumed increase in flows and suspended solids during this month. Secchi depths in March ranged only between 0.2 and 0.8 m, averaging 0.5 m. The most turbid waters were observed at Rice Creek, just west of the Talleyrand area, and at the confluence of the Ortega and Cedar Rivers (Stations 126, 107, and 18).

2. Sediment Characterization

Sediment appearance varied widely between stations, ranging from a gelatinous, highly organic mousse, to a relatively coarse shell hash. A light colored and clayey material was observed at some stations. At some locations, samplers recorded evidence of scour based on texture of bottom sediments. The majority of sediments collected, however, were fine textured and dark in color, high in percent moisture, and occasionally containing substantial components of recent shell fragments.

a. Grain Size

Sediment statistics calculated included mean and median particle size, inclusive graphic standard deviation or sorting coefficient, inclusive graphic skewness and kurtosis. Mean, median, and sorting coefficient are in units of phi, [$-\log_2$(particle diameter in mm)]. The remaining descriptors are unitless. (Table 2 provides corresponding mm diameters for the listed whole phi sizes.) Agreement between the three values for station replicates was typically good and visual examination of those sample sets with larger than normal variability generally revealed discrepancies in the shell content of the individual containers. Due to the sensitivity of grain size statistics to shell fragments, attempted particle size normalization techniques preferentially employed percent silt-clay as it appeared to be a more robust measure of sediment size.

The results of all grain size and percent moisture determinations by date appear in Appendix A and Table 3 summarizes study means by station. The overall fine texture is apparent and differences detectable between the 1987 and 1988 station suites. The median grain size averaged 2.87 phi for the 1987 sampling. The 1988 samples, however, with emphasis on tributary locations, averaged 3.28 phi for a median grain size, an indication of a more depositional environment in these stations. Individual replicates processed during all samplings of this study included median sizes from 0.19 to 4.39 phi.

Mean and median particle sizes need no further explanation. Sorting coefficients are a measure of the standard deviation associated with the distribution of particle size, or a measure of the uniformity of

Table 2. Comparison of particle diameter (mm) and corresponding phi value.

mm	phi*
2.0	-1
1.0	0.0
0.5	1.0
0.25	2.0
0.125	3.0
0.063	4.0
<0.063	>4.0

*phi = $-\log_2$ (diameter, mm)

Table 3. Physical sediment descriptors, St. Johns River 1987-88. Study means andstandard deviations by station.

		Percent Moisture %		Median Grain Size phi		Mean Grain Size phi		sorting Co-efficient		Skewness		Kurtosis		Percent Silt Clay %	
Sta	N	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.
1	6	20.51	1.40	2.11	0.52	1.60	0.48	1.66	0.27	-0.43	0.17	1.51	0.88	0.20	0.09
2	6	22.68	0.62	2.34	0.13	2.16	0.24	0.90	0.20	-0.40	0.13	1.54	0.29	0.18	0.16
3	6	39.16	3.52	3.19	0.20	3.18	0.11	0.81	0.04	0.05	0.16	0.94	0.08	15.03	3.04
4	6	39.77	13.32	2.85	0.65	2.48	1.01	1.61	0.40	-0.35	0.15	1.00	0.29	18.43	17.14
5	6	24.36	2.73	2.47	0.05	2.46	0.07	0.57	0.05	-0.04	0.11	1.44	0.24	2.48	1.83
6	6	38.19	12.24	2.74	0.21	2.81	0.27	0.71	0.21	0.18	0.10	1.13	0.25	9.75	7.20
7	6	38.33	4.93	2.44	0.38	2.55	0.48	1.15	0.45	0.18	0.17	1.09	0.19	14.28	7.80
a	6	30.63	6.70	2.57	0.27	2.49	0.27	1.10	0.43	-0.21	0.23	1.97	0.83	7.23	5.22
9	6	67.64	2.60	3.35	0.28	3.36	0.13	1.21	0.09	-0.14	0.20	1.00	0.16	34.78	4.10
10	6	41.41	5.02	2.77	0.12	2.90	0.11	0.78	0.08	0.28	0.14	1.12	0.22	10.70	3.91
11	6	65.04	1.50	3.33	0.48	3.23	0.47	1.18	0.21	-0.26	0.12	1.48	0.12	26.12	10.00
12	9	68.60	2.43	3.64	0.19	3.48	0.31	1.18	0.27	-0.29	0.08	1.13	0.13	36.70	5.92
13	6	41.11	1.40	2.74	0.08	2.91	0.10	0.79	0.08	0.37	0.02	1.03	0.13	12.02	4.03
14	6	43.62	4.58	2.79	0.07	2.95	0.06	0.83	0.05	0.32	0.06	0.98	0.09	12.98	1.99
15	6	24.91	1.63	2.51	0.27	2.06	0.72	1.27	0.65	-0.30	0.32	1.37	0.98	2.45	1.97
16	6	79.05	8.61	3.47	0.93	3.30	0.69	1.36	0.32	-0.31	0.37	1.06	0.39	48.58	20.28
17	6	74.45	1.10	3.00	0.24	2.78	0.35	1.68	0.30	-0.25	0.07	1.02	0.25	27.85	4.83
18	9	82.19	2.50	4.00	0.47	3.48	0.38	1.43	0.29	-0.56	0.21	1.20	0.67	60.89	14.29
19	6	72.95	5.49	3.71	0.68	3.35	0.74	1.47	0.50	-0.46	0.15	1.18	0.54	53.35	20.27
20	6	85.31	0.65	2.91	1.02	2.87	0.60	1.50	0.24	-0.10	0.38	0.68	0.05	37.72	12.15
21	6	84.55	1.45	2.92	1.30	2.72	0.87	1.80	0.49	-0.27	0.33	0.69	0.12	43.27	7.20
22	6	31.55	1.85	2.50	0.01	2.49	0.01	0.56	0.02	-0.01	0.02	1.47	0.03	1.93	0.40
23	6	85.47	0.86	3.57	0.46	3.01	0.27	1.74	0.27	-0.46	0.21	0.70	0.06	44.47	6.05
24	9	89.39	0.79	2.75	0.36	2.74	0.24	1.58	0.18	-0.07	0.16	0.73	0.05	30.93	6.29
25	6	49.43	6.75	2.52	0.17	2.42	0.52	1.20	0.43	0.00	0.38	1.95	0.90	9.93	2.63
26	6	55.57	20.61	2.88	0.16	2.87	0.15	0.91	0.30	0.02	0.21	0.90	0.12	8.52	5.29
27	6	87.65	1.20	2.44	1.52	2.44	1.10	1.83	0.69	-0.09	0.32	0.66	0.13	35.53	6.99
28	6	88.13	2.32	2.66	0.20	2.71	0.25	1.42	0.24	-0.02	0.09	1.05	0.15	19.48	3.00
29	6	87.87	1.20	2.31	0.62	2.22	0.40	1.77	0.38	-0.06	0.28	0.86	0.11	21.65	10.83
30	6	59.44	9.37	2.67	0.14	2.73	0.17	0.79	0.10	0.08	0.05	1.40	0.28	6.53	2.31

Table 3. Continued.

Sta	N	Percent Moisture %		Median Grain Size phi		Mean Grain Size phi		sorting Co-efficient		Skewness		Kurtosis		Percent Silt Clay %	
		$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.
101	3	55.98	6.05	3.07	0.10	3.24	0.08	1.06	0.06	0.15	0.07	0.79	0.05	29.27	5.82
102	3	30.11	0.55	3.16	0.26	3.09	0.18	0.71	0.05	-0.21	0.20	1.05	0.29	4.40	0.92
104	3	79.71	0.39	4.30	0.02	3.98	0.09	0.98	0.14	-0.57	0.04	1.43	0.12	72.00	2.26
105	3	65.82	12.75	3.88	0.46	3.71	0.35	1.05	0.16	-0.36	0.20	0.96	0.18	50.77	14.26
106	3	33.66	0.64	2.56	0.03	2.57	0.03	0.49	0.02	0.22	0.01	1.27	0.04	3.87	0.35
107	3	61.89	1.58	3.62	0.06	3.60	0.11	0.89	0.08	-0.07	0.04	0.87	0.12	34.63	1.12
108	3	41.16	2.44	3.25	0.30	3.27	0.27	0.67	0.20	0.15	0.08	0.96	0.13	13.67	0.64
109	3	76.05	2.57	3.71	0.18	3.47	0.12	1.25	0.11	-0.35	0.09	0.87	0.03	43.87	4.15
110	3	39.71	3.67	2.70	0.04	2.83	0.04	0.68	0.05	0.33	0.03	1.04	0.11	6.73	1.79
111	3	39.03	2.12	2.95	0.49	3.06	0.39	0.88	0.35	0.06	0.28	1.87	0.77	9.83	1.70
112	3	35.00	2.03	2.59	0.02	2.67	0.03	0.64	0.04	0.28	0.04	1.44	0.16	6.37	1.16
113	3	80.51	1.85	4.29	0.03	4.14	0.02	0.78	0.07	-0.44	0.02	1.36	0.19	70.60	2.16
114	3	78.34	0.90	4.34	0.04	4.07	0.15	0.89	0.16	-0.54	0.06	1.64	0.26	75.87	4.75
116	3	79.64	2.22	3.47	0.05	3.15	0.03	1.46	0.06	-0.33	0.06	0.68	0.01	41.37	3.21
117	3	75.13	2.11	3.04	0.06	3.20	0.07	1.06	0.09	0.16	0.07	0.78	0.06	27.63	1.07
118	3	82.36	1.84	3.62	0.44	3.20	0.19	1.49	0.08	-0.41	0.21	0.68	0.02	45.43	5.68
119	3	79.77	3.49	2.96	0.08	2.99	0.06	1.23	0.16	-0.02	0.11	0.95	0.05	21.77	3.08
121	3	81.97	0.81	3.27	0.29	3.17	0.25	1.41	0.26	-0.22	0.04	0.88	0.18	35.60	4.29
122	3	86.12	1.17	4.02	0.13	3.67	0.06	1.12	0.05	-0.47	0.10	0.79	0.01	52.53	5.25
123	3	85.07	4.77	2.79	0.05	2.88	0.15	1.31	0.21	0.02	0.13	0.95	0.18	22.33	5.10
124	3	72.17	2.05	3.61	0.02	3.57	0.03	0.92	0.04	-0.08	0.01	0.82	0.12	35.47	2.22
125	3	89.38	1.03	3.95	0.23	3.63	0.26	1.15	0.27	-0.44	0.13	0.99	0.27	51.47	10.19
126	3	89.93	0.72	2.67	0.36	2.42	0.48	1.68	0.40	-0.20	0.28	0.96	0.08	16.97	3.72
127	3	90.85	0.54	3.88	0.17	3.60	0.27	1.12	0.22	-0.38	0.07	0.82	0.11	47.57	4.97
128	3	28.49	1.01	2.57	0.01	2.57	0.01	0.44	0.02	0.17	0.00	1.12	0.02	0.40	0.17
129	3	26.14	0.34	2.49	0.01	2.49	0.01	0.40	0.02	-0.11	0.04	0.99	0.04	0.57	0.15
130	3	61.55	4.95	2.20	0.02	2.13	0.06	1.14	0.06	-0.06	0.06	1.29	0.03	7.97	1.40
131	3	27.47	1.07	2.52	0.02	2.52	0.02	0.44	0.01	0.11	0.05	1.11	0.02	0.87	0.21

the sediment. Values below 0.5 are very well sorted. Above 1.00 is a poorly sorted sediment. The majority of sediments analyzed from the St. Johns River were poorly sorted, with an average sorting coefficient of 1.15 phi. Skewness is a measure of the asymmetry of particle size distribution or a measure of the displacement of the median from the mean. Symmetrical curves have a skewness of 0.00, and those with excess fine material have negative values. The average skewness for the St. Johns samples was -0.13.

Kurtosis is a measure of the peakedness of the distribution curve or the ratio of sorting in the "tails" of the curve to the sorting in the central portion. Normal distributions have kurtosis values of 0.00; if the curve is flattened from normal or platykurtic, kurtosis is less than 0.00. Leptokurtic distributions are greater than 0.00 and indicate an excessively peaked distribution, with the central portions better sorted than the tails. Mean kurtosis values for this study were 1.11.

Of the all samples processed, silt-clay content was evenly distributed, with the majority of samples between 5 and 40% and a mean of near 25%. The maximum percentage of fine sediment (less than 0.063 mm in diameter) was observed at Station 114 in the Cedar River where over 75% of the sample by dry weight was the silt-clay fraction. Other stations noted for fines were 104, 113, 18, 19, 122, 125, and 105, all containing over 50% fine sediment.

Prior reports on the 1987 samplings noted the apparent spatial relationship of increasing percent silt-clay with distance of the station from the mouth of the river together with the assumption that this was likely an artifactual result of station selection. As current structure and the resulting micro-depositional and micro-erosional environments actually sampled would be expected to provide the overriding controls to grain size distribution, and as these were not considered during station selection, it was unlikely that spatial patterns observed could have any meaning. This was confirmed with the subsequent data set, where, with the addition of the tributary stations, no spatial pattern with river mile was apparent.

b. Total Organic Carbon

Organic carbon from all samplings ranged from 0.3 to over 150 mg/g of dry sediment and the higher concentrations were typically observed upriver. This distribution was evident in all data sets and does not appear to be totally artifactual as it is present even after normalization of values for percent silt-clay. From this it is apparent that a larger fraction of the fine sediments were comprised of organic materials at the upstream stations. Other points emerging from this data include the extremely high levels of TOC present in the sediments of Rice Creek (Station 126), over 50% greater than the next highest station. Individual station values by sampling date appear in Appendix A and Table 4 lists study means.

Regression of station means of percent silt-clay against TOC for the study as a whole produced significant correlations with power equations giving best agreements (r=0.9034, n=58). Stations outside the 95% confidence interval for the resulting relationship were Stations 5 and 3, the eastern end of Blount Island, and the confluence of Sisters Creek. In contrast to the remainder of the river, organic carbon was lower at these stations than expected, based on measured silt-clay content. Rice Creek, on the other hand, represents an area with comparably elevated levels of carbon.

The results from the regression of TOC and percent silt-clay data from individual samplings have all been significant , and each has identified different areas with correspondingly greater or lesser proportions of carbon in relation to amount of fines present. This individual analysis, however, is subject to the maximum skewing introduced by station location itself. Analysis of study means, broadens the geographical base and concentration range of the data, permitting detection of stations non-representative of the river as a whole, although this data treatment is insensitive to temporal trends.

Temporal trends of bulk carbon concentrations, in view of the differing depositional environments encountered at even the same station are not extremely useful. Carbon-nitrogen ratios, however, would be expected to provide a more accurate indication of trends at a particular location. Carbon:Nitrogen ratios averaged 10.1:1 on a weight:weight

Table 4. Study means and standard deviations by station of sediment carbon, nitrogen, and phosphorus concentrations. St. Johns River, 1987-1988. Units are per dry weight of sediment.

		Total Organic Carbon mg/g		Total Kjeldahl Nitrogen mg/g		Total Phosphorus mg/g	
Sta.	n	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
1	6	0.5	0.1	0.06	0.02	0.54	0.09
2	6	0.4	0.1	0.02	0.01	0.43	0.12
3	6	5.8	0.9	0.67	0.12	0.83	0.11
4	6	11.2	9.6	1.29	1.49	0.56	0.40
5	6	0.6	0.4	0.04	0.03	0.15	0.06
6	6	6.7	4.4	0.67	0.50	0.30	0.16
7	6	10.3	6.4	0.83	0.43	0.27	0.09
8	6	3.9	3.4	0.31	0.32	0.13	0.10
9	6	34.7	5.7	3.33	0.34	0.79	0.09
10	6	15.4	5.3	0.99	0.32	0.38	0.15
11	6	29.8	3.2	2.70	0.26	0.96	0.10
12	9	35.6	5.9	3.37	0.72	1.02	0.20
13	6	12.4	5.7	0.92	0.11	0.32	0.03
14	6	21.1	4.6	1.04	0.18	0.33	0.04
15	6	1.8	0.8	0.12	0.04	0.22	0.12
16	6	61.2	26.6	7.08	3.66	0.86	0.38
17	6	41.8	4.2	4.74	0.42	0.62	0.04
18	9	72.6	13.4	8.87	1.07	1.70	0.22
19	6	42.4	10.0	4.63	1.28	0.66	0.20
20	6	64.4	13.3	9.37	0.55	1.08	0.08
21	6	59.8	14.0	8.94	0.85	1.08	0.18
22	6	6.1	1.4	0.54	0.10	0.09	0.02
23	6	70.1	14.7	11.02	0.59	1.03	0.05
24	9	80.3	15.5	15.91	1.62	1.27	0.20
25	6	19.2	4.3	1.51	0.35	0.26	0.07
26	6	26.4	19.5	3.19	2.65	0.32	0.21
27	6	78.7	12.6	12.57	1.35	1.12	0.14
28	6	54.1	6.0	13.91	1.83	0.66	0.38
29	6	69.4	5.4	12.84	1.37	1.18	0.08
30	6	22.8	3.9	3.08	1.06	0.49	0.14
101	3	20.8	6.9	1.57	0.32	0.63	0.27
102	3	2.9	0.9	0.38	0.07	0.13	0.03
104	3	64.9	4.8	5.85	0.15	1.34	0.03
105	3	44.6	5.2	3.64	1.16	0.71	0.25
106	3	5.3	0.5	0.57	0.06	0.15	0.00
107	3	22.4	2.4	2.55	0.17	0.81	0.02
108	3	9.7	1.8	0.93	0.08	0.37	0.01
109	3	68.7	6.7	5.17	0.40	0.85	0.07
110	3	11.2	3.6	1.08	0.23	0.23	0.03
111	3	12.3	3.0	0.95	0.15	0.42	0.06

Table 4. Continued. Study means and standard deviations by station of sediment carbon, nitrogen, and phosphorus concentrations. St. Johns River, 1987-1988. Units are per dry weight of sediment.

		Total Organic Carbon mg/g		Total Kjeldahl Nitrogen mg/g		Total Phosphorus mg/g	
Sta.	n	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
112	3	10.2	1.3	0.80	0.13	0.16	0.04
113	3	82.6	3.5	7.65	0.47	1.17	0.09
114	3	82.2	11.6	6.00	0.30	1.92	0.11
116	3	77.9	13.4	7.75	0.93	1.08	0.12
117	3	54.4	11.5	5.70	0.48	0.71	0.05
118	3	64.7	3.4	8.72	1.15	1.00	0.08
119	3	52.4	2.2	7.47	1.31	0.69	0.12
121	3	67.7	9.2	7.39	1.20	1.04	0.23
122	3	71.2	9.1	11.12	0.53	1.05	0.10
123	3	79.7	29.6	10.59	3.68	0.92	0.37
124	3	32.1	12.7	4.61	0.63	0.51	0.07
125	3	82.5	4.2	14.37	0.48	1.46	0.16
126	3	159.7	14.6	13.96	1.24	2.48	0.11
127	3	99.1	7.2	18.39	0.97	1.57	0.43
128	3	1.4	0.1	0.24	0.08	0.06	0.02
129	3	1.8	0.2	0.26	0.03	0.07	0.01
130	3	24.9	6.2	3.29	0.36	0.34	0.05
131	3	2.0	0.2	0.37	0.10	0.10	0.02

basis (11.8:1 ugat:ugat) and ranged from 3.0:1 to 30.0:1 (weight:weight). A consistent decrease in ratio with distance upstream was also noted.

Between May and September, 1987, only six stations exhibited statistically significant changes in C:N ratios. Stations 11 and 21 decreased and Stations 2, 18, 20, and 30 increased. Not all changes in the ratios were produced by similar changes of either carbon or nitrogen concentrations and in the light of the mixed direction of change it is difficult to ascribe changing ratios to purely seasonal influences.

Examination of C:N ratios at the three stations sampled during all three episodes, Stations 12, 18 and 24, provided an even less conclusive picture of seasonal or temporal trends. No significant differences between samplings were observed at any of the three with the exception of Station 18, where an increase was only detectable between the September, 1987, and March, 1988, samplings.

3. Total Kjeldahl Nitrogen and Total Phosphorus

Nitrogen content of the sediments, as total Kjeldahl nitrogen (TKN) ranged between 0.02 and 19 mg/g dry weight of sediment. Analytical results as study means appear in Table 4 and individual data in Appendix A. The highest values were typically found at the more upstream stations. The relationship between station means of TKN and TOC was extremely well correlated during both individual samplings and for the study as a whole, power relationships providing the best correlation coefficient (r=0.9785, n=58). Stations with concentrations outside the 95% confidence intervals for this relationship included Stations 28, 128, and 131 which recorded higher nitrogen concentrations than expected based on the TOC content of the sediments, and Station 14 (near the Arlington River) where nitrogen content was slightly less than expected.

Examination of total Kjeldahl nitrogen against percent silt-clay content again provided significant correlations for a power relationship (r=0.8546, n=58) and indicated that Stations 128 and 129, Dunns Creek and the outlet from Lake George, were higher in nitrogen than would be deduced from the river-wide relationship with percent silt-clay.

Although significant differences in bulk concentrations of total Kjeldahl nitrogen were observed at many stations between the May and

September data sets, the differences did not produce comparable patterns in N:P ratios. Data from five stations, 6, 15, 21, 25, and 26 demonstrated decrease in N:P ratios, while Station 14 recorded an increase. Of the three stations sampled during each field effort, the only significant change in N:P ratio over time was recorded at Station 24, an increase between May, 1987, and March, 1988.

The river-wide distribution of total phosphorus exhibited no spatial trends during any sampling, and variabilities were higher than for nitrogen, both within and between stations. Raw sediment concentrations of phosphorus (Table 4, Appendix A) ranged between 0.04 and 2.57 mg/g of dry sediment. Correlations for study means of TOC or percent silt-clay with total phosphorus were also significant, especially for TOC (r=0.9084, n=58). In these river-wide relationships, Stations 3, 18, and 114, at Sisters Creek and at the junction of the Ortega and Cedar Rivers, were outside the 95% confidence interval, containing more phosphorus than would be expected based on TOC concentrations. For the silt-clay comparisons, only Station 126, Rice Creek, contained substantially more phosphorus than would have been predicted.

Nitrogen:phosphorous ratios for the study ranged between 0.05:1 and 38.1:1 on a weight:weight basis (0.07:1 to 84.2:1 ugat:ugat) and averaged 5.97:1 weight:weight. Although phosphorus exhibited no spatial pattern, N:P ratios were higher upstream due to the distribution of nitrogen previously discussed. This is illustrated in Figure 5 and may reflect the preferential mobilization of nitrogen from the estuarine sediments.

Regression of station means of nitrogen against phosphorus revealed several locations as outliers from within the 95% confidence interval for this relationship. Stations 18, 114, and 126 were elevated in phosphorus, while Station 28, near Palatka, was elevated for TKN with respect to the remainder of the stations sampled. Figure 6 summarizes those stations enriched on the basis of nutrient relationships to carbon, silt-clay, or other nutrients. Nutrient ratios determined are summarized in Table 5 and Appendix A.

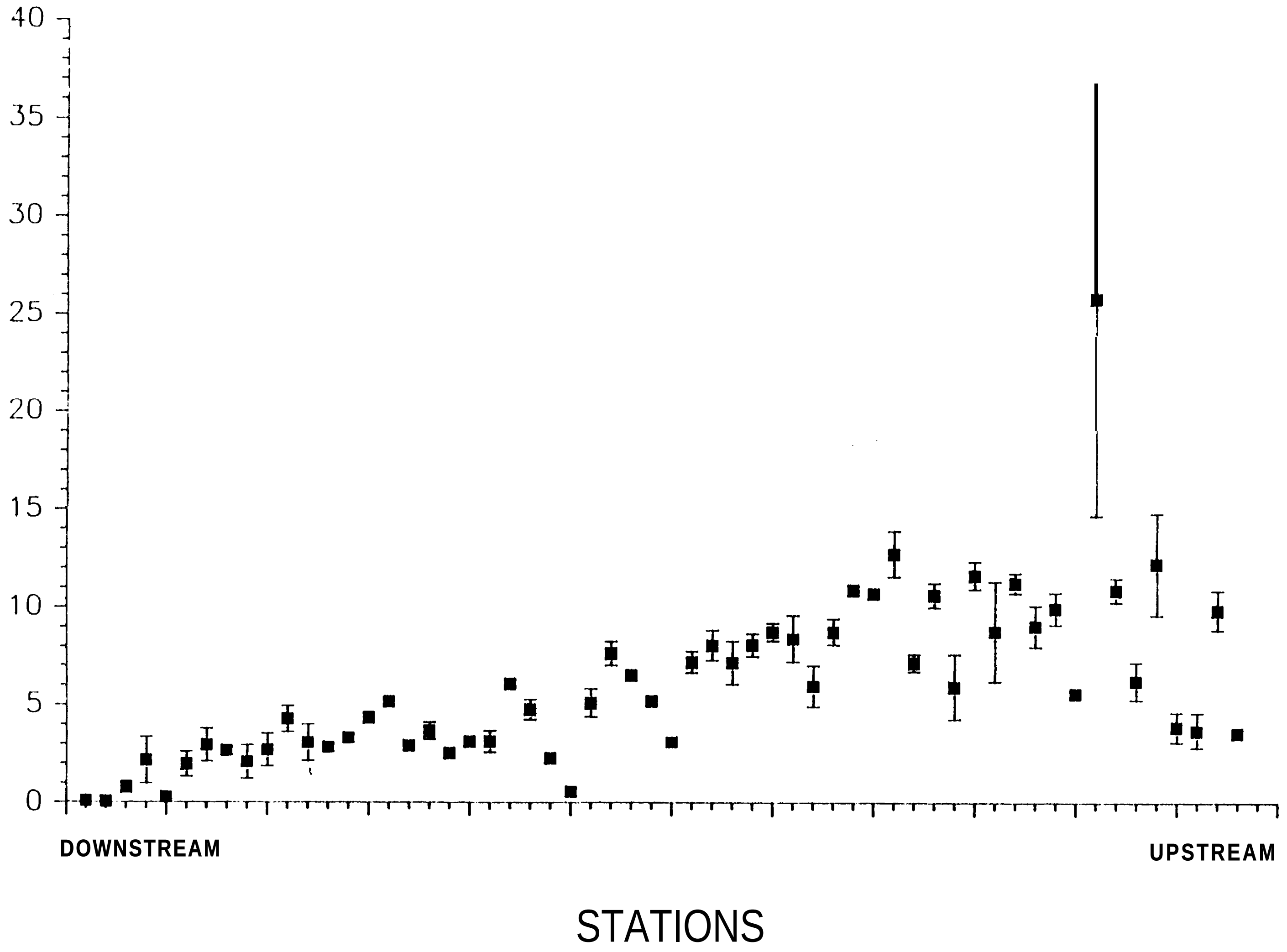


Figure 5. Sediment Nitrogen:Phosphorus Ratios, Study Means +/- Standard Deviations St. Johns River, 1987-88.

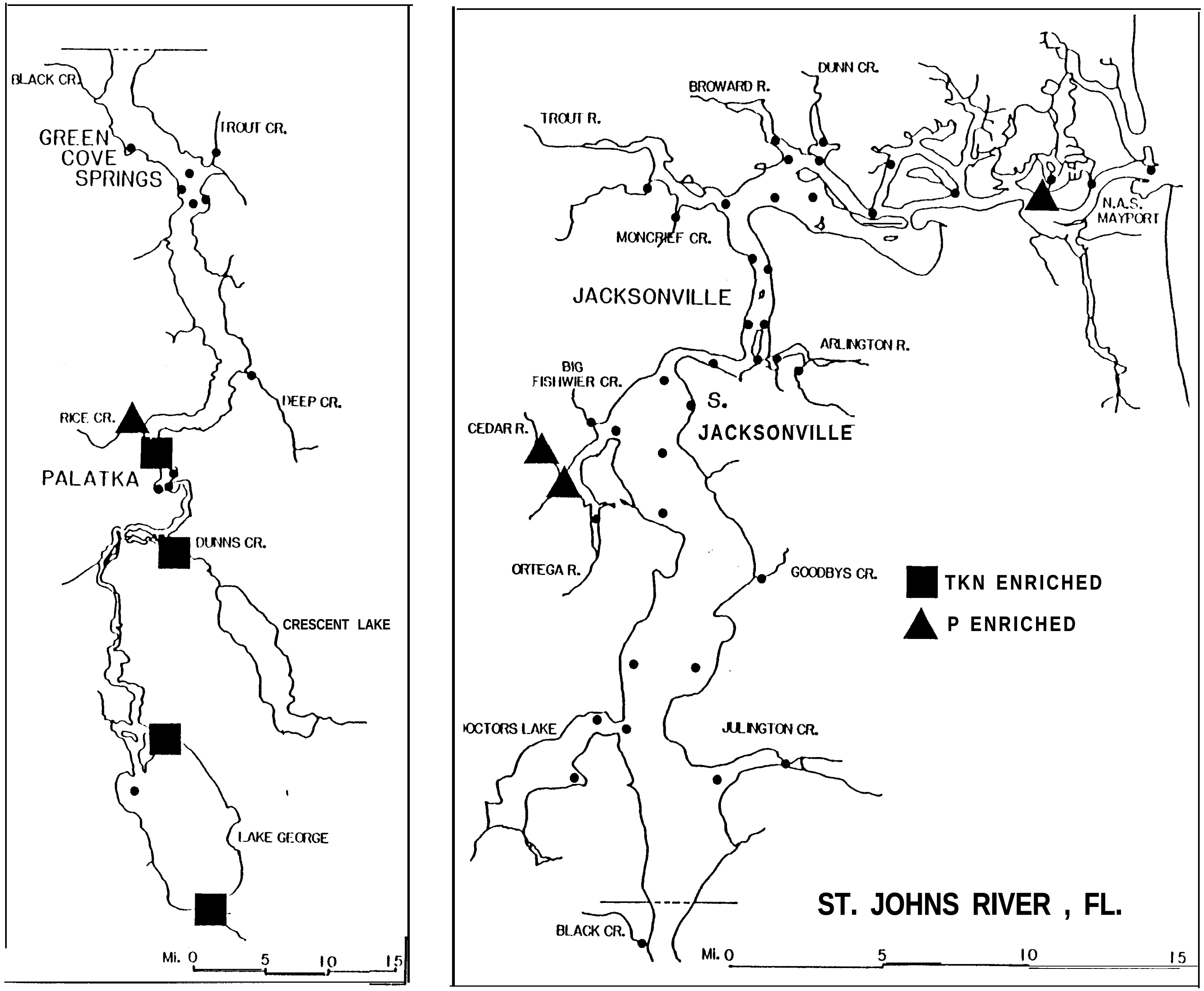


Figure 6. Sediments Enriched for N or P on the Basis of Riverwide Correlations with Carbon, % Silt-clay or Nutrients. St. Johns River, 1987-88.

Table 5. Study means and standard deviations by station of sediment N:P and C:N ratios. St. Johns River, 1987-1988. Units are weight: weight.

		Nitrogen:Phosphorus Ratio mg:mg		Carbon:Nitrogen Ratio mg:mg	
Sta.	n	$\bar{x}$	S.D.	$\bar{x}$	S.D.
1	6	0.11	0.02	7.92	2.12
2	6	0.06	0.02	18.71	6.82
3	6	0.81	0.20	8.88	1.24
4	6	2.17	1.20	10.03	4.62
5	6	0.28	0.19	15.92	6.03
6	6	1.97	0.65	11.35	2.69
7	6	2.94	0.85	12.96	6.16
8	6	2.08	0.87	14.59	7.64
9	6	4.28	0.68	10.50	2.01
10	6	2.66	0.29	15.52	3.22
11	6	2.84	0.25	11.14	1.75
12	9	3.32	0.38	11.15	3.58
13	6	2.92	0.15	13.38	5.59
14	6	3.13	0.56	20.27	2.14
15	6	0.58	0.13	14.94	2.87
16	6	8.05	0.78	9.10	2.85
17	6	7.64	0.61	8.89	1.28
18	9	5.24	0.30	8.41	2.43
19	6	7.16	1.11	9.30	1.75
20	6	8.72	0.48	6.95	1.78
21	6	8.38	1.19	6.70	1.48
22	6	5.97	1.05	11.61	3.56
23	6	10.68	0.37	6.33	1.14
24	9	12.70	1.17	5.11	1.15
25	6	5.95	1.67	13.27	4.69
26	6	8.77	2.54	9.70	2.99
27	6	11.22	0.52	6.24	0.56
28	6	25.82	11.12	3.97	0.84
29	6	10.86	0.62	5.44	0.58
30	6	6.27	0.95	8.07	2.66
101	3	2.70	0.86	13.29	3.99
102	3	3.07	0.95	7.57	1.56
104	3	4.36	0.20	11.08	0.73
105	3	5.18	0.37	13.72	6.88
106	3	3.68	0.45	9.48	1.14
107	3	3.13	0.18	8.79	0.39
108	3	2.54	0.15	10.52	2.41
109	3	6.09	0.30	13.32	1.02
110	3	4.77	0.54	10.22	1.33
111	3	2.27	0.42	12.78	1.12
112	3	5.15	0.72	12.78	0.50
113	3	6.54	0.22	10.81	0.46

Table 5. Continued. Study means and standard deviations by station of sediment N:P and C:N ratios. St. Johns River, 1987-1988. Units are weight: weight.

		Nitrogen:Phosphorus Ratio mg:mg		Carbon:Nitrogen Ratio mg:mg	
Sta.	n	$\overline{x}$	S.D.	$\overline{x}$	S.D.
114	3	3.13	0.21	13.79	2.46
116	3	7.18	0.56	10.10	1.66
117	3	8.06	0.62	9.69	2.72
118	3	8.73	0.67	7.50	1.00
119	3	10.86	0.12	7.22	1.68
121	3	7.17	0.44	9.33	1.94
122	3	10.60	0.64	6.38	0.52
123	3	11.60	0.72	7.56	1.08
124	3	9.02	1.05	6.85	1.87
125	3	9.93	0.82	5.75	0.38
126	3	5.62	0.27	11.45	0.63
127	3	12.21	2.62	5.41	0.69
128	3	3.93	0.77	6.27	2.62
129	3	3.75	0.92	6.93	0.25
130	3	9.87	1.01	7.50	1.14
131	3	3.64	0.37	5.62	0.88

4. Metals

The relatively consistent proportions observed between most trace elements and major constituents such as aluminum in natural mineral sediments make the use of metal:aluminum ratios, or other relationships, a useful tool for determining metal enrichment that may be attributable to anthropogenic activities. The natural ratios will be a function of the composition of the source material for sediments within the drainage basin and will necessarily display geographic variations. This should be considered especially when comparing samples from the lower peninsula of the carbonate platform of Florida and those with sediment sources in the Piedmont crustal material. Sediments can be considered enriched when metal concentrations fall statistically outside the range of natural ratios. Use of metal:aluminum ratios can also allow the assessment of enrichment despite varying grain size between stations or differences in total concentrations.

FDER has employed this technique in the past utilizing literature values for metal content and metal:aluminum ratios in carbonate rock. It was readily apparent from visual examination of the St. Johns River sediments, however, that carbonate forms a very small percentage of these samples and that carbonate ratios alone might not be appropriate to determine enrichment. More recently, FDER (1987) has developed an expanded technique where samples are assessed against a large data base drawn from many different and comparatively pristine locations throughout Florida. This analysis was applied (by Mr. Steve Schropp, FDER) to the results obtained from the May sampling in this study and repeated by MML for the second and third data sets. Enriched samples are detailed below.

Those stations selected for metals analysis during the first two samplings are illustrated in Figure 7. Sediment aliquots from these locations were also processed for the suites of organic parameters (Section III). Three replicate samples from each of fifteen (15) stations were processed. Stations were to be those ten sampled for microbiological analyses, as well as five additional, selected to increase spatial coverage and on the basis of unusual nutrient ratios. (One other station in the Palatka, Station 29, area was analyzed for metals in addition to those specified by the scope of the project.)

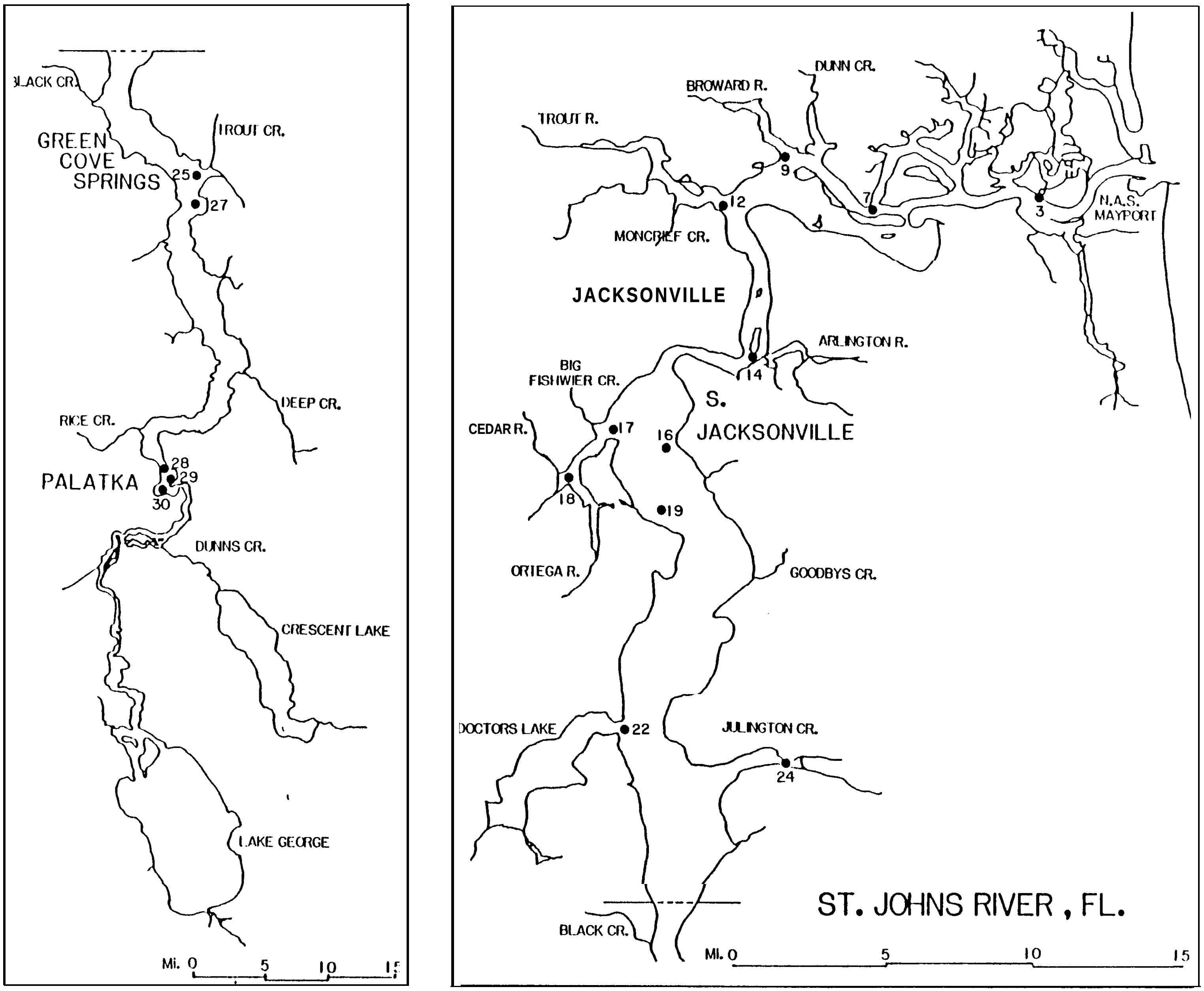


Figure 7. Sediment Stations Analyzed for Selected Metals Content, St. Johns River, May and September, 1987.

For the March, 1988, sampling, sixteen (16) of the thirty-one stations collected were analyzed for metals and organics. These locations are illustrated in Figure 8 and were all areas previously unsampled during this study, with the exception of Station 18. Stations for metals analyses were concentrated in the Jacksonville area where diseased fish had been recently reported, with some coverage towards the southernmost part of the study area, Lake George. Again, one station beyond scope requirements, Station 107, was processed for metals data. All analytical data appear in Tables 6, 7, and 8 and Appendix A.

Noteworthy in the metals data are the results obtained on sediments from the Cedar and Ortega Rivers, and Big Fishweir and Moncrief Creeks (Stations 18, 104, 113, 114, 116). Either as raw concentrations, or as data normalized for percent silt-clay, carbon, or aluminum content, the values at these stations were routinely the highest for all metals analyzed.

Examination of individual metals data from the 1987 samplings after normalization to sample percent silt-clay, total organic carbon, or aluminum concentration did not improve the overall agreement (measured as percent relative standard deviation) between replicates at a given station. It was apparent, therefore, that these simple ratios alone could not be an effective tool for pinpointing areas of the St. Johns River where metal concentrations were elevated above background.

FDER's analysis of metal enrichment in May samples was limited to cadmium, copper, lead and zinc, as statewide mercury:aluminum relationships apparently have too weak and an anomalously inverse correlation to provide useful information. In this analysis, Station 18 was enriched for all four metals, and the only station enriched for cadmium and copper. Lead concentrations were above background for Stations 12, 14, 16, 17, and 24 in addition to Station 18. These six stations plus Station 9 were also enriched for zinc. All enriched stations, with the exception of Station 18, were only slightly outside of the 95% confidence interval of FDER's regression. Graphic approximations of FDER's method were repeated on the September data set with similar results. Station 18 was again enriched in all four of the metals so treated. Copper enrichment was again noted only at this station.

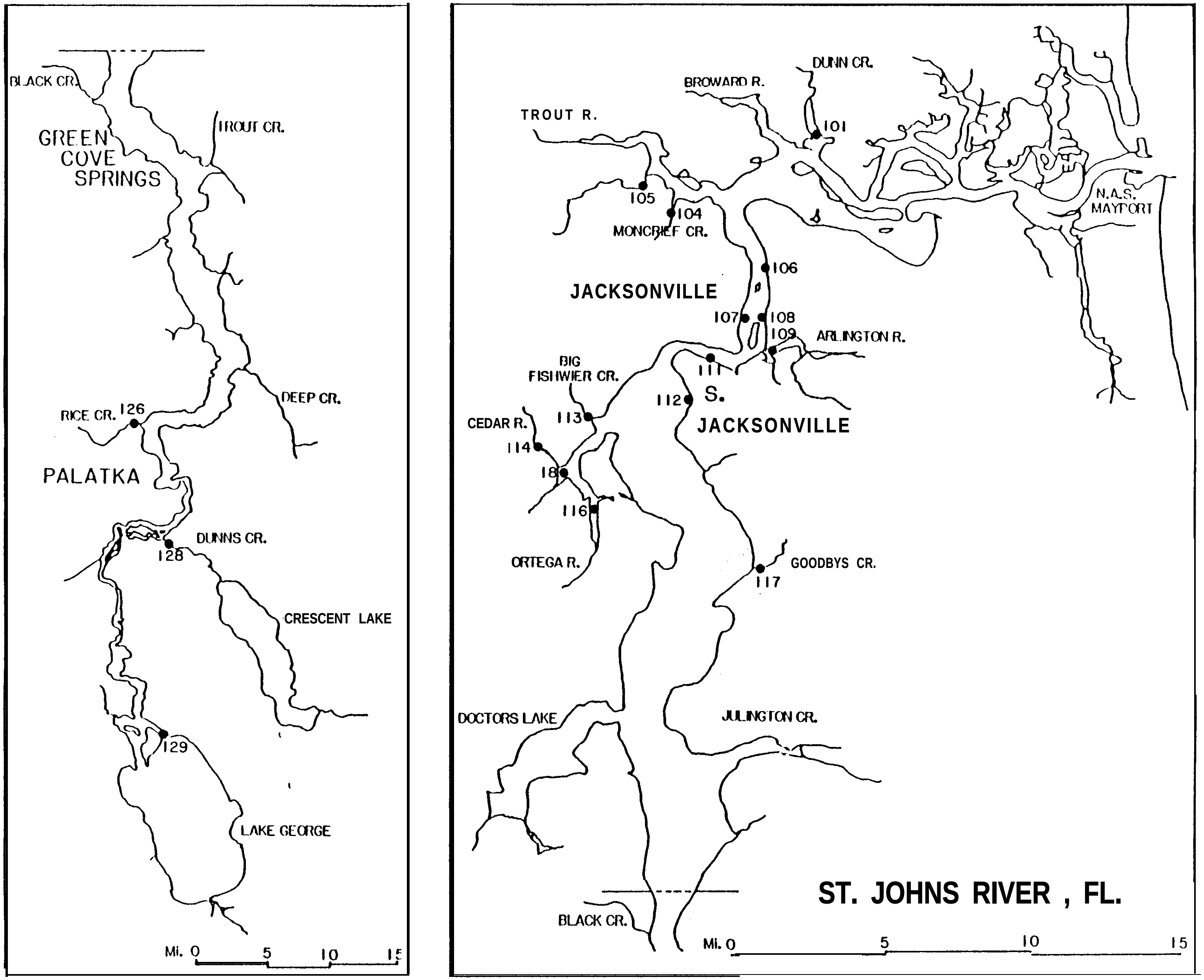


Figure 8. Sediment Stations Analyzed for Selected Metal Content, St. Johns River, March 1988.

Table 6. Sediment metal concentrations, St. Johns River, May 1987 collection. Station means and Standard deviations of three replicate samples. Units are per dry weight of sediment.

Station	Aluminum mg/g		cadmium µg/g		Copper µg/g		Lead µg/g		Mercury µg/g		Zinc µg/g	
	X	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
3	19.80	5.79	0.11	0.07	2.9	0.1	7.2	1.0	0.020	0.000	15.6	3.2
7	20.18	11.69	<0.05	0.05	3.1	1.1	5.9	0.5	0.027	0.014	20.2	6.6
9	30.19	7.45	0.28	0.20	14.1	1.6	27.3	1.1	0.089	0.008	88.3	8.8
12	29.65	11.94	0.24	0.07	17.6	2.5	32.1	6.4	0.135	0.071	100.2	8.8
14	11.10	0.69	0.10	0.08	7.3	0.3	20.3	3.6	0.051	0.013	40.4	1.2
16	42.67	2.44	0.50	0.10	23.8	1.1	51.4	1.4	0.286	0.039	165.7	4.4
17	22.52	1.51	0.48	0.19	16.5	2.2	30.6	4.6	0.183	0.023	83.2	7.3
18	42.64	8.54	1.96	0.22	61.3	3.1	213.6	17.5	0.905	0.150	490.0	21.6
19	30.20	6.02	0.57	0.21	11.4	1.4	26.7	2.4	0.090	0.014	71.5	8.6
22	1.79	1.36	0.09	0.03	1.8	0.1	3.3	0.3	0.012	0.002	6.5	0.3
24	30.38	1.50	0.66	0.06	14.8	1.4	44.4	3.2	0.244	0.057	105.5	3.3
25	11.86	2.22	<0.05	0.05	1.9	0.6	5.0	1.0	0.033	0.008	13.1	0.3
27	24.53	1.88	0.45	0.06	12.0	0.8	27.4	1.2	0.191	0.004	69.6	1.0
28	8.29	0.37	<0.05	0.00	3.1	0.3	5.9	0.2	0.100	0.082	8.8	0.1
29	20.59	1.75	0.30	0.04	10.3	1.1	23.3	2.6	0.043	0.020	33.7	5.1
30	3.14	0.57	0.17	0.03	1.7	0.2	4.2	0.7	0.031	0.010	8.4	1.5

Table 7. Sediment metal concentrations, St. Johns River, September 1987 collection. Station means and standard deviations of three replicate samples. Units are per dry weight of sediment.

Station	Aluminum mg/g $\bar{X}$	SD	Cadmium μg/g $\bar{x}$	SD	Copper ug/g $\bar{x}$	SD	Lead μg/g $\bar{x}$	SD	Mercury μg/g $\bar{x}$	SD	Zinc μg/g $\bar{x}$	SD
3	15.65	3.39	0.25	0.05	3.0	0.7	7.3	0.3	0.017	0.007	12.6	3.3
7	7.65	3.14	0.18	0.04	4.6	5.0	6.3	2.2	0.012	0.004	8.9	2.8
9	24.73	4.14	0.54	0.17	18.6	1.1	32.9	3.7	0.156	0.024	101.4	4.8
12	26.37	3.64	0.23	0.18	17.3	1.5	30.1	6.0	0.136	0.020	91.6	9.0
14	10.75	1.68	0.27	0.07	8.2	0.8	20.5	0.1	0.059	0.006	42.6	0.5
16	23.24	8.58	0.24	0.04	7.2	1.3	5.9	3.8	0.044	0.021	36.7	2.3
17	19.02	1.27	0.83	0.19	22.6	2.1	45.9	1.6	0.300	0.045	104.0	11.8
18	37.60	2.99	2.78	0.35	56.5	0.9	168.1	6.0	1.372	0.292	436.2	39.1
19	40.17	7.82	0.72	0.38	10.9	0.6	18.3	6.4	0.156	0.089	57.1	10.1
22	2.23	0.25	0.09	0.08	1.4	0.3	3.6	0.4	0.010	0.001	6.0	0.2
24	25.65	6.78	0.85	0.07	16.5	1.5	43.5	2.2	0.357	0.104	102.7	5.3
25	9.79	2.30	0.17	0.04	1.5	0.2	6.6	0.4	0.028	0.007	8.7	0.8
27	20.71	3.42	0.29	0.27	13.0	0.6	24.6	0.3	0.279	0.037	58.7	4.5
28	6.47	1.32	0.14	0.13	5.4	1.2	8.0	2.5	0.089	0.024	11.2	1.9
30	5.15	0.81	0.22	0.03	2.5	0.3	8.6	0.9	0.048	0.018	8.0	0.8

Table 8. Sediment metal concentrations, St. Johns River, March 1988 collection. Station means and standard deviations of three replicate samples. Units are per dry weight of sediment.

Station	Aluminum mg/g		cadmium µg/g		Copper µg/g		Lead µg/g		Mercury µg/g		Zinc µg/g	
	$\bar{X}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
18	70.36	3.55	1.91	0.17	62.1	4.2	179.5	8.6	0.732	0.049	436.9	9.2
101	29.86	10.92	0.10	0.07	5.9	1.2	9.6	1.8	0.048	0.005	40.2	3.4
104	63.09	3.37	1.09	0.09	296.1	23.9	120.7	13.2	0.303	0.032	290.1	21.7
105	45.92	8.14	0.64	0.08	37.5	2.9	63.4	0.8	0.111	0.019	142.5	27.3
106	6.63	0.63	0.06	0.02	4.3	2.1	8.6	1.9	0.019	0.003	17.0	1.4
107	43.49	6.13	0.15	0.03	29.1	6.6	34.4	2.1	0.091	0.003	108.1	9.1
108	13.16	2.15	0.30	0.10	10.8	6.6	14.6	0.6	0.030	0.003	24.7	2.4
109	43.84	4.82	0.51	0.07	25.8	3.5	50.2	6.5	0.191	0.007	141.8	16.6
111	12.29	2.96	0.21	0.06	16.0	1.1	76.6	9.0	0.067	0.039	56.2	1.8
112	6.06	0.13	0.19	0.19	5.3	1.0	23.3	8.4	0.024	0.005	27.6	8.0
113	50.30	2.05	2.00	0.08	57.4	2.6	425.4	18.0	0.367	0.023	388.3	46.9
114	65.87	2.77	2.80	0.29	88.2	3.4	358.5	10.8	0.534	0.049	702.5	34.2
116	52.41	7.68	1.06	0.16	30.5	2.9	111.0	10.4	0.308	0.059	190.9	24.7
117	32.46	3.71	0.49	0.07	28.4	6.1	69.5	10.1	0.252	0.084	113.2	19.7
126	24.65	2.31	0.58	0.05	18.7	2.4	17.1	2.7	0.264	0.070	93.5	9.2
128	1.79	0.20	<0.05	0.01	1.1	0.3	4.9	2.9	0.005	0.001	1.5	0.8
129	0.53	0.09	0.10	0.05	0.7	0.3	0.8	0.7	0.004	0.000	0.4	0.1

Station 24, up Julington Creek, was also enriched for cadmium on this occasion, however, and Station 17 was very slightly enriched for this metal, as well. Station 16, off Point La Vista, was no longer elevated for lead concentrations. Zinc enrichment was observed at the same stations as in May.

The determination of enrichment by these techniques was finally repeated on station means for the entire study (Table 9), having combined all samplings. These results appear graphically in Figures 9 through 12 for four metals, cadmium, copper, lead, and zinc. Table 10 summarizes these results, presenting enrichment ratios, or the ratio of the observed mean concentration to the maximum value permitted (based on observed aluminum content) and yet still within the 95% confidence interval for uncontaminated sediments. Values above 1.00 in this table indicate sediments that are enriched in the particular metal. Figure 13 illustrates those stations enriched for one or metals by this determination.

For mercury concentrations, FDER has determined that for "pristine" sediments, a weak inverse relationship with aluminum exists and as such, aluminum concentrations are not useful for determining enrichment. Instead, the maximum value of mercury observed in that "clean" data set, 0.21 ug/g, is taken as the upper end of natural mercury concentrations. Mercury enrichment ratios presented in Table 10 for the St. Johns River, therefore are simply bulk mercury concentrations, divided by the value of 0.21 ug/g. Again values greater than 1.00 represent stations enriched in this metal (Figure 14).

Despite Florida-wide relationships of mercury with aluminum, sediments from the St. Johns show a distinct and positive correlation for power relationships (r=0.8526, n=32). Figure 15 illustrates these data. As uncontaminated sediments displayed an inverse relationship, the inference is that the St. Johns River sediments as a whole were quite contaminated. Re-analysis of data after removal of those sediments with bulk concentration greater than 0.21 ug/g, however, still produced significant and positive correlations (r=0.8534, n=22). It is possible that mercury: aluminum relationships are useful within a single basin

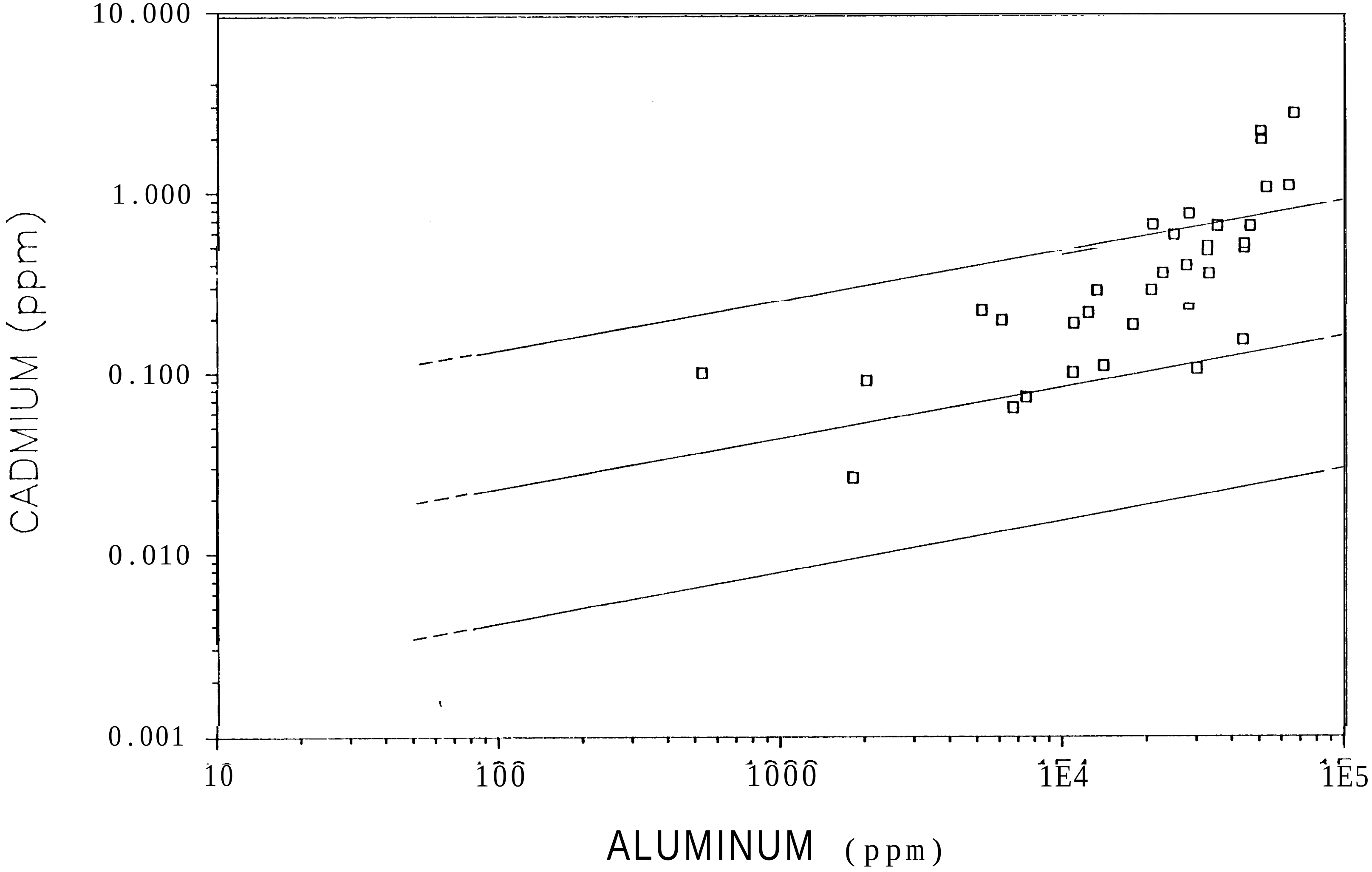


Figure 9. Cadmium:Aluminum Concentrations. St. Johns River Sediments, 1987-88.

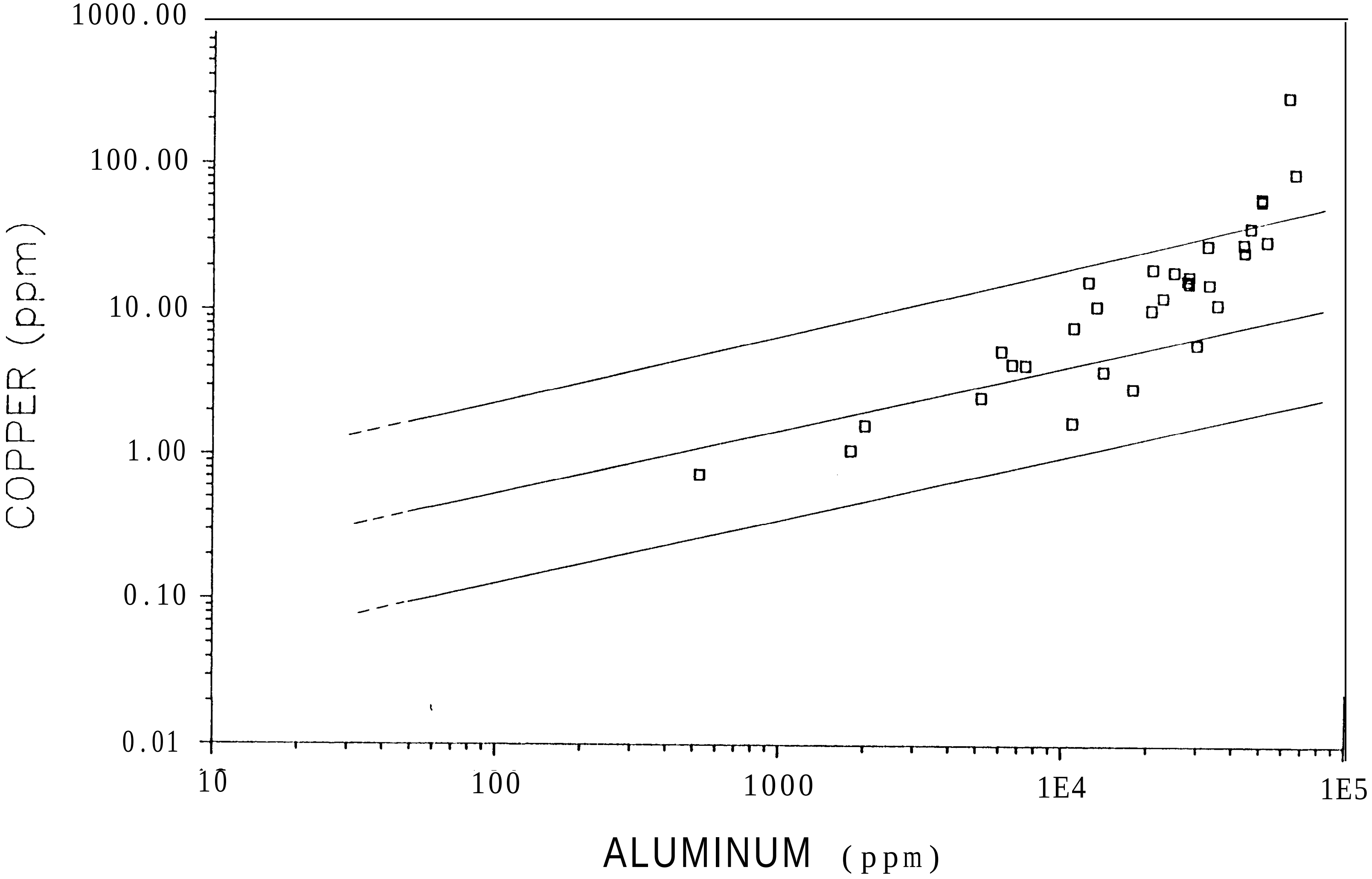


Figure 10. Copper:Aluminum Concentrations. St. Johns River Sediments, 1987-88.

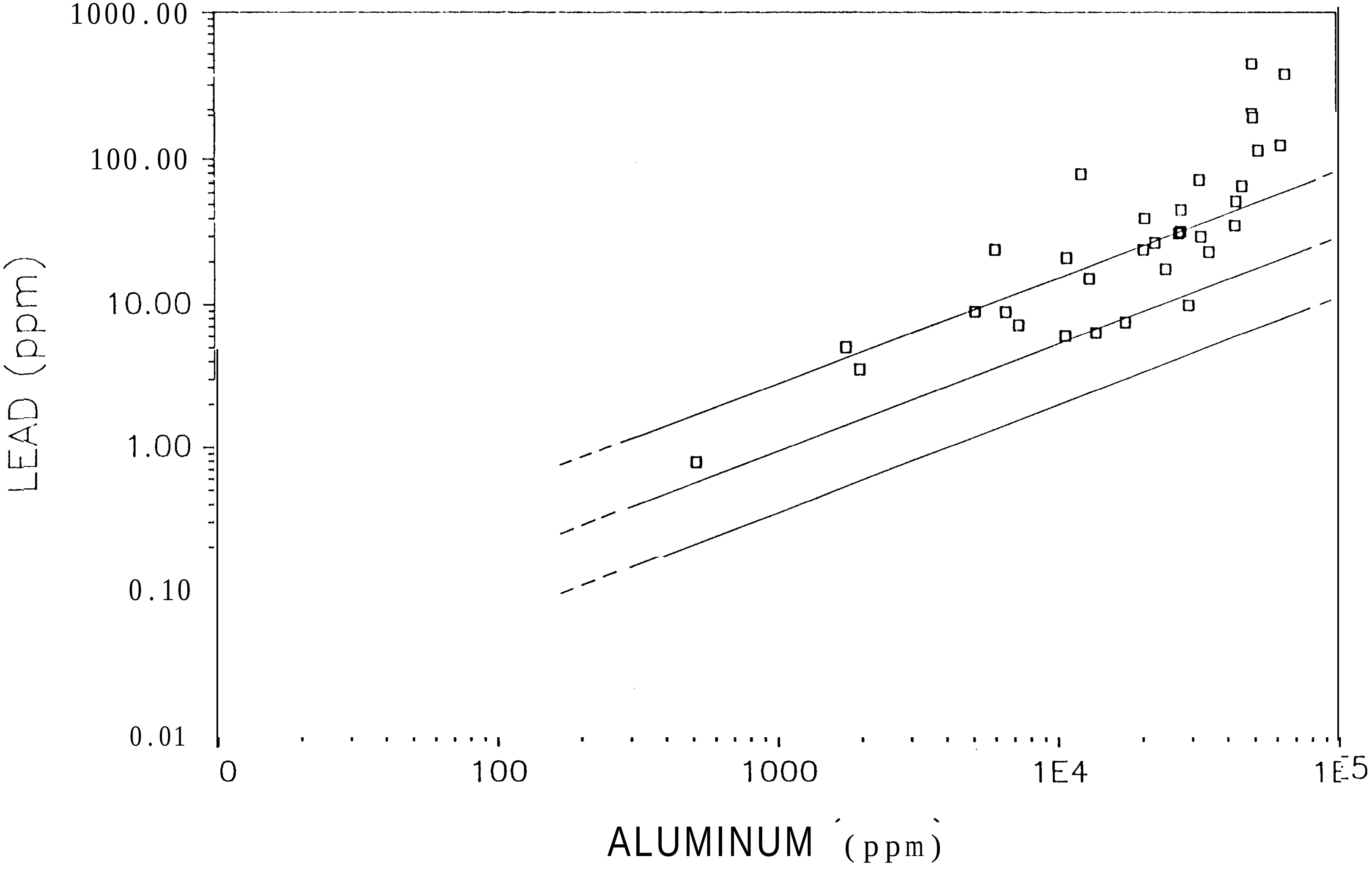


Figure 11. Lead:Aluminum Concentrations. St. Johns River Sediments, 1987-88.

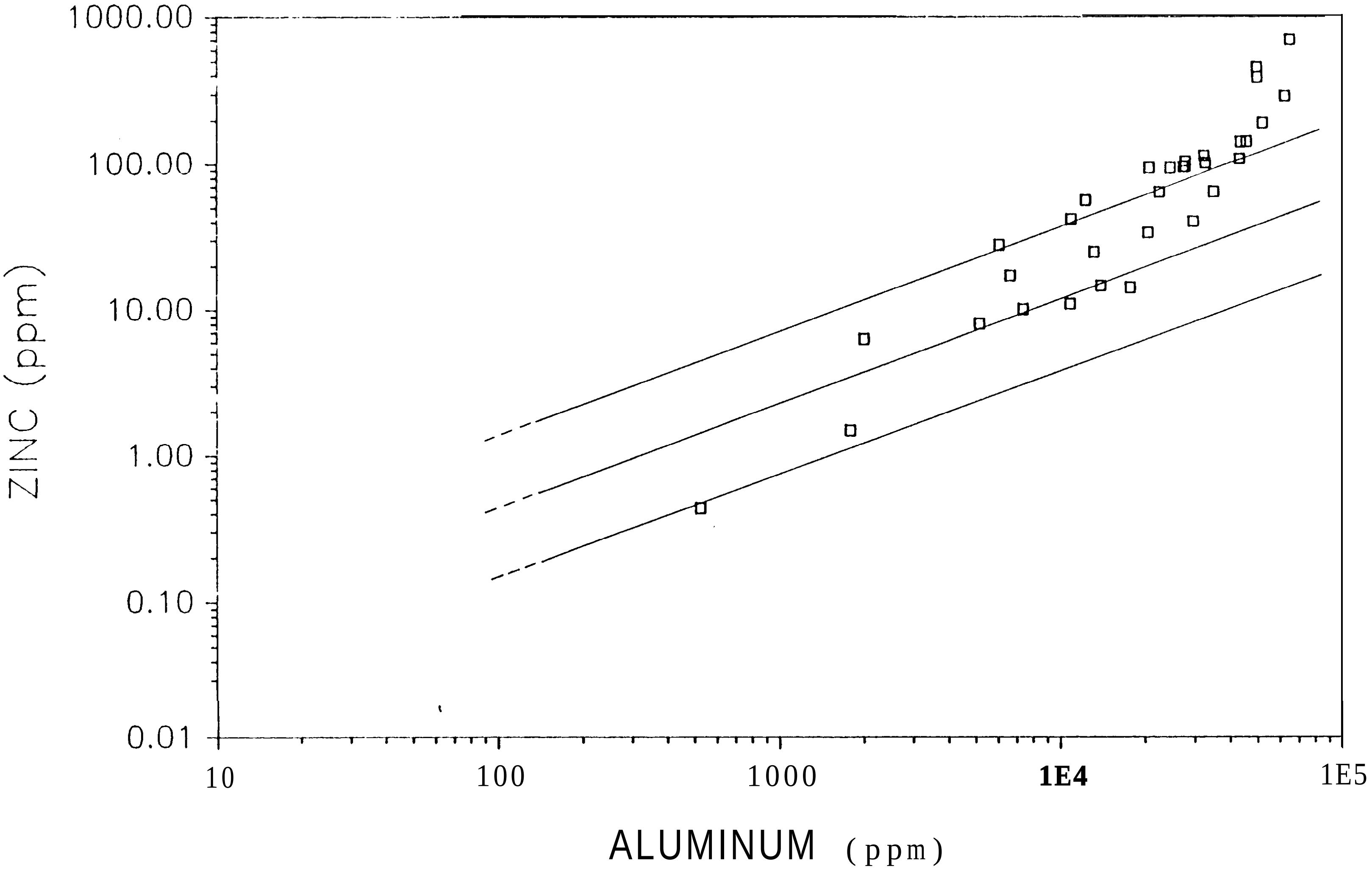


Figure 12. Zinc:Aluminum Concentrations. St. Johns River Sediments, 1987-88.

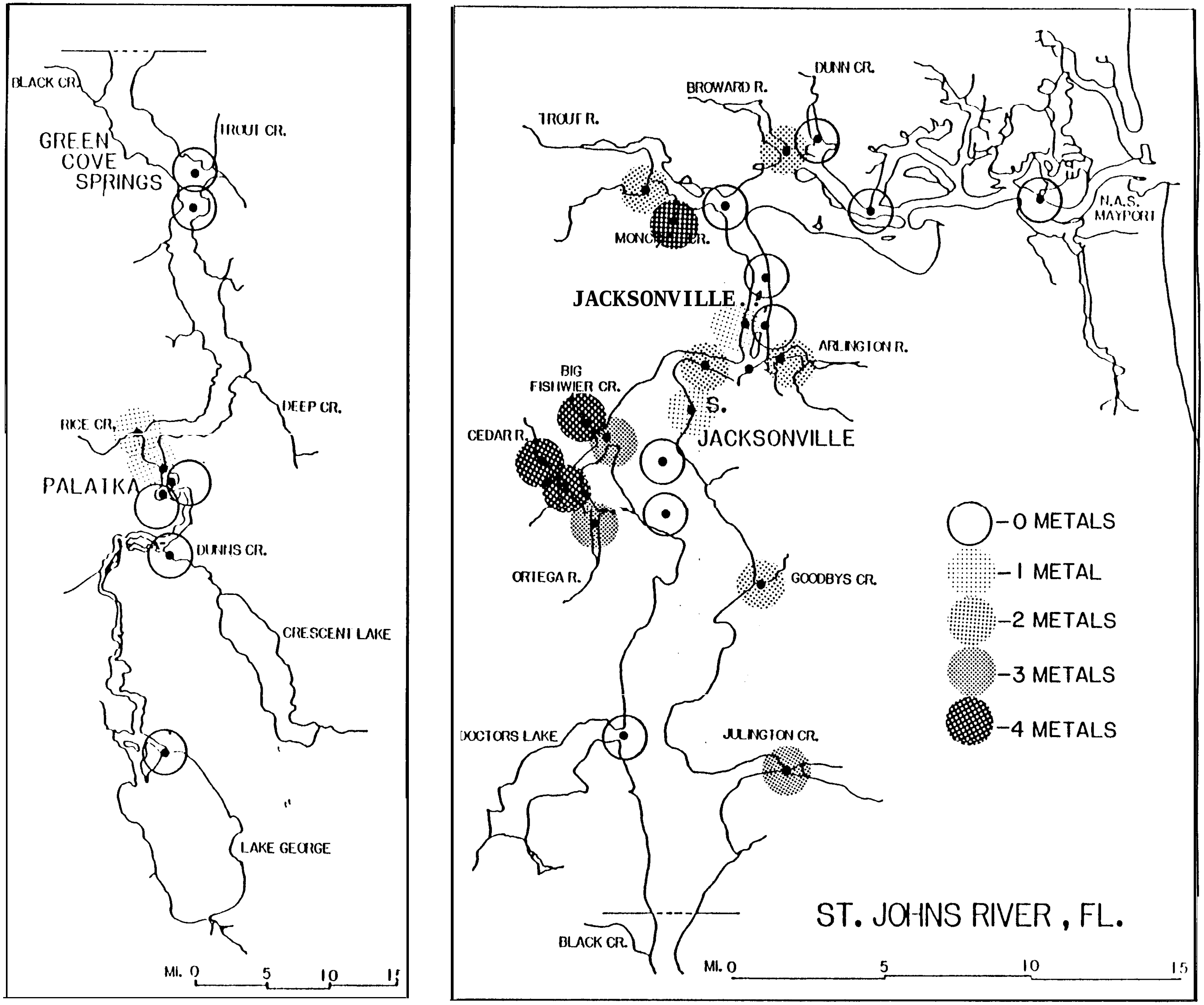


Figure 13. Sediment Stations Enriched in Metals, St. Johns River, 1987-88. Cadmium, Copper, Lead and Zinc.

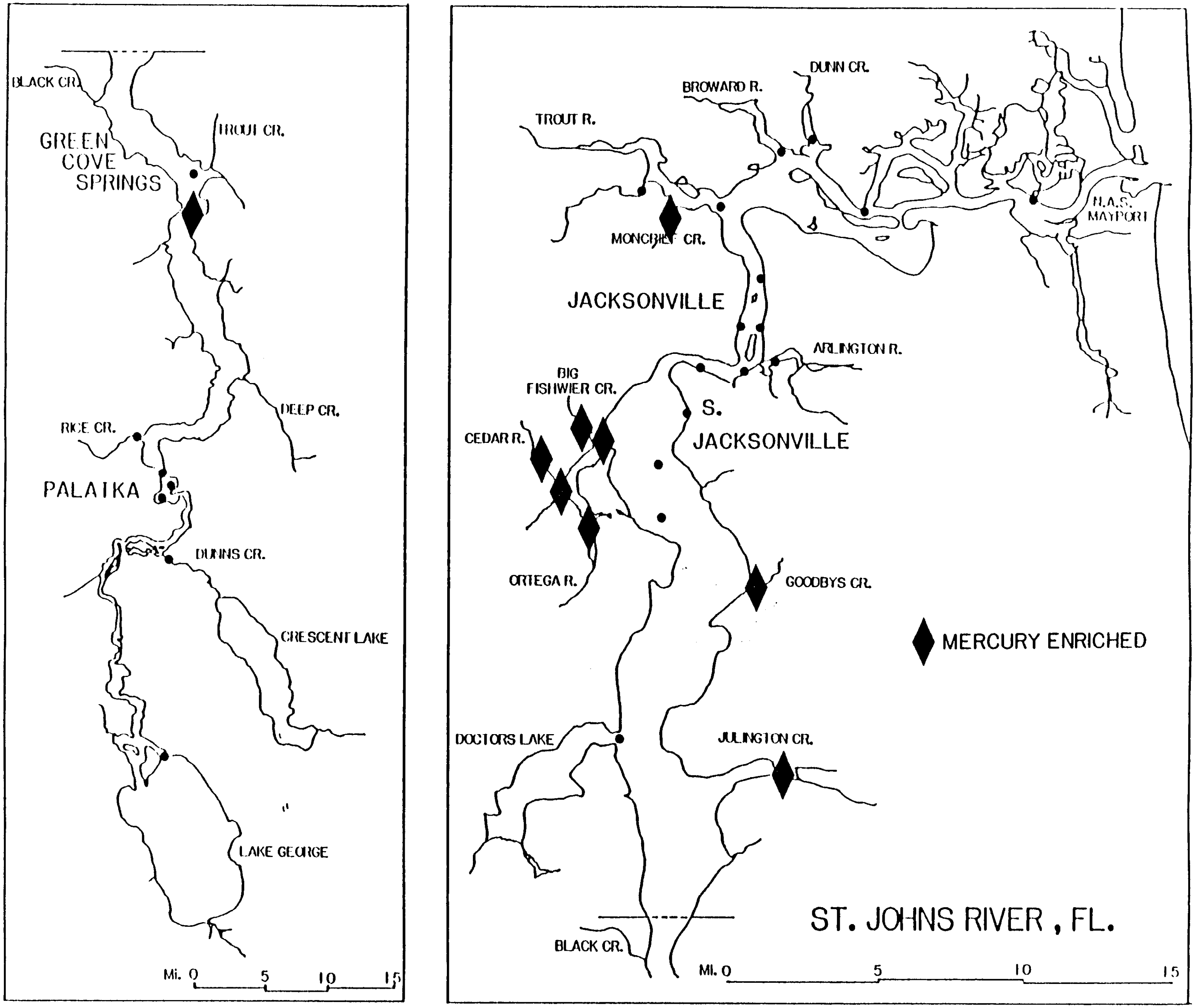


Figure 14. Sediment Stations Enriched in Mercury (>0.21 ug/g). St. Johns River, 1987-88.

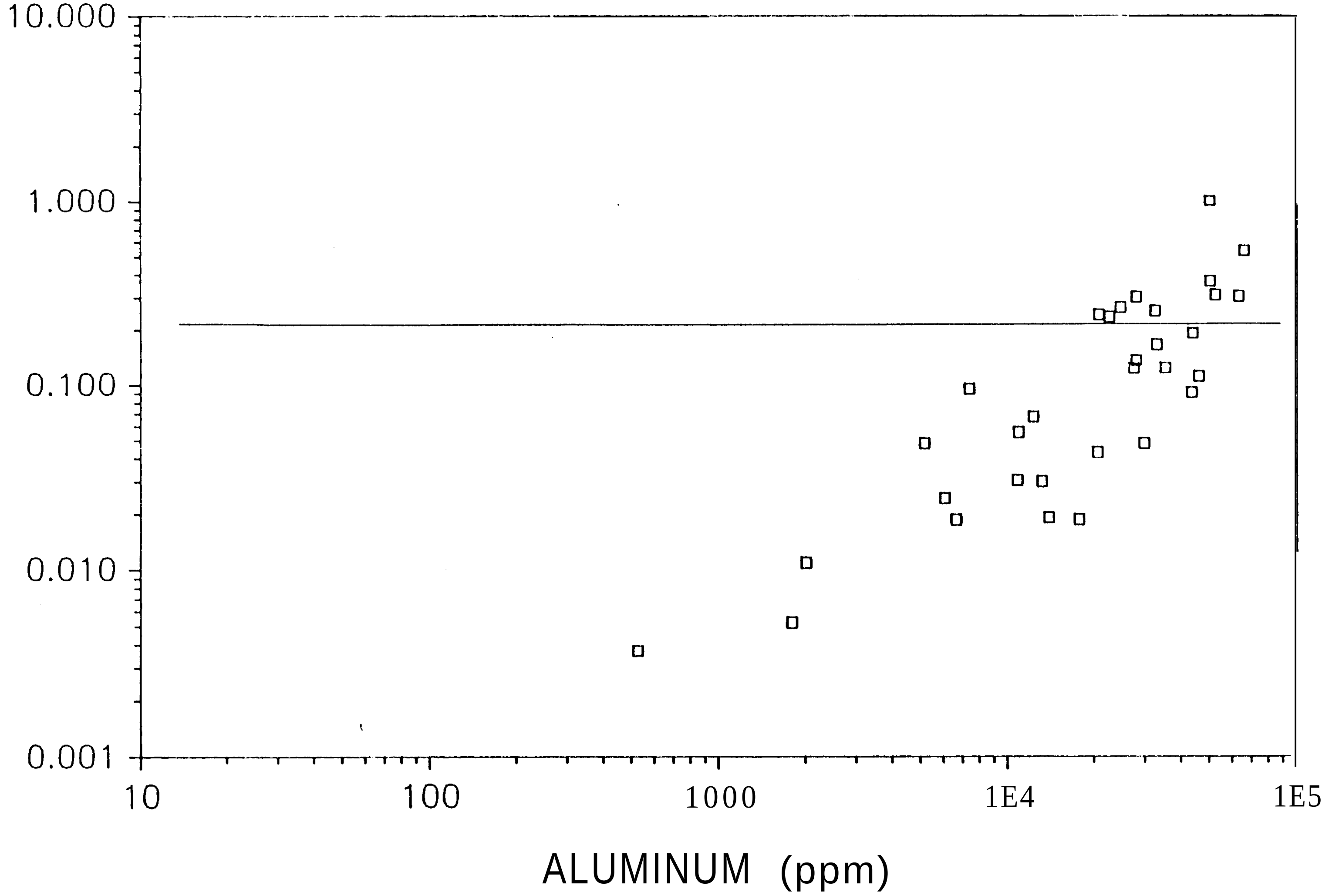


Figure 15. Mercury:Aluminum Concentrations. St. Johns River Sediments, 1987-88.

Table 9. Sediment metal concentrations, St. Johns River. Study mans and standard deviations by station, 1987-1988. Units are per dry weight of sediment.

		Aluminum mg/g		**cadmium** µg/g		**Copper** µg/g		Lead µg/g		Mercury µg/g		zinc µg/g	
Station	n	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
3	6	17.72	4.82	0.18	0.10	2.9	0.5	7.3	0.7	0.019	0.005	14.1	3.3
7	6	13.92	10.28	0.11	0.09	3.9	3.4	6.1	1.4	0.019	0.012	14.5	7.7
9	6	27.46	6.16	0.41	0.22	16.4	2.7	30.1	3.9	0.123	0.040	94.9	9.6
12	6	28.01	8.10	0.23	0.12	17.5	1.8	31.1	5.7	0.136	0.047	95.9	9.2
14	6	10.92	1.16	0.18	0.12	7.7	0.8	20.4	2.3	0.055	0.010	41.5	1.5
16	6	32.95	12.04	0.37	0.16	15.5	9.2	28.7	25.0	0.165	0.135	101.2	70.7
17	6	20.77	2.28	0.66	0.25	19.6	3.8	38.2	8.9	0.241	0.072	93.6	14.4
18	9	50.20	16.03	2.22	0.48	60.0	3.7	187.1	22.9	1.003	0.331	454.4	35.1
19	6	35.18	8.29	0.64	0.29	11.1	1.0	22.5	6.3	0.123	0.067	64.3	11.5
22	6	2.01	0.90	0.09	0.06	1.6	0.3	3.4	0.3	0.011	0.002	6.2	0.4
24	6	28.01	5.10	0.76	0.12	15.7	1.6	43.9	2.5	0.301	0.097	104.1	4.3
25	6	10.82	2.32	0.10	0.09	1.7	0.4	5.8	1.1	0.030	0.007	10.9	2.4
27	6	22.62	3.23	0.37	0.19	12.5	0.8	26.0	1.7	0.235	0.053	64.1	6.6
28	6	7.38	1.32	0.07	0.11	4.2	1.5	6.9	1.9	0.095	0.054	10.0	1.8
29	6	20.59	1.75	0.30	0.04	10.3	1.1	23.3	2.6	0.043	0.020	33.7	5.1
30	6	5.15	0.81	0.22	0.03	2.5	0.3	8.6	0.9	0.048	0.018	8.0	0.8
101	3	29.86	10.92	0.10	0.07	5.9	1.2	9.6	1.8	0.048	0.005	40.2	3.4
104	3	63.09	3.37	1.09	0.09	296.1	23.9	120.7	13.2	0.303	0.032	290.1	21.7
105	3	45.92	8.14	0.64	0.08	37.5	2.9	63.4	0.8	0.111	0.019	142.5	27.3
106	3	6.63	0.63	0.06	0.02	4.3	2.1	8.6	1.9	0.019	0.003	17.0	1.4
107	3	43.49	6.13	0.15	0.03	29.1	6.6	34.4	2.1	0.091	0.003	108.1	9.1
108	3	13.16	2.15	0.30	0.10	10.8	6.6	14.6	0.6	0.030	0.003	24.7	2.4
109	3	43.84	4.82	0.51	0.07	25.8	3.5	50.2	6.5	0.191	0.007	141.8	16.6
111	3	12.29	2.96	0.21	0.06	16.0	1.1	76.6	9.0	0.067	0.039	56.2	1.8
112	3	6.06	0.13	0.19	0.19	5.3	1.0	23.3	8.4	0.024	0.005	27.6	8.0
113	3	50.30	2.05	2.00	0.08	57.4	2.6	425.4	18.0	0.367	0.023	388.3	46.9
114	3	65.87	2.77	2.80	0.29	88.2	3.4	358.5	10.8	0.534	0.049	702.5	34.2
116	3	52.41	7.68	1.06	0.16	30.5	2.9	111.0	10.4	0.308	0.059	190.9	24.7
117	3	32.46	3.71	0.49	0.07	28.4	6.1	69.5	10.1	0.252	0.084	113.2	19.7
126	3	24.65	2.31	0.58	0.05	18.7	2.4	17.1	2.7	0.264	0.070	93.5	9.2
128	3	1.79	0.20	<0.05	0.01	1.1	0.3	4.9	2.9	0.005	0.001	1.5	0.8
129	3	0.53	0.09	0.10	0.05	0.7	0.3	0.8	0.7	0.004	0.000	0.4	0.1

Table 10. Enrichment ratios of metals in sediments, St. Johns River. Study means and standard deviations. Observed concentrations divided by the upper limit (95% confidence interval) of uncontaminated sediments based on observed aluminum content. (From FDER, 1987). *Values above 1.00 are statistically enriched.

		Cadmium		**Copper**		Lead		zinc		Mercury**	
Station	n	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.
3	6	0.37	0.16	0.09	0.02	0.39	0.07	0.24	0.02	0.06	0.02
7	6	0.27	0.21	0.07	0.23	0.30	0.27	0.25	0.06	0.07	0.06
9	6	0.54	0.33	0.61	0.11	1.30*	0.21	1.54*	0.21	0.64	0.19
12	6	0.17	0.19	0.43	0.06	0.74	0.36	0.99	0.29	0.65	0.22
14	6	0.60	0.22	0.35	0.04	1.18*	0.20	0.94	0.08	0.31	0.05
16	6	0.31	0.17	0.24	0.18	0.49	0.55	0.67	0.54	0.32	0.65
17	6	1.25*	0.42	0.76	0.15	2.06*	0.47	1.80*	0.29	1.30*	0.34
18	9	1.87*	0.76	1.16*	0.19	2.98*	1.10	2.77*	0.94	3.74*	1.58
19	6	0.40	0.38	0.23	0.05	0.35	0.23	0.42	0.19	0.47	0.32
22	6	0.00	0.18	0.16	0.06	0.61	0.33	0.41	0.24	0.04	0.01
24	6	1.43*	0.23	0.49	0.06	1.87*	0.25	1.60*	0.16	2.15*	0.46
25	6	0.41	0.17	0.09	0.02	0.54	0.10	0.26	0.05	0.14	0.03
27	6	0.89	0.28	0.37	0.05	0.88	0.07	0.80	0.09	1.31*	0.25
28	6	0.53	0.25	0.36	0.09	1.04*	0.23	0.46	0.08	0.47	0.26
29	6	0.53	0.06	0.31	0.03	0.87	0.06	0.44	0.08	0.23	0.09
30	6	0.49	0.05	0.16	0.01	0.98	0.03	0.38	0.04	0.19	0.09
101	3	0.22	0.10	0.19	0.04	0.48	0.15	0.62	0.11	0.22	0.03
104	3	1.13*	0.11	6.01*	0.35	2.11*	0.32	1.96*	0.23	1.53*	0.15
105	3	0.76	0.07	0.85	0.03	1.35*	0.21	1.40*	0.14	0.63	0.09
106	3	0.15	0.04	0.18	0.13	0.81	0.16	0.57	0.05	0.10	0.01
107	3	0.21	0.04	0.80	0.14	0.82	0.05	1.02*	0.13	0.42	0.02
108	3	0.40	0.18	0.28	0.29	0.69	0.12	0.42	0.10	0.14	0.01
109	3	0.69	0.08	0.61	0.05	1.22*	0.06	1.28*	0.05	0.95	0.04
111	3	0.45	0.09	0.65	0.05	3.32*	1.30	1.09*	0.24	0.53	0.19
112	3	0.92	0.43	0.27	0.06	1.78*	0.79	0.83	0.28	0.10	0.02
113	3	2.34*	0.08	1.17*	0.05	8.81*	0.37	2.80*	0.32	1.75*	0.11
114	3	3.47*	0.29	1.53*	0.09	6.26*	0.02	4.48*	0.26	2.32*	0.23
116	3	1.47*	0.18	0.70	0.06	2.33*	0.04	1.70*	0.15	1.15*	0.28
117	3	0.65	0.09	0.74	0.14	1.62*	0.47	1.30*	0.14	1.64*	0.40
126	3	0.93	0.07	0.62	0.06	0.74	0.12	1.36*	0.09	0.94	0.34
128	3	0.07	0.02	0.09	0.02	0.58	0.63	0.09	0.07	0.02	0.01
129	3	0.35	0.22	0.09	0.08	0.01	0.41	0.07	0.03	0.02	0.00

** Mercury enrichment computed as a simple **ratio** of observed concentration to 0.21 µg/g, the maximum observed for uncontaminated sediment.

although this technique is admittedly complicated by analytical detection limits and low natural concentrations of this metal.

To assess mercury concentrations further, a technique was employed using literature mercury:aluminum ratios in both carbonate and soils as reported by Turekian and Wedepohl (1961) and by Martin and Whitfield (1983). The aluminum concentration of each sample was used to interpolate where, between carbonate and soils values, a sample should fall. This percentage was then applied to the difference between the reported mercury concentrations for these two categories to obtain an expected value for mercury.

An interpolated enrichment factor was then calculated by dividing the observed concentration of the sample by its expected mercury concentration. These interpolated ratios, however, provide no estimate of the statistical error associated with the prediction of the expected concentrations and are more analogous to enrichment as determined against FDER's central regression relationship rather than against the upper confidence interval as previously discussed. Numerically they will typically be larger than those presented previously. Accordingly, only when station means of interpolated enrichment factors less one standard deviation were greater than 1.00 were sediments considered to be enriched above theoretical levels.

By this technique, stations in the central portion of the river, from the Broward River to Goodbys Creek were enriched in the most metals. Other tributaries, Julington and Rice Creeks, and an area near Palatka also appeared to be a source of metals to the St. Johns River. Stations 18 114, 113, and 104 were again the most noteworthy, with all interpolated enrichment factors greater than 2.00 and several metals and stations with factors greater than 10.00. This is consistent with the patterns of enrichment determined by FDER relationships. Table 11 lists enrichment factors calculated by the above interpolation technique for all metals and Figure 16 identifies those stations considered enriched in one or more metals on this basis.

Metal:aluminum ratios, the basis of FDER's enrichment determinations, were examined with respect to the May and September, 1987, dry and wet season samplings. Of the seventy-five possibilities

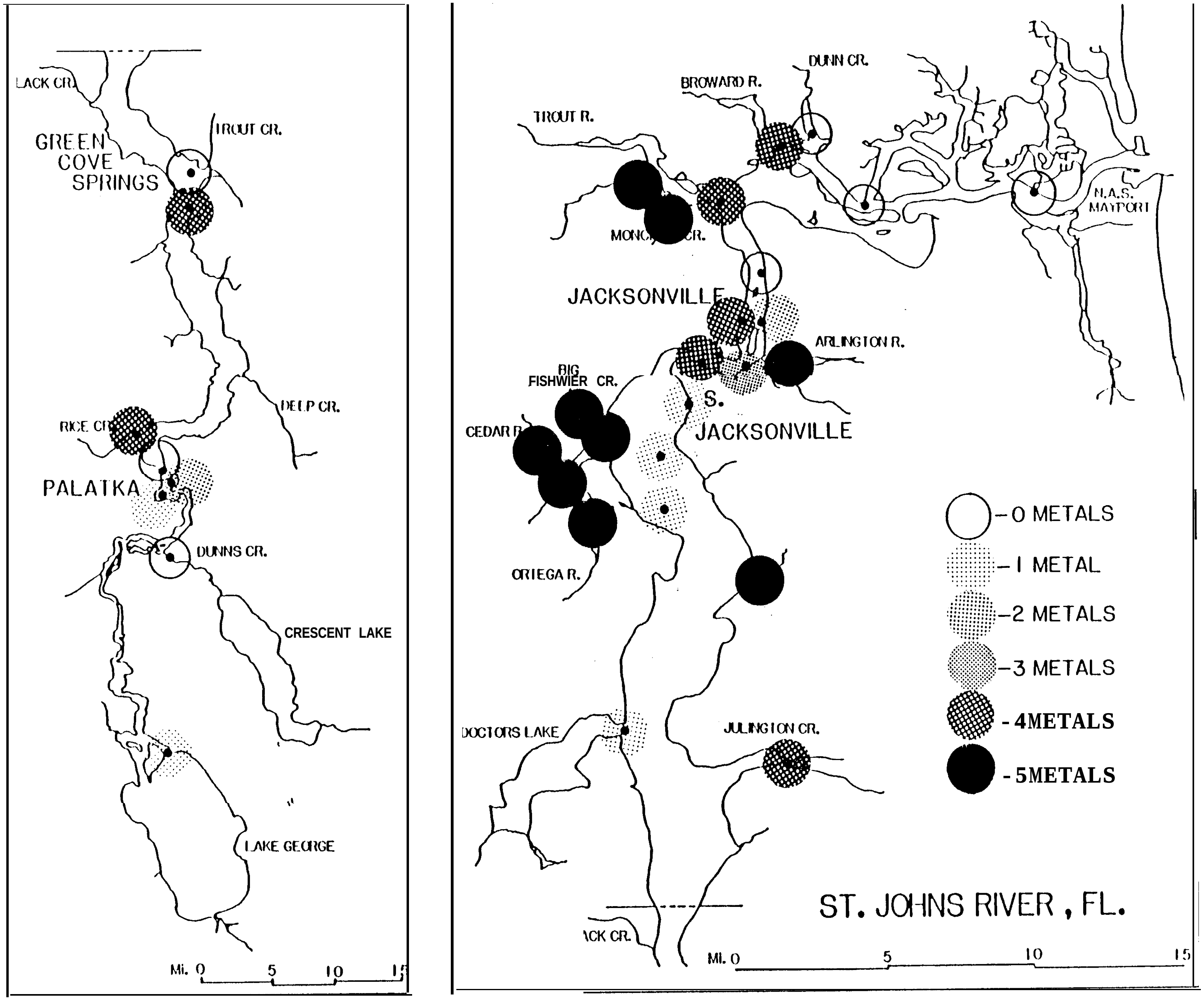


Figure 16. Sediment Stations Enriched in Metals Through Interpolated Ratios. St. Johns River, 1987-88.

Table 11. Interpolated enrichment ratios of metals in sediments, St. Johns River. Study means and standard deviations, 1987-88. Based on theoretical percentages of metals in carbonates and soils and sample cm-position, as determined from aluminum concentrations.

		cadmium		Copper		Lead		Zinc		Mercury*	
Sta.	n	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.
3	6	1.98	1.11	0.30	0.09	0.52	0.08	0.41	0.04	0.39	0.09
7	6	2.03	2.26	0.63	0.83	0.52	0.22	0.46	0.12	0.41	0.25
9	6	3.03*	1.77	1.18	0.33	1.70*	0.32	2.17*	0.36	2.30*	0.79
12	6	1.72	1.09	1.23*	0.23	1.76*	0.53	2.19*	0.46	2.52*	0.90
14	6	2.75	1.78	1.10	0.13	1.76*	0.22	1.54*	0.08	1.25*	0.23
16	6	2.13*	0.38	0.86	0.31	1.27	0.98	1.85	0.99	2.71	2.05
17	6	6.01*	2.76	1.74*	0.45	2.51*	0.71	2.52*	0.48	4.86*	1.51
18	9	9.79*	4.21	2.60*	0.69	7.29*	1.91	7.03*	1.77	15.51*	6.69
19	6	3.69*	1.56	0.65	0.17	1.10	0.39	1.26	0.33	2.10	1.11
22	6	3.81*	2.50	0.54	0.14	0.42	0.05	0.35	0.04	0.28	0.05
24	6	5.36*	1.79	1.09	0.20	2.43*	0.35	2.34*	0.24	5.64*	2.16
25	6	1.63	1.59	0.25	0.06	0.51	0.11	0.40	0.08	0.69	0.16
27	6	2.91*	1.33	1.03	0.19	1.61*	0.08	1.64*	0.15	4.63*	1.18
28	6	1.70	2.64	0.80	0.33	0.68	0.21	0.43	0.09	2.26	1.28
29	6	2.67*	0.41	0.90	0.05	1.51*	0.11	0.91	0.14	0.86	0.38
30	6	5.50*	0.36	0.57	0.02	0.92	0.07	0.38	0.04	1.19	0.43
101	3	0.79	0.61	0.41	0.15	0.54	0.21	0.88	0.16	0.88	0.12
104	3	3.49*	0.34	9.72*	0.51	3.80*	0.57	3.56*	0.42	4.03*	0.32
105	3	2.80*	0.32	1.67*	0.17	2.54*	0.35	2.23*	0.25	1.71*	0.29
106	3	1.35	0.44	0.85	0.44	0.86	0.18	0.75	0.06	0.45	0.06
107	3	0.69	0.18	1.35*	0.28	1.42*	0.08	1.78*	0.23	1.43	0.14
108	3	3.94*	1.58	1.38	0.93	1.18	0.12	0.85	0.14	0.66	0.07
109	3	2.30*	0.11	1.18*	0.05	2.05*	0.12	2.30*	0.09	3.00*	0.18
111	3	2.83*	0.40	2.13*	0.26	6.39*	1.29	1.99*	0.24	1.48	0.80
112	3	4.42	4.53	1.09	0.20	2.39*	0.86	1.26	0.36	0.59	0.11
113	3	7.93*	0.28	2.32*	0.09	15.79*	0.65	5.68*	0.57	5.43*	0.41
114	3	8.59*	0.67	2.79*	0.20	10.86*	0.05	8.31*	0.47	6.96*	0.78
116	3	4.08*	0.63	1.20*	0.16	4.00*	0.08	2.71*	0.28	4.48*	0.96
117	3	2.94*	0.39	1.70*	0.30	3.51*	0.76	2.27*	0.27	4.41*	1.33
126	3	4.41*	0.46	1.42*	0.17	1.02	0.19	2.25*	0.16	5.04*	1.22
128	3	1.09	0.24	0.37	0.08	0.60	0.36	0.08	0.05	0.13	0.03
129	3	5.62*	2.72	0.31	0.14	0.10	0.09	0.03	0.00	0.10	0.00

* Sediments considered enriched if x less one S.D. is greater than 1.00.

(15 stations, 5 metals), statistically significant changes were observed in over 25% of the cases. The majority of these, almost 20% of the total, represented increases in metal concentration with respect to sediment aluminum content. Not all metals at a given station were significantly different from sampling to sampling; however, if an increase in one metal was observed, other significant changes also represented increases. At Station 16, off Point La Vista, decreases in all metals except cadmium were recorded, while increases in metal content were observed at Station 17, at the mouth of the Ortega River, again for all metals except cadmium. Table 12 summarizes these observed changes.

Station 18, at the confluence of the Ortega and Cedar Rivers, was the only location processed for sediment metals during all three field episodes. Although no significant changes in metal enrichment had been observed between May and September, 1987 at this station, the March, 1988, sampling brought a reduction in all metal ratios with the exception of mercury. This was primarily the result of a significant increase in bulk aluminum concentrations as the remainder of the raw metal concentrations showed little change from previous results at this location. Nevertheless, this station was still considered extremely enriched for all metals, with concentrations between 1.1 and 3.4 times that of the upper 95% confidence interval.

Using the study means of all stations sampled, multiple linear correlations were run of particular metal concentrations against the respective carbon, percent silt-clay, or aluminum content of the samples. Aluminum accounted for only slightly more variability in copper,lead, and zinc concentrations than did percent silt-clay. This would indicate that metal:aluminum ratios were most consistent among stations for these metals, i.e. fewer outliers. Cadmium, on the other hand, was slightly more strongly correlated with percent silt-clay and mercury was more closely associated with organic carbon content among the stations sampled.

The results of the above regressions, however, are indicative of not only processes within the St. Johns River basin, but also a function of the stations sampled and degree of contamination. For basin wide relationships, therefore, those stations and means determined as enriched

Table 12. Changes in Metal:Aluminum ratios of sediment, St. Johns River, May to September 1987.

Station	Cadmium	Copper	Lead	Mercury	Zinc
3	I				
7	I				
9				I	
12					
14	I				
16			D	D	D
17				I	I
18					
19			D		D
22					
24					
25					
27					
28					
30					

I - Increase May to September 1987.

D - Decrease May to September 1987.

- Statistically significant (t-test, 0.05 level).

by FDER techniques were eliminated from the data base and multiple regressions repeated using aluminum, percent silt-clay and TOC as independent variables. Results of regressions with uncontaminated stations were similar to those on the entire data base. Most of the inter-station variability in sediment copper, lead, and zinc levels could again be accounted for by aluminum concentrations. Both cadmium and mercury concentrations, on the other hand, were more closely correlated with percent silt-clay, followed by organic carbon levels. This result may account to some degree for the poorer fit for cadmium-aluminum regressions in FDER's "clean" data set and for the inverse relationship between mercury and aluminum in the same data.

Whether determining enriched areas as statistical outliers from a Florida-wide data base, or whether interpolated from reported global ratios, the spatial pattern of metal contamination within the St. John’s River is quite similar. Sediments in the region from the Trout to the Ortega Rivers are the most enriched and for the more of the metals analyzed. Specific tributaries or localities with the most severe metals contamination are the Cedar River, Big Fishweir Creek as it enters the St. Johns River, the confluence of the Ortega and Cedar Rivers, and Moncrief Creek entering the Trout River. These sites were enriched in all metals analyzed, as determined by the more conservative FDER technique. The Tallyrand and Arlington River areas, where diseased fish had been collected were, on the other hand, less notable, with only zinc and lead slightly enriched. Julington Creek also represents a substantial source of metals contamination to this estuary.

D. QUALITY ASSURANCE

In accordance with the FDER approved quality assurance program for The Characterization of Baseline Conditions of the Physical, Chemical, and Microbiological Environments in the St. Johns River Estuary, the following are highlights of the items performed as internal quality assurance measures for this task.

Instruments used for in situ water column measurements, Martek Mark VII and YSI 57, were pre- and post-calibrated against known standards or alternate instrumentation before and after each sampling effort. Logbook pages identify the serial numbers of the instruments actually used. In situ measurements were also routinely repeated to give a combined measure of field precision and system variability. The agreement between replicate measurements, as percent relative standard deviations, appear in Tables 13, 14, and 15. These precisions were within those stated as quality assurance goals for this project in Section 5 of the above referenced document.

All samples were maintained on ice from collection until receipt at the various laboratories (MML and Dr. Gary Rodrick). Custody control procedures were performed as stated in the project plan. No anomalies were noted at the time of sample receipt. Samples were stored as appropriate for the various analyses. Samples for nutrients, carbon, grain size, moisture and metals were refrigerated at 4°C for one week or less and then were subsequently frozen until remaining grain size and mercury analyses could be performed. Analytical methods were as stated in the Quality Assurance Program, and as described previously in this document. Tables 13 through 15 also summarize precision and accuracy results obtained from analytical data groups and the number of quality assurance analyses processed. Precision and accuracy values for all data groups reported were within the target values specified by the quality assurance program. All samples were processed within the holding times specified by EPA/CE-81-1.

Analytical instrumentation --Technicon AutoAnalyzer II, OI 524 Total Carbon Analyzer, IL 251 Atomic Absorption Spectrophotometer-- were calibrated daily and during each analytical run by analyzing known standard solutions or gases. Standards and spikes were digested with samples to obtain overall as well as matrix dependent accuracies.

Data entry followed MML standard conventions in that 100% of all manual transfers of data were proofed. Calculations employed, for salinity, correction of dissolved oxygen for ambient salinity, sediment statistics, percent moisture, and all conversions from analytical concentrations to concentrations based on sediment weights are performed as described in the Quality Assurance Program using tested microcomputer programs to minimize operator keypunch error.

Table 13. Quality assurance targets and results for precision and accuracy, St. Johns River, May 1987 collection.

	TARGET				RESULTS					
	Precision		Accuracy		Precision			Accuracy		
Parameter	$\overline{x}$ %RSD,	S.D.	$\overline{x}$ % Recovery,	S.D.	n,	$\overline{x}$ %RSD,	S.D.	n,	$\overline{x}$ % Recovery,	S.D.
Dissolved Oxygen	3,	5	101,	2	8,	0.7,	0.8	2,	100.1,	1.0
Salinity	5,	8	102,	5	8,	0.4,	0.7	1,	100.9,	--
Temperature	5,	4	99,	4	8,	0.3,	0.5	1,	98.4,	--
pH	2,	3	99,	3	8,	0.2,	0.2	1,	101.8,	--
Total Kjeldahl Nitrogen	8,	12	100,	9	18,	8.3,	10.6	17,	100.4	11.3
Total Phosphorus	7,	8	104,	12	15,	8.2,	6.4	14,	100.7	14.0
Total Organic Carbon	9,	5	97,	11	112,	8.1,	5.4	24,	96.8,	14.8
% Moisture	2,	1	--		11,	1.0,	1.3		--	
Grain Size (mean)	5,	3	--		14,	1.7,	1.7		--	
Aluminum	6,	4	99,	9	15,	4.5,	5.4	11,	92.4,	15.5
Cadmium	8,	5	97,	8	8,	8.9,	7.0	8,	87.3,	5.4
Copper	7,	3	99,	6	17,	5.1,	5.3	12,	93.2,	7.7
Lead	8,	5	97,	8	19,	5.1,	5.3	12,	92.7,	5.1
Mercury	8,	4	98,	7	15,	9.1,	6.8	13,	88.9,	9.8
zinc	7,	3	98,	6	19,	3.2,	3.3	11,	97.2	7.6

Table 14. Quality assurance targets and results for precision and accuracy, St. Johns River, September 1987 collection.

	TARGET				RESULTS					
	Precision		Accuracy		Precision			Accuracy		
Parameter	$\bar{x}$ %RSD,	S.D.	$\bar{x}$ % Recovery,	S.D.	n,	$\bar{x}$ %RSD,	S.D.	n,	$\bar{x}$ % Recovery,	S.D.
Dissolved Oxygen	3,	5	101,	2	7,	0.1,	0.3	2,	99.2,	0.8
Salinity	5,	8	102,	5	7,	0.9,	1.2	1,	96.5,	--
Temperature	5,	4	99,	4	7,	0.2,	0.1	1,	97.5,	--
pH	2,	3	99,	3	7,	0.3,	0.3	2,	99.4,	6.7
Total Kjeldahl Nitrogen	8,	12	100,	9	19,	8.0,	6.3	10,	97.1	9.5
Total Phosphorus	7,	8	104,	12	17,	7.3,	5.4	11,	90.5	17.4
Total Organic Carbon	9,	5	97,	11	101,	8.1,	6.0		--	
% Moisture	2,	1	--		12,	0.5,	0.6		--	
Grain Size (man)	5,	3	--		11,	5.2,	5.1		--	
Aluminum	6,	4	99,	9	9,	4.6,	3.0	5,	87.8,	12.7
Cadmium	8,	5	97,	8	8,	8.6,	6.9	10,	96.1,	7.9
Copper	7,	3	99,	6	9,	3.5,	2.7	10,	92.3,	5.5
Lead	8,	5	97,	8	9,	8.3,	7.3	9,	91.0,	7.6
Mercury	8,	4	98,	7	9,	9.1,	6.7	6,	101.3,	15.7
zinc	7,	3	98,	6	9,	4.4,	3.4	4,	107.5	15.8

Table 15. Quality assurance targets and results for precision and accuracy, St. Johns River, March 1988 collection.

Parameter	TARGET Precision		TARGET Accuracy		RESULTS Precision			RESULTS Accuracy		
	$\bar{x}$ %RSD,	S.D.	$\bar{x}$ % Recovery,	S.D.	-n,	$\bar{x}$ %RSD,	S.D.	n,	$\bar{x}$ % Recovery,	S.D.
Dissolved Oxygen	3,	5	101,	2	2,	0.4,	0.6	2,	103.2,	2.2
Salinity	5,	8	102,	5	2,	2.1,	2.1	11,	100.3,	9.7
Temperature	5,	4	99,	4	2,	0.3,	0.4	2,	98.9,	0.3
pH	2,	3	99,	3	2,	0.3,	0.1	2,	101.2,	3.1
Total Kjeldahl Nitrogen	8,	12	100,	9	22,	4.5,	6.0	16,	102.4	13.2
Total Phosphorus	7,	8	104,	12	22,	3.1,	4.0	12,	86.1	11.8
Total Organic Carbon	9,	5	97,	11	93,	5.9,	4.5		91.2	11.5
% Moisture	2,	1	--		20,	4.5,	4.6	--		
Grain Size (mean)	5,	3	--		14,	4.4,	6.3		--	
Aluminum	6,	4	99,	9	9,	3.7,	3.4	8,	106.6,	10.1
cadmium	8,	5	97,	8	8,	5.7,	5.5	7,	88.4,	3.4
Copper	7,	3	99,	6	8,	3.5,	3.1	7,	89.4,	6.7
Lead	8,	5	97,	8	9,	5.6,	3.8	5,	97.9,	9.9
Mercury	8,	4	98,	7	11,	12.0,	8.8	11,	100.2,	12.0
zinc	7,	3	98,	6	8,	4.5,	4.7	13,	104.3	5.2

III. TOXIC ORGANIC SUBSTANCES

A. INTRODUCTION

Toxic organics are of major concern, because many have been associated with carcinogenicity and mutagenicity in aquatic organisms. The organic parameters measured during this study include: polynuclear aromatic hydrocarbons (PNA), chlorinated hydrocarbon pesticides (ClP), polychlorinated biphenyls (PCB) and coprostanol. Although coprostanol is not known to be toxic, it has been used extensively as an indicator of sewage-derived material which may include the aforementioned compounds along with human enteric bacteria and viruses. The sources of these toxic organics include industrial and agricultural activities. These substances may enter the St. Johns River through direct discharges, land runoff, and from aeolian transport of airborne contaminants.

Most organic contaminants, due to their hydrophobicity, absorb to suspended particles upon entering aquatic systems and become incorporated within the sediments. Analyzing sediment for these contaminants provides a historical record of input and helps to define depositional areas. By comparing sediment contaminant concentrations with various physical-chemical parameters (i.e., % silt-clay, total organic carbon, etc.) it is possible to establish input sources as well as regional impacts.

In addition to inter-site comparison of data, it is possible to compare the condition of the St. Johns River with other areas nationally due to the standardization of analytical methods. The analytical methods utilized in this study were similar to the method established by the National Oceanographic and Atmospheric Administration (NOAA) for the National Status and Trends Program (NS&T), which is designed to evaluate the impacts of human activities on U.S. coastal and estuarine areas (NOAA, 1985). In particular, data obtained from this study were compared to data produced for the NS&T Program Benthic Surveillance Project, which focus on contaminants in sediments, bottom-fish tissue, and histopathological disorders in fish.

B. METHODS

1. Sampling

Three sampling episodes were performed; May 1987 (dry season), September 1987 (wet season), and one in March 1988 as described above (Introduction). Sediment for toxic organic chemical analysis was collected as a composite of 3 grabs with a Ponar sampler at each of 30 sites organics analyzed at 15 sites (Figures 2 and 8) during the first two events. A new set of 16 sample sites was selected for the March 1988 sampling as described above for Metals (Figures 3 and 8), except that organics were not analyzed at site #107. Site 18 was a replicate site from the 1987 sampling stations. Samples were placed in clean 1 pint glass jars with teflon-lined caps and stored on ice for transport to the Laboratory, where they were stored at 4°C until analyzed.

2. Extraction

For analysis, samples were brought to room temperature, and an aliquot of homogenized sample (10-20 g wet wt) was placed in a 250-ml boiling flask. Internal standards and cyclohexane (C_6H_{12}) was added to the flask, and a Stark and Dean moisture trap was attached to the boiling flask. The sample was refluxed until all the water was isolated in the trap. The C_6H_{12} was recovered and samples extracted with dichloromethane (CH_2Cl_2) under reflux, and the C_6H_{12} and CH_2Cl_2 extracts were combined. The combined extracts were concentrated by flash-evaporation, and the C_6H_{12}/CH_2Cl_2 mixture was replaced with hexane (C_6H_{14}). An additional aliquot of sediment sample was oven dried at 103°C until a constant weight for moisture determination.

3. Column Chromatography

Characteristic fractions of these compounds were obtained by chromatographic separations through a column of silica gel and alumina. The extract was charged to the column with hexane, and the constituents eluted from the column as follows: SA1-elute with C_6H_{14} and collect saturated hydrocarbons; SA2-elute with C_6H_{14}:CH_2Cl_2 (20:80) and collect

PNA's, Cl-Pest and PCB's; SA3-elute with methanol (CH_3OH) and collect coprostanol.

4. Gas Chromatography (GC) and Gas Chromatography/Mass Spectrometry (GC/MS)

Quantitative and qualitative determinations of the toxic organics were performed by GC, with confirmatory results by GC/MS of at least 20% of the samples. Analysis of the PNA's and coprostanol was done utilizing a high resolution Varian model 6000 GC (Sunnyvale, CA), equipped with a flame ionization detector (FID). The Cl-Pest and PCB's were analyzed with a Varian model 6500 GC and an electron capture detector (ECD). Both GC's were coupled to a Varian 401 Chromatography Data System (CDS), which was used for data processing and storage.

Each GC was equipped with a 30 m x 0.25 mm DB-5 fused silica column (J&W Scientific, Rancho Cordova, CA) with He as the carrier gas and N_2 as make-up at the detector.

GC/MS confirmation of results was performed by Charles Henry, Louisiana State University, Department of Environmental Studies. The samples were analyzed with a Hewlett-Packard 5890 GC (Palo Alto, CA) directly interfaced to a Hewlett-Packard 5870B Mass Spectrometer. Comparable analytical conditions were followed, thereby allowing direct correlation between GC and GC/MS results.

C. RESULTS

1. Polynuclear Aromatic Hydrocarbons

The concentration of total PNA hydrocarbons for each of the three sampling episodes are shown in Appendix B expressed as ug/g sediment as well as ug/g silt-clay. For those samples containing (10% silt-clay, the PNA relative to % silt-clay is listed in Table 16, indicating questionable reliability of the concentration reported for assessing biological impact from exposure to that sediment environment. The individual PNA concentrations for all stations are listed in Tables 19, 20 and 21. The PNA concentrations from Event 1 ranged from 0.04 ug/g dry sediment at Station 3 at the mouth of the river, to 25.25 ug/g dry sediment at Station 18, located in the Ortega River. The PNA concentrations observed during Event 2 ranged from 0.04 to 7.64 u/g dry sediment with the low and high values again observed at Station 3 and 18, respectively. The new set of stations sampled during March 1988 revealed that tributaries leading to the central St. Johns River contained exceedingly high concentrations of PNA's, implicating these tributaries as major sources for PNA contamination.

Concentrations of individual PNA's observed at each station are given in Appendix B. All stations indicated the presence of both petrogenic (petroleum source; alkyl homologues of PNA's) and pyrogenic (combustion source) hydrocarbons. In most instances, however, the combustion material was dominant (i.e., pyrenes, benzopyrenes, etc.). The source of these pyrogenic hydrocarbons originates from the incomplete combustion of fossil fuels (oil, wood and coal) indicative of a highly industrialized environment, forest fires and marine engine exhaust. These materials may be introduced into the river through direct discharges, from aeolian transport or from drainage of contaminated water shed areas. Most notable was the absence of PNA contamination in the station at the entrance to Lake George (#129).

The sediment composition throughout the study area ranged from very fine silt-clays to coarse sand and shell. Since the hydrocarbons are known to be associated with fine-grain materials, the hydrocarbon distribution is best observed by considering the hydrocarbon concentration relative to the silt-clay content of the sediment. However, those stations containing less than 10% silt-clay were considered unreliable relative to biological impact because of the resulting bias to apparently high PNA content representing less than 10% of the actual sediment sample. From a single-variable regression, it can be shown that there was a good correlation between PNA concentration and % silt-clay material (Event 1 r=0.83; Event 2 r=0.66; Event 3 r=0.70). For uniform comparison, the hydrocarbon concentrations were normalized to the percent silt-clay content of the sediment present at each station (Table 16). From these data it can be seen that high PNA concentrations were observed in the mid regions of the study area for Event 1 (Stations 9, 16 and 18), with lower, yet still high PNA concentrations observed in these regions for Event 2. These stations, with PNA distributions depicted in Figures 17a, 17b, and 17c, showed that elevated amounts of PNA's associated with silt-clay were observed at selected sites throughout the study region. Even though there was considerable variability in PNA concentrations between adjacent sites, the relationship between PNA concentration and silt-clay material indicates ubiquitous distribution through the study area most probably originating from aeolian deposition of pyrogenic PNA's to the water shed with subsequent influx to the river as land runoff at specific sites.

The mean PNA concentration obtained from all stations sampled during Event 1 was 4.58 ug/g dry sediment, 2.32 ug/g dry sediment for Event 2, and 10.74 ug/g dry sediment for Event 3. From the NS&T 1984 Benthic Surveillance Project, St. Johns River was ranked 12th highest in the nation, with a PNA (total of 18 select PNA's) concentration of 4.65 ug/g dry sediment. The mean PNA concentration for the top 20 most contaminated sites was 9.53 ug/g dry sediment, with the highest value reported from Boston Harbor, Massachusetts (65.40 ug/g dry sediment), showing that select tributary stations within the St. Johns River study area are within the range of the top 20 most contaminated sites observed during the NS&T 1984 study.

Table 16. St. Johns River-Toxic Organics.

Event 1

Dry Season Total Polynuclear Aromatic Hydrocarbons

Station	PNA[1] (µg/g dry sed.	% Silt-clay	PNA[2] (ug/g silt-clay)
3	0.04	16.03	0.25
7	0.16	17.81	0.90
9	9.94	31.54	31.52
12	2.71	33.22	8.16
14	1.91	11.24	16.99
16	14.93	36.67	40.71
17	2.26	24.67	9.16
18	25.25	68.69	36.76
19	2.66	24.15	11.01
22	0.09	1.77	(5.10)
24	3.33	34.87	9.55
25	0.08	7.89	(1.00)
27	2.02	32.32	6.05
28	0.32	19.19	1.67
30	2.96	4.56	(65.00)

Event 2

Wet Season Total Polynuclear Aromatic Hydrocarbons

Station	PNA[1] µg/g dry sed.)	% Silt-clay	PNA[2] (ug/g silt-clay)
3	0.04	10.0	0.40
7	0.30	10.8	2.78
9	2.68	38.0	7.05
12	4.26	36.8	11.58
14	2.16	14.7	14.69
16	3.36	65.7	5.11
17	2.54	31.0	8.19
18	7.64	68.8	11.10
19	2.08	70.6	2.95
22	0.31	2.1	(15.00)
24	3.47	57.7	6.01
25	0.22	29.5	0.75
27	2.07	38.7	5.81
28	0.82	19.8	4.14
30	2.83	8.5	(33.00)

Table 16. Continued. St. Johns River-Toxic Organics.

Event 3

Dry Season Total Polynuclear Aromatic Hydrocarbons

Station	PNA[1] (ug/g dry sed.)	% Silt-clay	PNA[2] (ug/g silt-clay)
18	22.38	45.19	49.52
101	8.18	29.25	27.96
104	8.62	71.99	11.97
105	15.45	50.75	30.44
106	2.31	3.87	(59.00)
108	2.19	13.68	16.01
109	2.69	43.86	6.11
111	5.69	9.84	57.82
112	2.58	6.35	(41 .00)
113	21.96	70.56	31.12
114	32.45	75.83	42.79
116	16.33	41.34	39.50
117	17.89	27.64	64.72
126	2.51	16.98	14.78
128	0.54	0.29	(186.00)
129	0.20	0.55	(36.00)

[1] PNA = Total of 18 polynuclear aromatic hydrocarbons.

2 () = Represents sediment containing <10% silt-clay content.

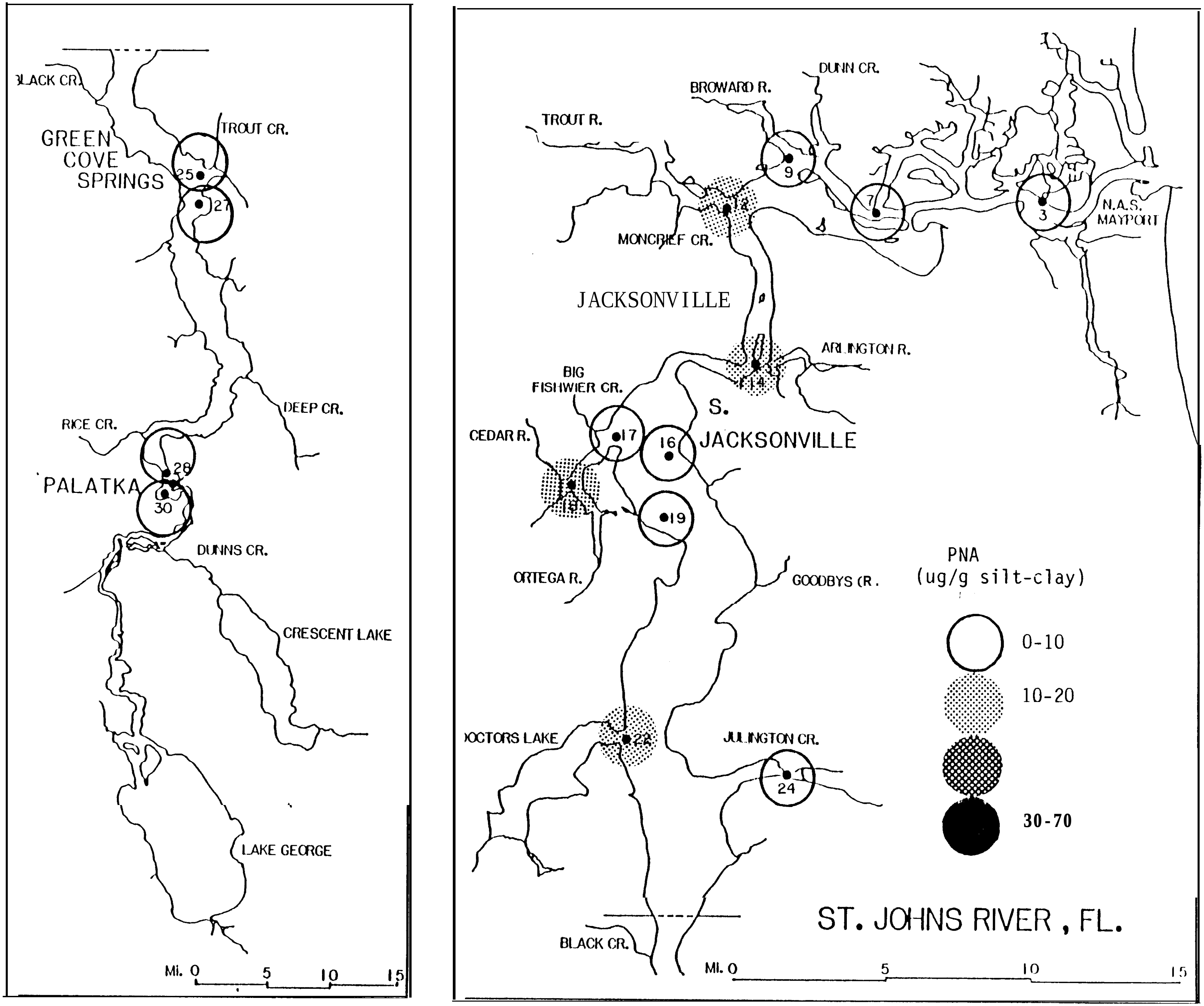


Figure 17a. Total PNA Distribution - Event 1 (May 1987).

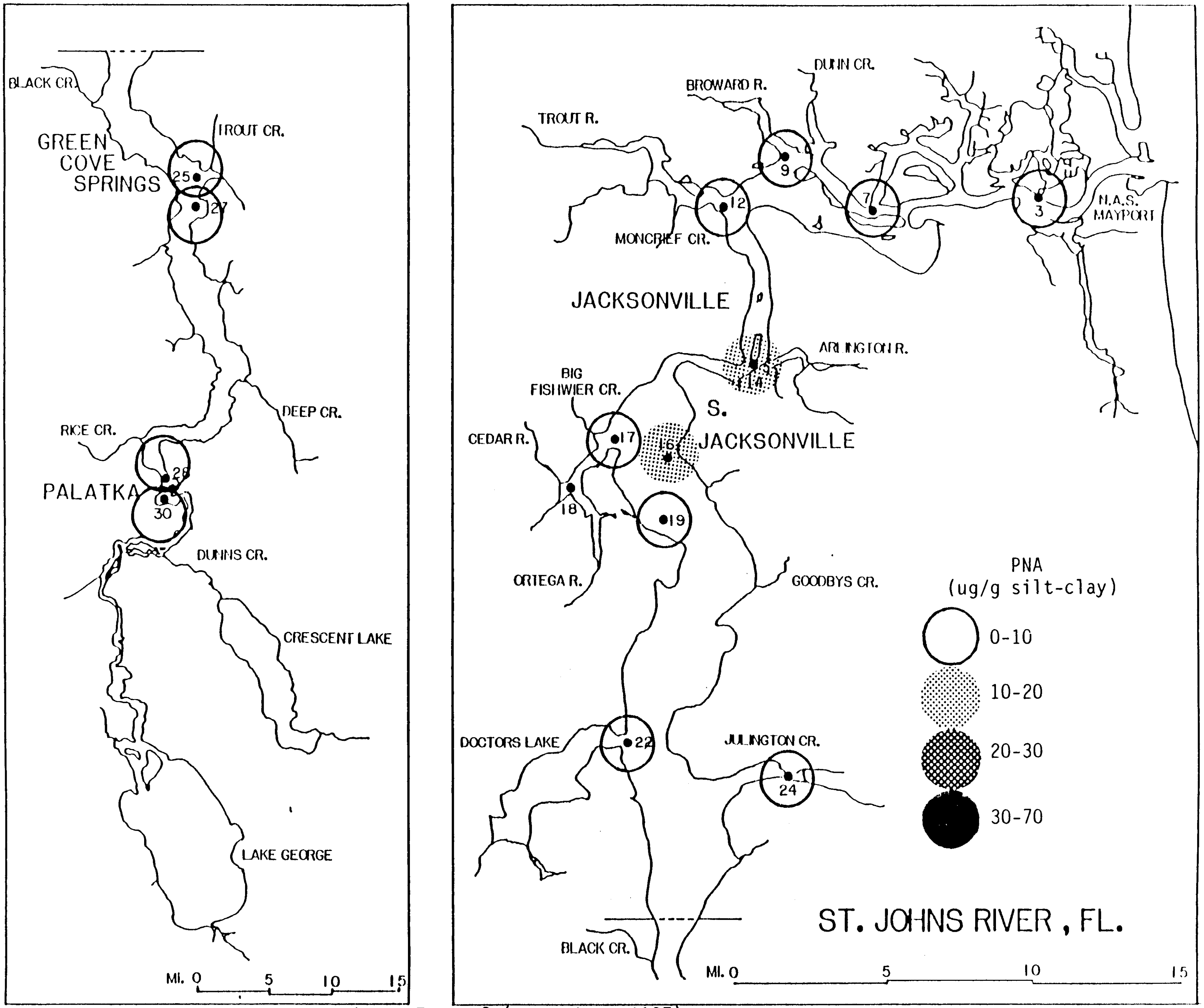


Figure 17b. Total PNA Distribution - Event 2 (September, 1987).

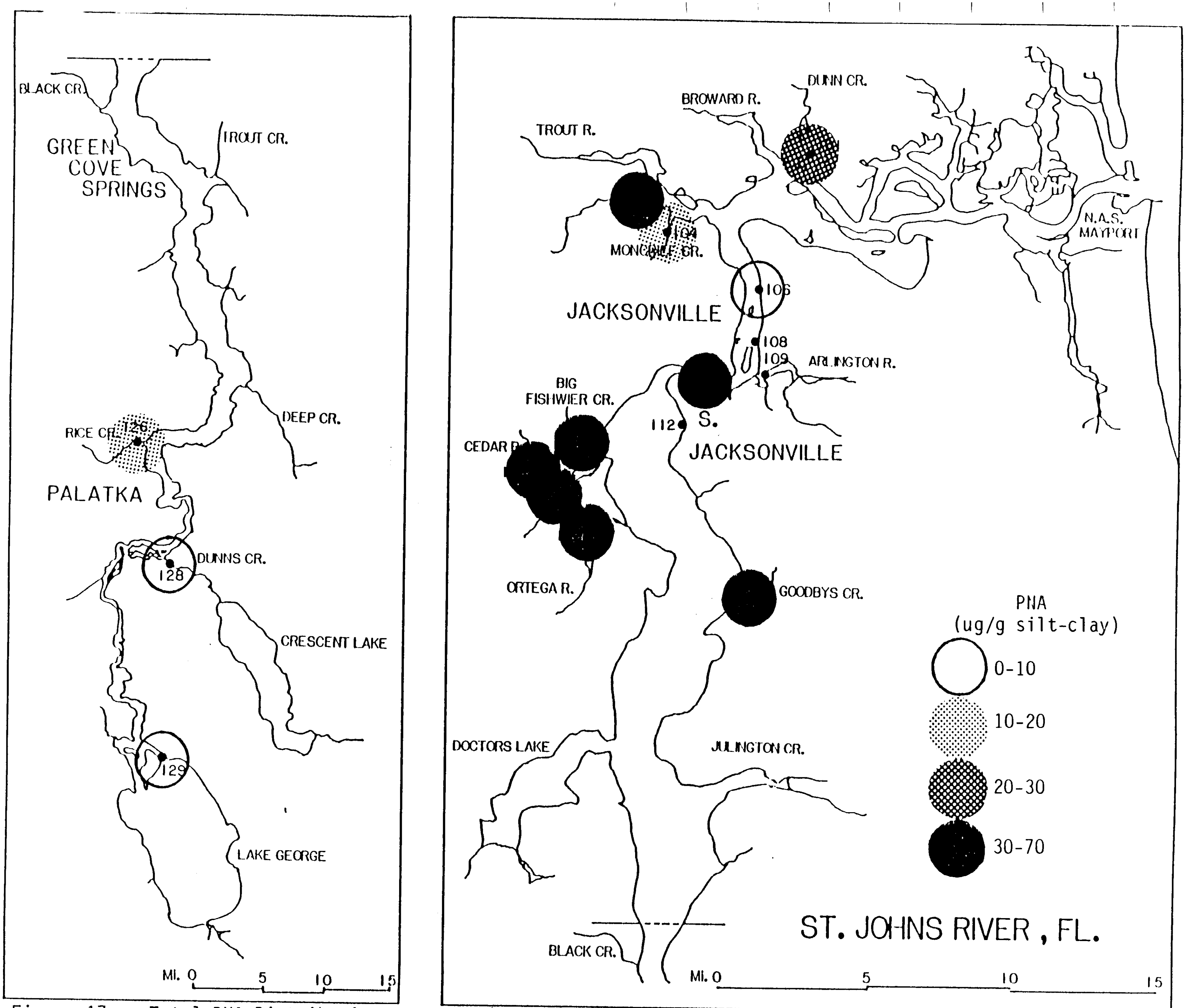


Figure 17c. Total PNA Distribution, Event 3 (March, 1988).

2. Coprostanol

Coprostanol is used to evaluate the input of fecal-derived material to aquatic systems. These materials may enter the river from direct discharge of treated wastes, liveaboard boats, septic tank leachates, and runoff from pastures and barnyards (Brown & Wade, 1984; Walker et al., 1982).

The sediment content of the fecal sterol, coprostanol, is given in Table 17. The concentrations for Event 1 samples, ranged from below detectable limits (0.01 ug/g dry sediment) at Station 3 to 3.69 ug/g dry sediment at Station 24, located in Julington Creek; those observed during Event 2 ranged from 0.02-2.18 ug/g dry sediment; and Event 3 samples ranged from 0.06 to 2.17 ug/g dry weight sediment indicating similar fecal matter input to all stations sampled. Coprostanol, like the PNA's tends to associate with fine-grain material in the aquatic environment; therefore, all concentrations were normalized to the amount of silt-clay material determined at each site, except for those stations containing (10% silt-clay.

Similar to the PNA distribution, the greatest impact observed from sewage derived material from Event 1 sites occurred in the mid and upper reaches of the river from the mouth of the Broward River to Palatka (Figure 18a). Event 2 results exhibited a similar distribution with lower concentrations overall (Figure 18b), and Event 3 showed similar concentrations in the tributaries (Figure 18c). Unlike the PNA's, there was very poor correlation of coprostanol with silt-clay material (Event 1 r=0.44; Event 2 r=0.54; Event 3 4=-0.11). Also, coprostanol did not exhibit higher concentrations in the tributaries over the St. Johns River stations as did the PNA, indicates that the PNA's and coprostanol originated from different sources. This concept is supported by the fact that no correlation exists between PNA and coprostanol concentrations for Event 1 r=0.25 and Event 2 r=0.43, which represent primarily river stations. Event 3 stations show r=0.73 with PNA, which reflects the fact that tributaries contained elevated concentrations of both coprostanol and PNA.

Comparison of coprostanol concentrations from the St. Johns River (<0.01-3.69 ppm) with those observed from other coastal areas of the U.S.

(NOAA Benthic Surveillance Program, 1984 (mean of top 20 most contaminated is 4.40 ppm), show that areas within the river and major tributaries are quite heavily contaminated with sewage derived material. No appreciable fecal input was observed at the Lake George station, relative to total sediment. The silt-clay fraction (8.5%) of total sediment, would have contained high coprostanol content (4.5 ug/g) if all of the coprostanol was associated with this fraction only. These data indicate a potent source of sewage-derived material to the Lake George area, but the station sampled did not represent a site for accumulation of these substances or of impact of sewage-derived material to aquatic organisms.

Table 17. St. Johns River-Coprostanol.

Event 1

Station	Coprostanol (µg/g dry sed.	% Silt-clay	Coprostanol (ug/g Silt-clay)
3	<MDL[1]	16.03	0.01
7	0.05	17.81	0.28
9	0.73	31.54	2.31
12	0.51	33.22	1.53
14	0.16	11.24	1.42
16	2.70	36.67	7.36
17	0.46	24.67	1.86
18	0.86	68.69	1.25
19	1.48	24.15	6.13
22	0.05	1.77	(2.82)
24	3.69	34.87	10.58
25	0.20	7.89	(2.53)
27	1.50	32.32	4.64
28	1.57	19.19	8.18
30	0.35	4.56	(7.67)

Event 2

Station	Coprostanol µg/g dry sed.)	% Silt-clay	Coprostanol (ug/g Silt-clay)
3	0.09	14.0	0.64
7	0.02	10.8	0.18
9	0.16	38.0	0.42
12	0.25	36.8	0.68
14	0.05	14.7	0.34
16	1.96	65.7	2.99
17	0.40	31.0	1.29
18	1.14	68.8	1.66
19	1.02	70.6	1.44
22	0.04	2.1	(1.90)
24	2.18	57.7	3.78
25	0.16	29.5	0.54
27	1.61	38.7	4.16
28	0.84	19.8	4.24
30	0.38	8.5	(4.47)

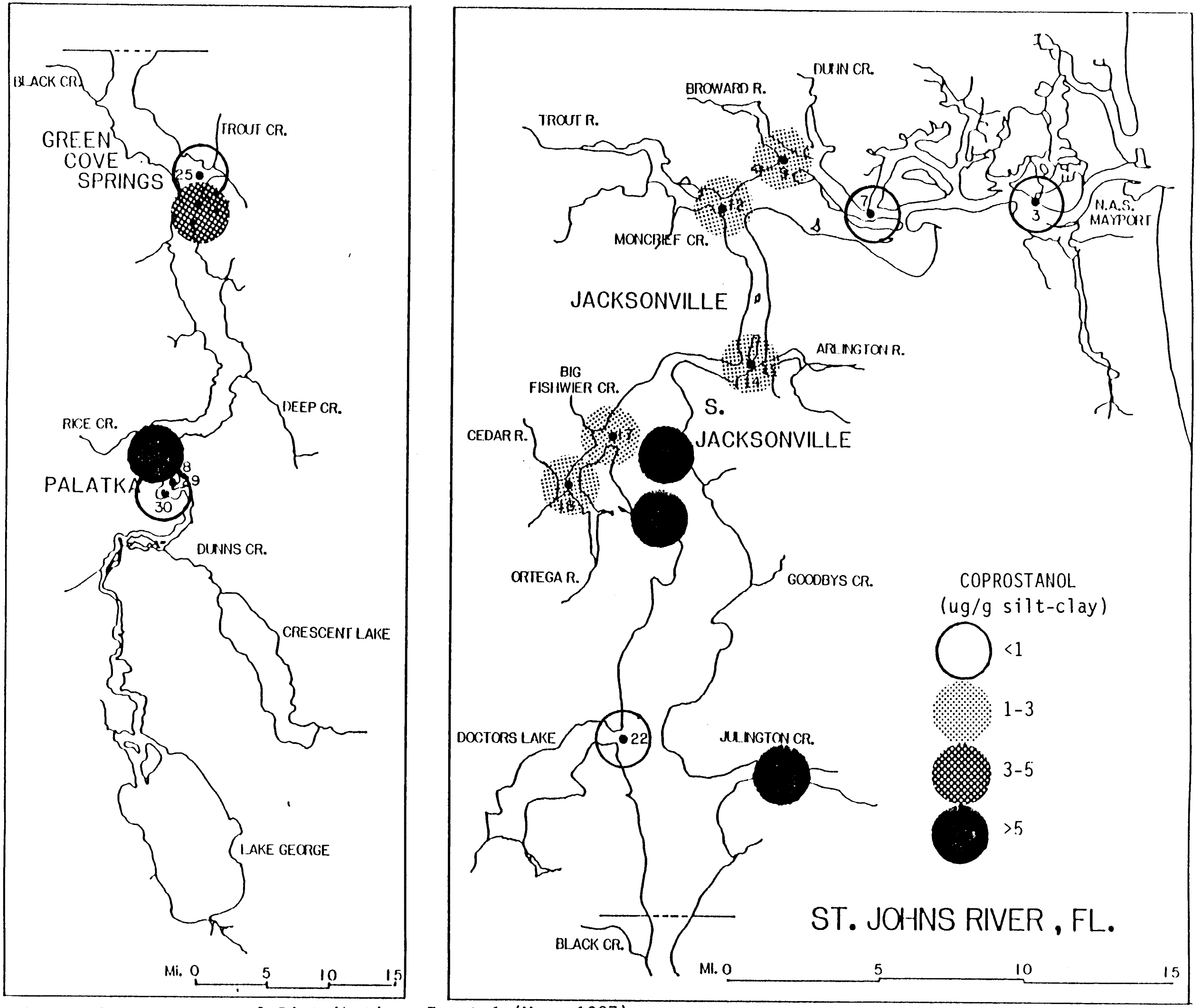
---

[1] MDL = method detection limit (0.01 ug/g dry sediment).

Table 17. Continued. St. Johns River-Coprostanol.

Event 3

Station	Coprostanol µg/g	% Silt-clay	Coprostanol (ug/g silt-clay)
18	1.38	45.19	3.05
101	0.69	29.25	2.36
104	1.63	71.99	2.26
105	1.82	50.75	3.59
106	0.06	3.87	(1.57)
108	0.09	13.68	0.66
109	0.30	43.86	0.68
111	0.10	9.84	(10.20)
112	0.09	6.35	(1.43)
113	1.04	70.56	1.47
114	1.49	75.83	1.96
116	2.17	41.34	5.25
117	0.89	27.64	3.22
126	0.62	16.98	3.65
128	0.07	0.39	(17.90)
129	0.15	0.55	(27.30)



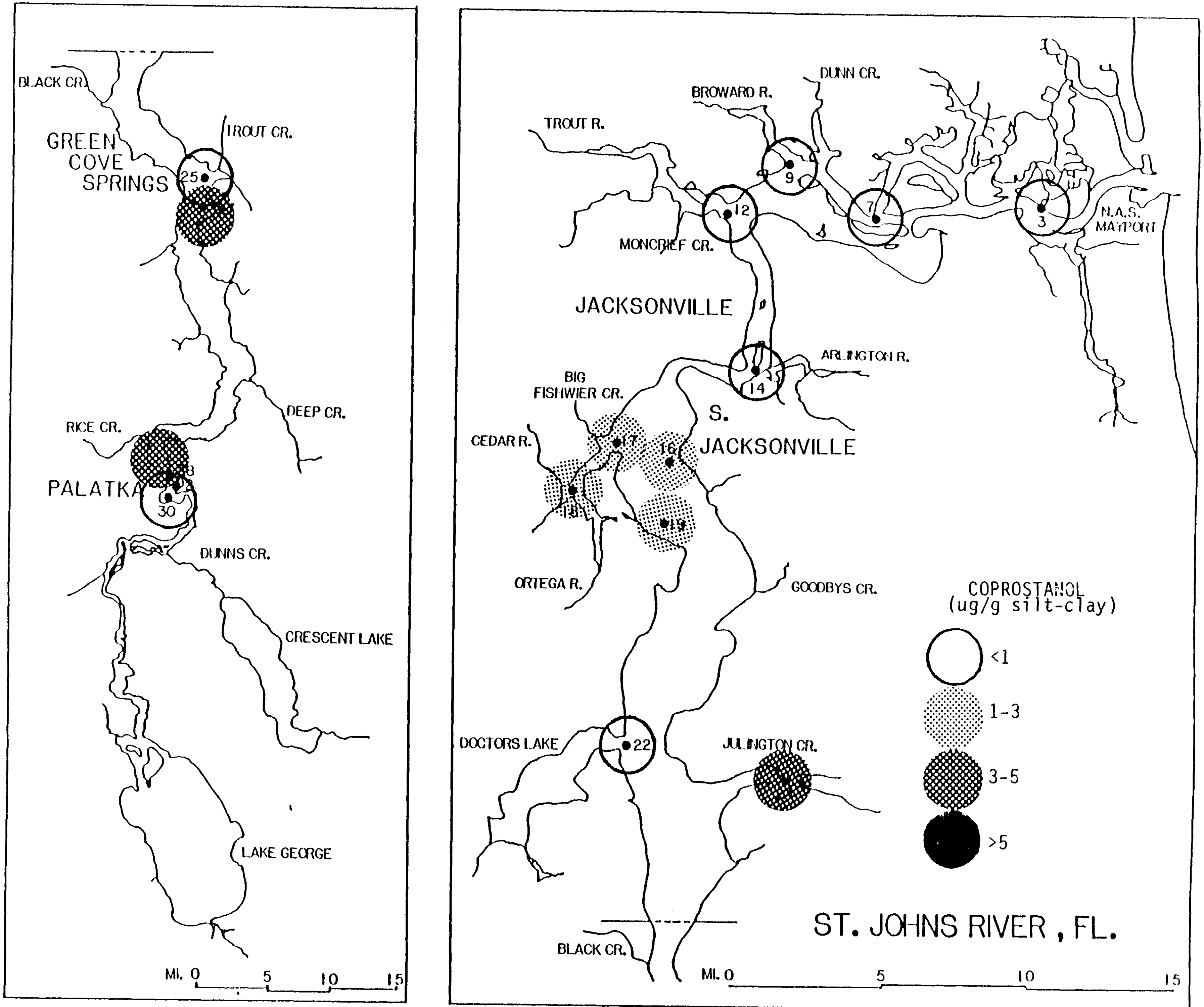


Figure 18b. Coprostanol Distribution, Event 2 (September, 1987).

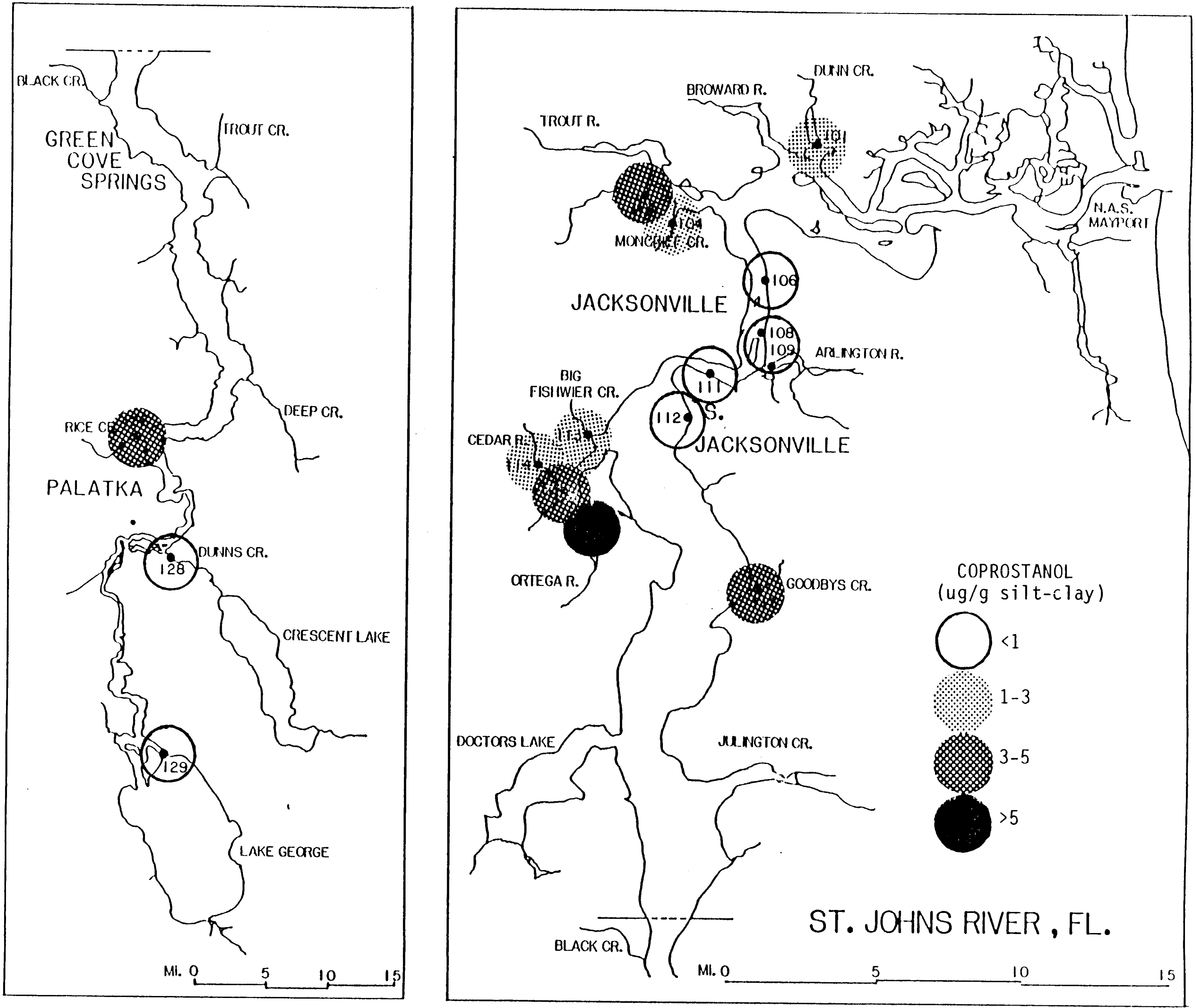


Figure 18c. Coprostanol Distribution, Event 3 (March 1988).

3. Chlorinated Hydrocarbon Pesticides and PCB's

Chlorinated pesticides (Cl-Pest) and PCB's enter the marine environment from select industrial and agricultural activities as well as from aeolian deposition. Even though the use of many of the compounds has been terminated, many toxic degradation products as well as the parent compounds are still observed in aquatic systems due to their persistence. Some of these Cl-Pest, along with select PCB isomers (Cl-2 through Cl-9 homologues) were analyzed in St. Johns River sediment to determine impact from agricultural and industrial activities.

The most abundant Cl-pest included -chlordane; trans-nanochlor and some of the DDT derivations (Appendix B). Predominant PCB compounds were the tri-, tetra-, penta- and hexa-chlorinated isomers (Appendix B).

Analysis of total Cl-pest in sediment during Event 1 exhibited elevated concentrations (>50 ng/g silt-clay) at 8 of the stations with an average concentration from all 15 stations of 134 ng/g silt-clay. Event 2 samples showed a slight decrease in concentration (113 ng/g silt-clay) yet more of the stations elevated amounts (10 stations) (Table 18; Figures 19a, 19b and 19c). Event 3 stations, situated to evaluate major tributaries, exhibited similar Cl-Pest concentrations to the previous sampling in the tributaries, but much less in St. Johns River stations, resulting in an average concentration of 75 ng/g silt-clay. These results show that of those monitored, DDT and chlordane was the primary chlorinated hydrocarbon pesticide contaminants. For chlordane, the concentration was generally less than 50 ng/g dry weight sediment (0.05 ppm) except for Event 1 Station 18 (Ortega River) and Event 2 Stations 18 (Ortega River and 19 (St. John River off the Naval Air Station). These data show that Cl-pest were present in surface sediment throughout the St. Johns River (none detected in the Lake George station) with the highest levels occurring in the Ortega River through the South Jacksonville areas.

For several years, chlordane has been used extensively for termite control around buildings and not for crops. DDT has not been used for almost 20 years, yet the parent compounds, op'- and pp',DDT were the most abundant isomers, indicating recent input, or preservation in association with sediment.

The PCB distribution was similar to that for Cl-pest, showing no preference for tributaries over the main river (Table 18, Figures 20a, 20b and 20c). The highest concentrations were observed along the mid-St. Johns River area, with very high (>1,000 ng/g silt-clay) at Stations 14 and 18.

The concentration of PCB isomers reported in the NS&T Benthic Surveillance Program for St. Johns River was 232 ng/g dry sediment. This value was ranked nineteenth, with the highest concentration observed in Boston Harbor, Massachusetts, with 50,500 ng/g dry weight sediment.

Although low levels of PCB contaminants have been attributed to aeolian transport, the high levels exhibited at several sites within the study area indicate direct input from point, or fairly distinct non-point sources. These data show that chlorinated organics did not originate from the same sources as PNA's (primarily combustion source, aeolian distribution to watershed runoff) or from the same source as coprostanol (sewage). These results indicate that the source of chlorinated compounds would be from various residential-industrial sources. The locations exhibiting elevated Cl compound concentrations are indicative of specific pollution sources on tributaries and direct drainage into the St. Johns River.

Table 18. St. Johns River - Toxic Organics, Sampling Event 1.

Chlorinated Pesticides

Station	Cl-Pest (ng/g dry sed.)	% Silt-Clay	Cl-Pest (ng/g silt-clay)
3	4	16.0	25.0
7	<0.1	17.8	<0.1
9	37	31.5	117.5
12	60	33.2	180.7
14	56	11.2	500.0
16	76	36.7	207.1
17	34	24.7	137.6
18	165	68.7	240.2
19	50	24.2	206.6
22	5	1.8	(277.8)
24	17	34.8	48.7
25	6	7.9	(75.9)
27	106	32.3	328.2
28	3	19.2	15.6
30	18	4.6	(391.3)

PCB's

Station	PCB[1] (ng/g dry sed.)	% Silt-Clay	PCB (ng/g silt-clay)
3	6	16.0	37.5
7	6	17.8	33.7
9	86	31.5	273.0
12	126	33.2	379.5
14	216	11.2	1928.6
16	177	36.7	482.3
17	123	24.7	498.0
18	788	68.7	1147.0
19	124	24.2	512.4
22	8	1.8	(444.4)
24	42	34.9	120.3
25	6	7.9	(75.9)
27	36	32.3	111.4
28	16	19.2	83.3
30	16	4.6	(347.8)

[1] Total of select PCB isomers.

Table 18. Continued. St. Johns River - Toxic Organics, Sampling Event 2.

Chlorinated Pesticides

Station	Cl-Pest (n/g dry sed.)	% Silt-Clay	Cl-Pest (ng/g silt-clay)
3	3	14.0	21.5
7	3	10.8	27.8
9	28	38.0	73.7
12	26	36.8	70.6
14	41	14.7	278.9
16	85	65.7	129.4
17	24	31.0	77.4
18	310	68.8	450.6
19	167	70.6	236.5
22	6	2.1	(285.7)
24	115	57.7	199.3
25	6	29.5	20.3
27	45	38.7	116.3
28	12	19.8	60.6
30	26	8.5	(305.9)

PCB's

Station	PCB[1] (n/g dry sed.)	% Silt-Clay	PCB (ng/g silt-clay)
3	4	14.0	28.6
7	6	10.8	55.6
9	61	38.0	160.5
12	109	36.8	296.2
14	272	14.7	1850.3
16	214	65.7	325.7
17	107	31.0	345.2
18	1776	68.8	2581.4
19	250	70.6	354.2
22	7	2.1	(333.3)
24	193	57.7	334.5
25	15	29.5	50.8
27	111	38.7	286.8
28	10	19.8	50.5
30	11	8.5	(129.4)

[1] Total of select PCB isomers.

Table 18. Continued. St. Johns River - Toxic Organics, Sampling Event 3.

Chlorinated Pesticides

Station	Cl-Pest (ng/g dry sed.)	% Silt-Clay	Cl-Pest (ng/g silt-clay)
18	84.8	45.19	187.7
101	60.7	29.25	207.2
104	25.7	71.99	36.7
105	24.6	50.75	48.4
106	27.9	3.87	(734.0)
108	29.9	13.68	218.2
109	17.1	43.86	39.0
111	55.3	9.84	553.0
112	13.5	6.35	NA
113	113.0	70.56	160.3
114	31.6	75.83	41.7
116	63.5	41.34	153.8
117	69.1	27.64	33.0
126	<0.1	16.98	<1.0
128	<0.1	0.39	<1.0
129	<0.1	0.55	<1.0

PCB's

Station	Cl-Pest (n/g dry sed.)	% Silt-Clay	Cl-Pest (ng/g silt-clay)
18	119.1	45.19	263.5
101	70.0	29.25	238.9
104	247.1	71.99	343.2
105	6.0	50.75	11.8
106	9.4	3.87	(247.0)
108	47.3	13.68	345.3
109	5.5	43.86	12.5
111	7.2	9.84	72.7
112	6.3	6.35	(100.0)
113	31.5	70.56	44.6
114	243.6	75.83	320.5
116	55.5	41.34	134.4
117	31.0	27.64	112.3
126	12.7	16.98	74.7
128	19.5	0.39	(5000.0)
129	2.1	0.55	(318.0)

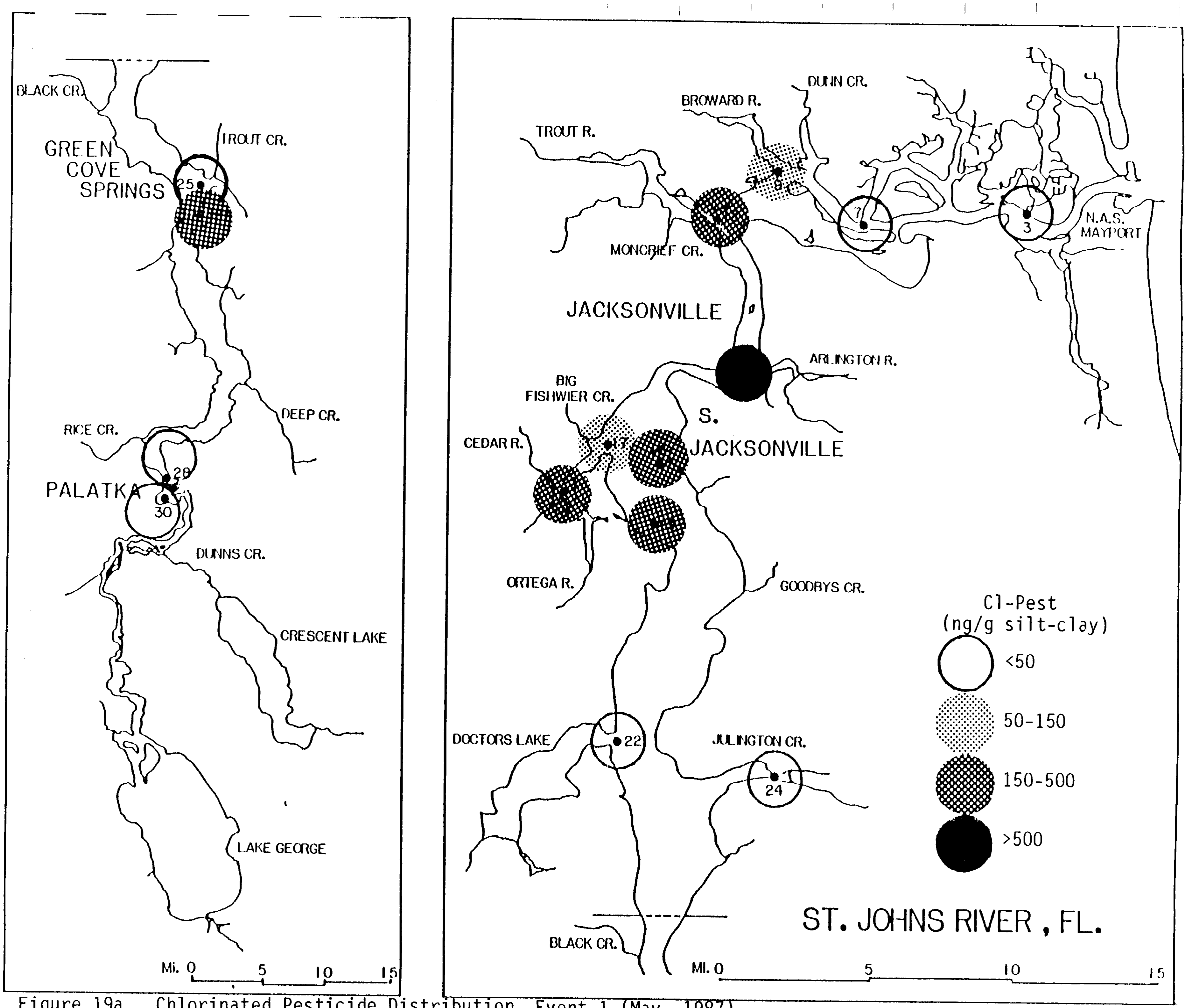


Figure 19a. Chlorinated Pesticide Distribution, Event 1 (May, 1987).

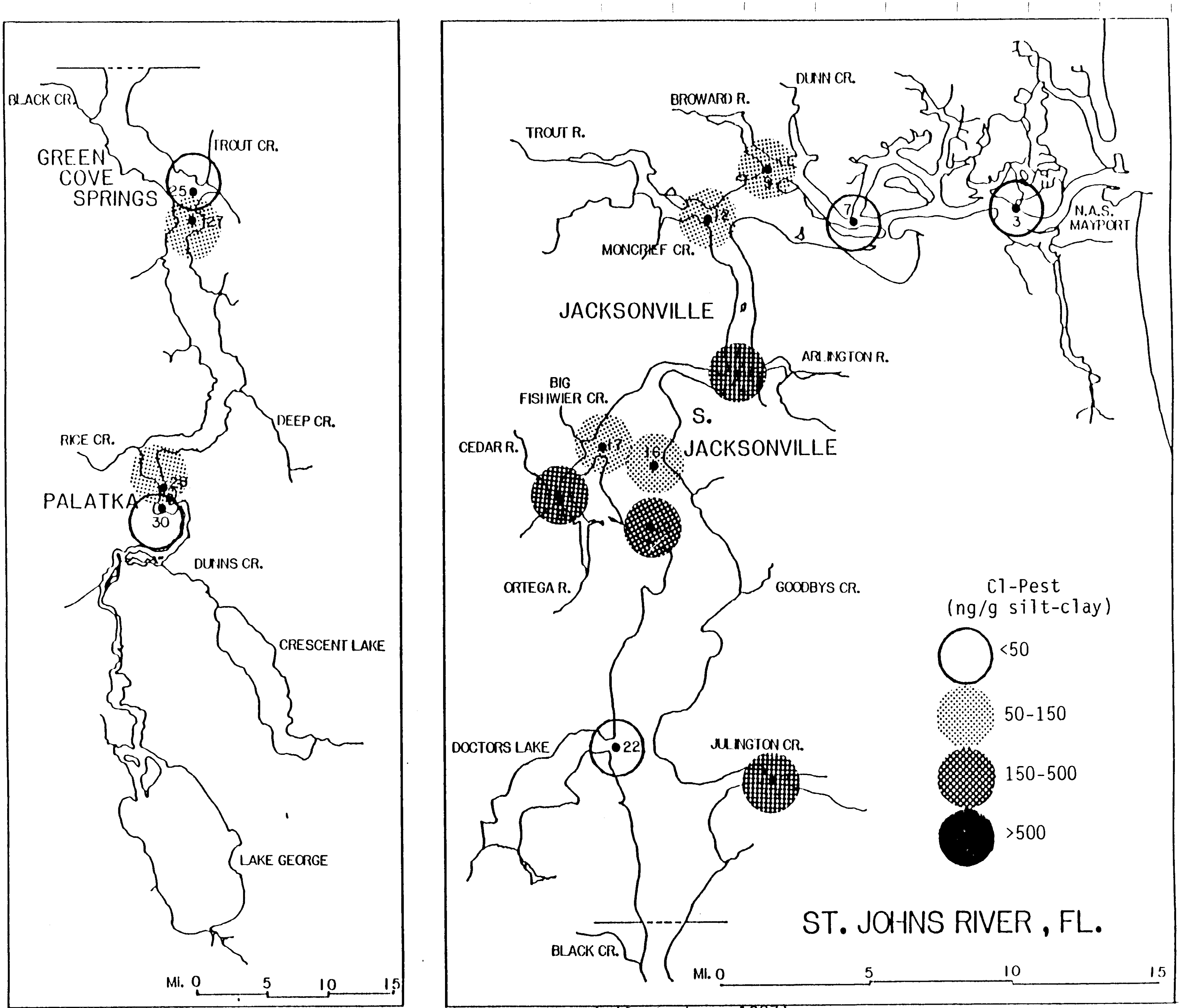


Figure 19b. Chlorinated Pesticide Distribution, Event 2 (September, 1987).

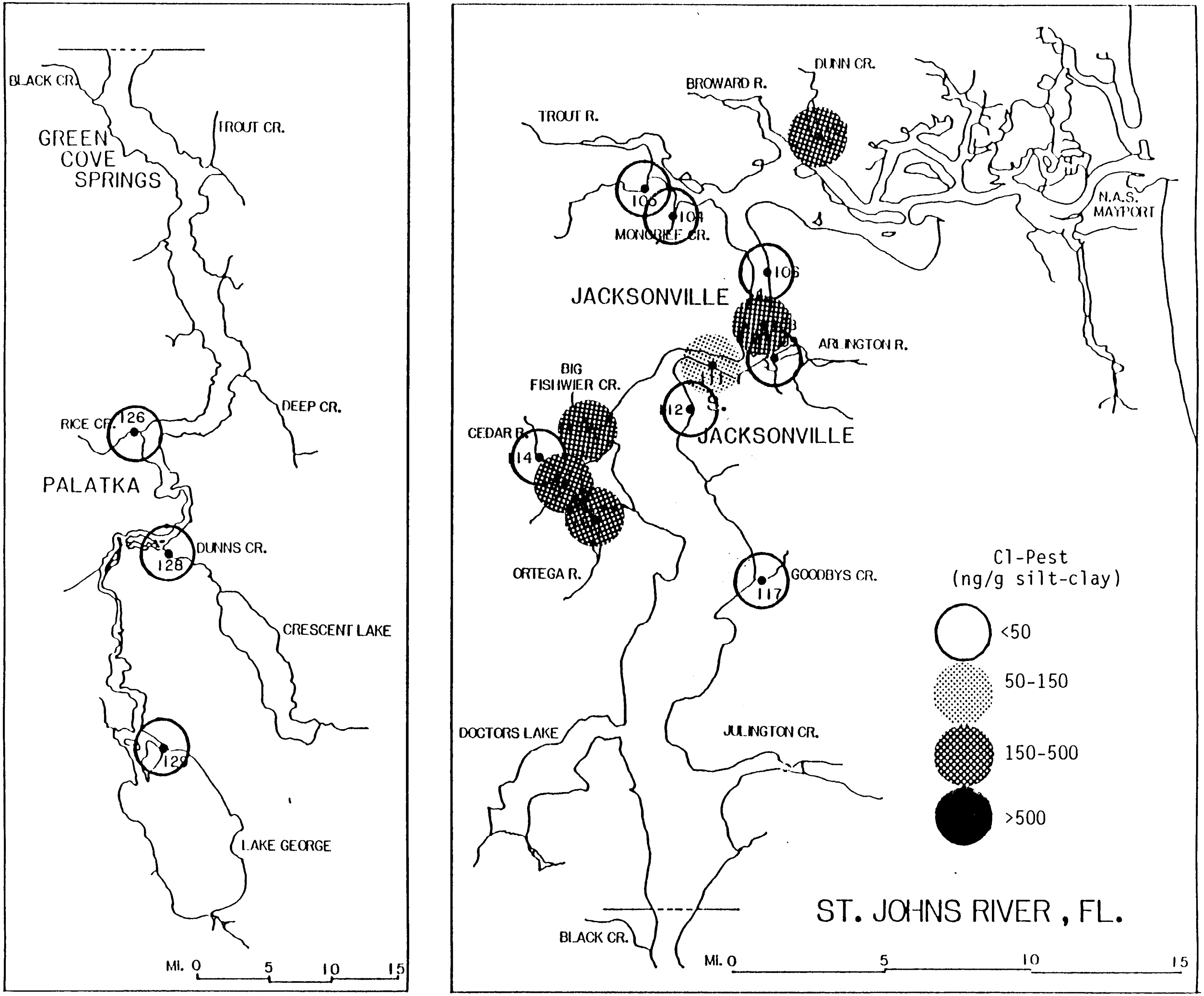


Figure 19c. Chlorinated Pesticide Distribution, Event 3 (March, 1988).

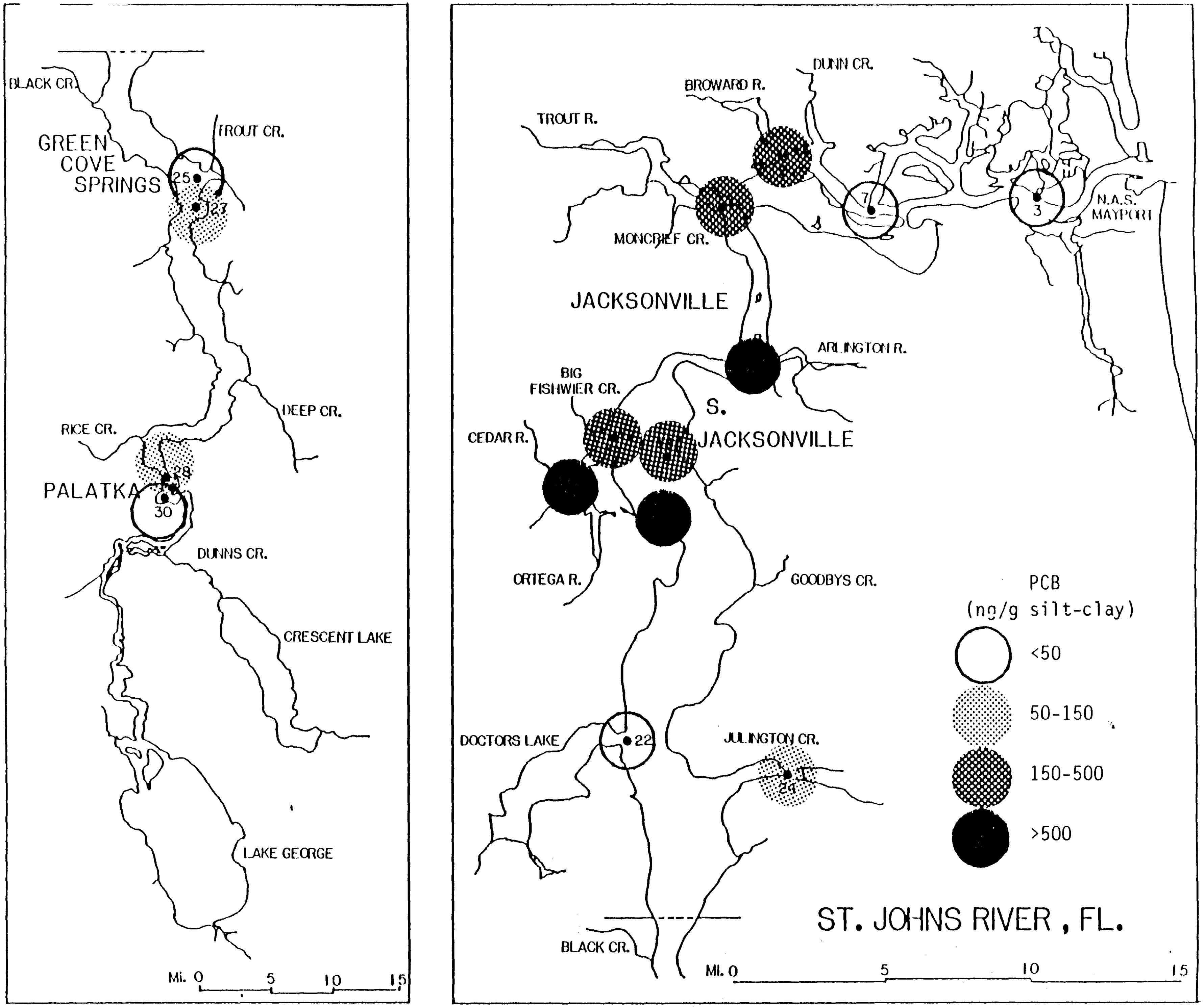


Figure 20a. Total PCB Concentration, Event 1 (May, 1987).

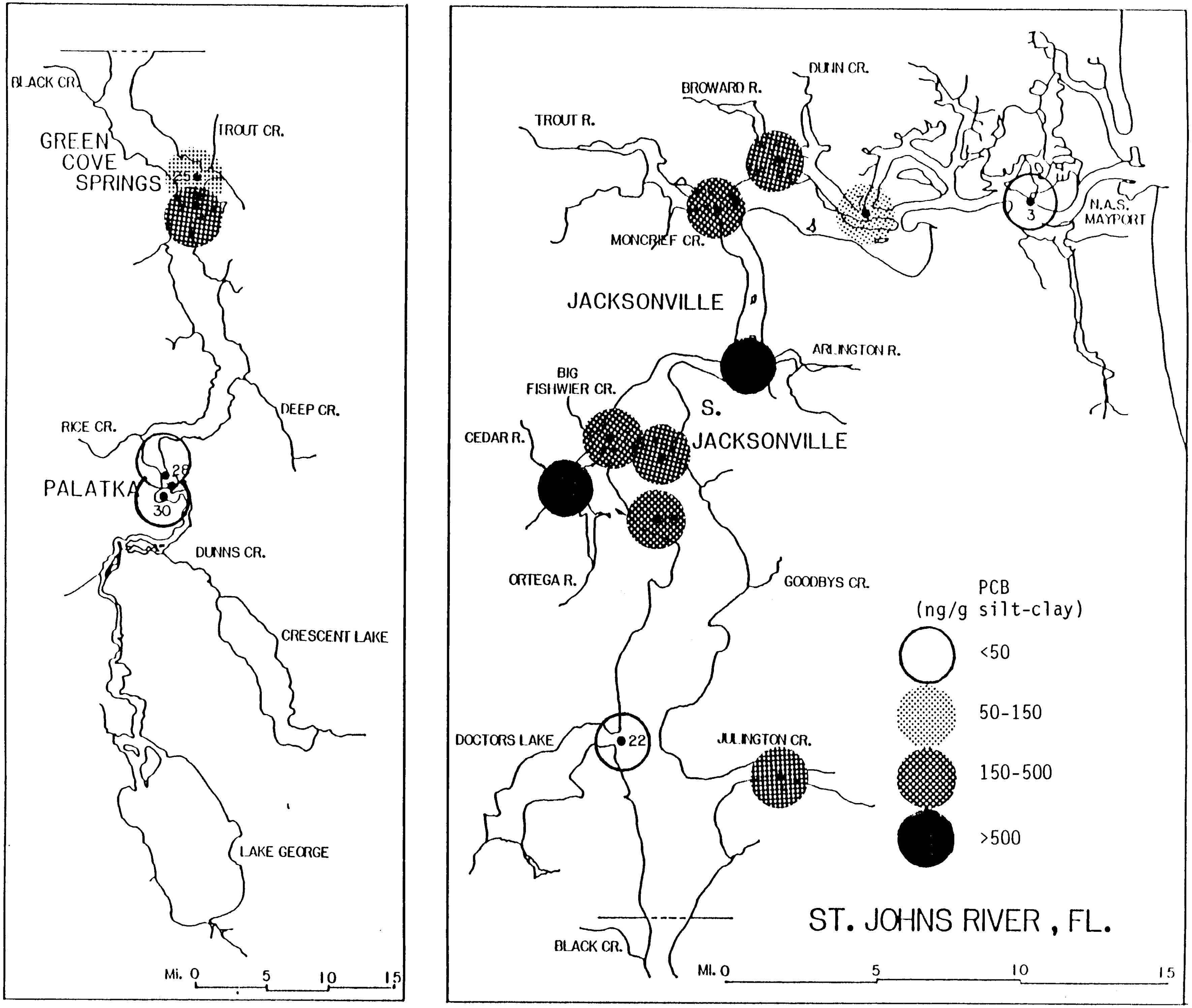


Figure 20b. Total PCB Distribution, Event 2 (September, 1987).

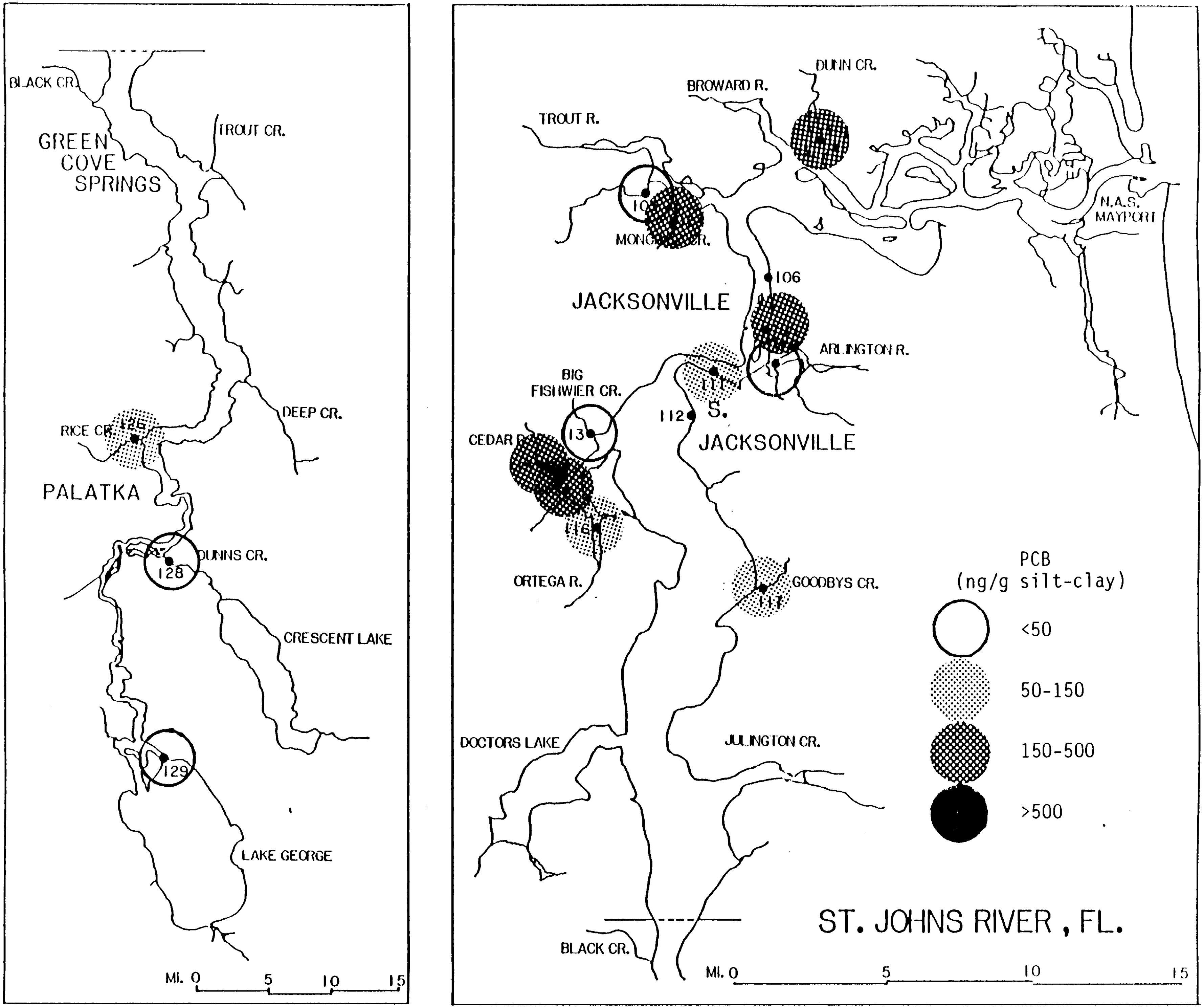


Figure 20c. Total PCB's, Event 3 (March, 1988).

D. QUALITY ASSURANCE-TOXIC ORGANICS

1. Precision and Accuracy

Targets for precision and accuracy of data for the toxic organics are given in Table 19. Completeness of the data is 100% with approximately 65% of results verified by GC/MS. Analytical accuracy was established by analysis of two (2) samples spiked with standard amounts of compounds representative of each class of chemicals investigated and by comparison of results from NOAA, NS&T Duwamish River sediment. Precision among environmental samples was established by duplicate analysis of every fifth sample (20% duplicates).

Data for precision and accuracy measurements are shown in Table 19. All targets described for the toxic organic measurements from the dry season sampling event have been satisfied.

2. Calibration

Quantitative and qualitative determinations of the toxic organics were done by GC, with confirmatory results of GC/MS. The PNA's and coprostanol were analyzed with a Varian 6000 GC equipped with a flame ionization detector (FID) and the Cl-Pest/PCB's with a Varian 6500 GC equipped with an electron capture detector (ECD). Each instrument was calibrated daily by injecting standard solution mixtures and by obtaining relative response factors for the analytes compared to the internal standards added to each sample prior to extraction. The identical standard solutions were used to calibrate the GC/MS, thereby allowing direct correlation between GC and GC/MS results.

3. Data Reduction and Analysis

The concentration of each organic compound is calculated by the chromatography data system (CDS) by comparing its detector response to that of known amount of an internal standard added to the sample matrix prior to extraction. The amount of the organic constituent (in ug) in the sample is calculated and reported by the CDS. Each printout is verified by the P.I., and the concentration results are tabulated on a project worksheet.

Internal QA indicated occasional unacceptable recovery of the internal standard in the appropriate fraction; therefore, the samples were reconstituted, re-chromatographed on the silica gel/alumina column and reanalyzed by GC. Subsequent reanalysis revealed acceptable recovery of the internal standard for each fraction. Also GC-ECD analysis of the Cl-Pest/PCB's revealed the presence of large amounts of sulfur, which may interfere with the analysis, in approximately 50% of the samples. This problem was corrected by passing the extract through a column of activated granular copper, which removes the sulfur. Further analysis indicated that the sulfur was removed by this process and was no longer interfering with the analysis.

GC/MS verification was performed on 100% of Event 1 samples and representative samples for Event 2 and Event 3.

Table 19. Toxic Organics-Precision and Accuracy Targets, St. Johns River.

Measurement Parameters	Experimental Matrix	Precision (%RSD, SD)	Accuracy (%Rec., SD)	Completeness (%)
PNA's	Sediment	10, 8	95, 10	100%
Coprostanol	Sediment	12, 7	110, 20	100%
Cl-Pest/PCBs	Sediment	10, 7	105, 10	100%

<u>Precision</u> - Duplicate analysis of 22% of environmental samples (goal was 20%).

<u>Parameter</u>	<u>Precision</u>	
	n, $\bar{x}$ %RSD, SD	$\bar{x}$ %RSD, SD
PNA's	10, 10.3, 6.6	7.4, 6.4
Coprostanol	10, 6.7, 3.3	6.2, 2.8
Cl-Pest	10, 5.9, 4.5	4.5, 4.1
PCB's	10, 5.8, 4.3	6.3, 4.1

<u>Accuracy</u> - Spiked recovery of internal standards (% recovery).

<u>Parameter</u>	<u>Accuracy</u>	
	n, $\bar{x}$ %Rec., SD	$\bar{x}$ %Rec., SD
PNA's	5, 95.4, 5.1	94, 4.9
Coprostanol	5, 101.6 5.0	101, 5.0
Cl-Pest	5, 96.6 5.9	95, 6.4
PCB's	5, 95.2 2.6	96, 3.7

$\bar{x}$ %RSD: mean of the percent standard deviation, base on 10, replicate anlayses mean value of the %RSD for each sample set.
SD: standard deviation from the mean.
%RSD: % Relative Standard deviation.
x%Rec: mean % Recovery.

IV. MICROBIOLOGY

A. SAMPLE COLLECTION

Water samples were collected for microbiological analysis at ten select stations during both May and September sampling episodes. Samples from near surface and near bottom were collected at each station in sterile 1-l bottles, stored on ice, and transported to the Laboratory for processing within 12 hours of collection.

Sediment was collected from ten (10) stations (coincident with the above-mentioned 10 water sampling stations) for microbiological analysis. Each sample consisted of a composite of three grabs of the top 2.5 cm of sediment, using a petite Ponar sediment sampler to obtain a total of 100 g wet sediment. Samples were placed in sterile jars and stored on ice for transport to the Laboratory for processing within 12 hours.

B. BACTERIOLOGICAL ANALYSES

One liter portions of collected seawater and 100 grams of collected sediments were individually diluted serially from 10^0 to 10^{-5} concentration into 1% peptone water. One milliliter aliquot was then transferred into alkaline peptone and incubated for 8 to 12 hrs at 42°C. All inoculated alkaline peptone tubes positive for growth were streaked into TCBS plates. Appropriate dilution was noted. Isolated colonies from the TCBS plates were identified by biochemical methods described below.

Colony counts per unit, both presumptive total and confirmed fecal coliforms, and aerobic plate count was determined by established techniques, which are specified for shellfish meats and seawater in "Recommended Procedures for the Examination of Seawater and Shellfish", using the Standard Plate Count (SPC) and Most Probable Number (MPN) on seawater and sediment samples. When high numbers of fecal coliforms were encountered, the methods of Richards (1978) were employed for the numeration of total and fecal coliforms.

In addition, the seawater and sediments were tested for the presence of Escherichia coli, Vibrio cholerae, Vibrio parahaemolyticus, V.alginolyticus, group F (EF6) Vibrio, Aeromonas hydrophila, and Yersinia enterocolytica. All Vibrio sp. and Aeromonas sp. were tested by gram stain, negative oxidase and for 0 129 sensitivity.

Aeromonas hydrophila were determined using Rimler-Shotts media according to established techniques, while the presence of Yersinia enterocolytica was cultured using MgCl enrichment broth and by methods of Lee (1977). Isolated typical colonies were biochemically tested according to Edwards and Ewing (1972).

Vibrio cholerae, V. parahaemolyticus, V. vulnificus, V. alginolyticus, and group F (EF6) Vibrios were incubated in simple alkaline peptone enrichment broth for approximately 10-18 hrs at 42°C. Negative enrichment broths were held at 10°C and restreaked after 5-7 days on thiosulfate-citrate-bile salts (TCBS). Isolated colonies screened for oxidase reaction and string tested positive colonies were further tested biochemically using API-20E (Analy Tab) strips. Serotyping testing followed the established techniques.

Quality control of culture identification was established by standard cultures obtained from American Type Culture. Cultures of Yersinia enterocolytica, Vibrio cholerae, V. alginolyticus group F (EF6) Vibrios, Aeromonas hydrophila, and V. parahaemolyticus were used for positive controls.

C. FUNGAL ANALYSES

Fungi was isolated from water and sediment using potato-dextrose and corn meal agar supplemented with penicillin and streptomycin, tetracycline and cycletetracycline (100 units/ml each). All cultures were incubated at room temperature for 3-5 days. Fungal hyphae and spores were identified using Bergeys Manual. Specific attention was given to the oomycete, Aphanomyces sp. and Saproleqnia sp.

D. RESULTS

1. Event 1 (May 1987)

A total of thirty (30) samples (20 water and 10 sediment) from ten stations were analyzed microbiologically. All samples were analyzed bacteriologically for total and fecal coliforms; heterotrophic plate counts; Vibrios and Aeromonas species; and mycologically for oomycetes fungi, specifically, Saprolegnia sp.

During Event 1 (May 5-7 sampling) Stations 3, 19 and 22 tested positive for oomycetes fungi. These were determined to be Saprolegnia sp. at all three stations (Table 20).

Heterotrophic plate counts were high at all stations, indicating a health environment for microflora (Table 21). Total coliforms and fecal coliforms indicated sewage contamination of the water column at Sites 3 and 25, and in sediment at Sites 3, 9, 12, 19, 22, 25, and 30 (70% of sites samples) with the highest concentration at Sites 22 and 25 (Table 21).

Pathogenic organism counts are shown in Table 22. The most prevalent Vibrio was V. parahaemolyticus, present throughout the water column and sediment at Stations 3, 7, and 18, and in water at Station 25. V. alginolyticus was present in the water at Sites 7, 9, 12, 19, 22, and 30, but was found in sediment only at Site 30. Other Vibrios found include V. cholera, V. vulnificus, V. anguillarum, and V. hollisae. Aeromonas hydrophila was found at four stations with the highest counts observed in surface water at Station 25.

In general, relatively low incidence of pathogenic bacteria or oomycetes were observed, indicating that the river and sediment was not heavily impacted with pathogenic microorganisms.

2. Event 2 (September 1987)

The same 10 stations sampled during Event 1 were analyzed microbially during Event 2. Specifically, only two samples had fungi of the class oomycetes, Station numbers 3 and 19 (both bottom water samples). Both isolates were determined to be of the genus Saprolegnia (Table 23).

Bacteriologically, low counts were found for both total and fecal coliforms. Highest counts for total and fecal coliforms were 264 at Station 22 (top water) and 128 at Station 12 (top water), respectively (Table 24).

The most prevalent Vibrio species found was V. parahaemolyticus. It was detected at four different stations (3, 12, 17 and 30). Aeromonas hydrophila was found at two stations (12 and 17) where three other Vibrios species occurred. Vibrio damsela, V. hollisae, and V. minictus and Aeromonas sobria were not detected (Table 25).

3. Event 3 (March 1988)

A selection of eleven new stations were sampled during Event 3 (March 1988) to evaluate the microbiology of major tributaries as well as specific areas of the St. Johns River. Fungi analyses (Table 26) show similar results as the previous studies, indicating the mid-St. Johns River section (Stations 106, 108 and 111) as fungi-contaminated areas.

Bacterial analyses for Event 3 revealed much lower total coliforms than Event 1, and about the same as Event 2, showing no difference between River and tributary stations (Table 27). Vibrios also were similar to previous samplings with the exception that two forms of V. vulnificus were observed at Station 112 (Table 28). This station is in the mid-St. Johns River area, indicating direct input to the River in this area. Tributaries did not appear to contain greater amounts of bacterial or fungal contamination than were found in the St. Johns River.

E. MICROBIOLOGY SUMMARY

A total of 93 water samples were analyzed for heterotrophic plate, total and fecal coliforms, eight species of *Vibrio*, two species of *Aeromonas* and fungi.

Results of the sampling revealed low to median heterotrophic counts with highest being associated with the sediments. High total and fecal coliforms were found during the first sampling at Stations 22, 25 and 30. However, fecal coliforms were somewhat low at the sties. This may be indicative of animal or nonhuman feces.

With respect to the *Vibrios*, *Vibrio parahaemolyticus* was found often in the 93 water samples analyzed. V. *alginolyticus* was also found at a high frequency. This is consistent with other workers found different areas. Sporadic occurrences of V. *ang*, V. *cholerae*, V. *damsela*, V. *anguillarum*, V. *minicus*, V. *vulnificus*, V. *hollisae*, and V. *fluvialis*.

Two forms of V. *vulnificus* were found during the last sampling. The two forms were isolated at Station 112 on heart fusion agar of V. *vulnificus* (virulent/encapsulated and avirulent/nonencapsulated.

Fungal analysis revealed low levels of *Saprolegnia* at a total of 7 out of 93 samples.

Little if any correlation/association could be made between levels of total and fecal coliforms and the presence or absence of *Vibrios* and/or *Saprolegnia*.

Table 20. Fungal Analysis of Event 1 Samples.

Station Designation	Probable Class of Fungi	Genera
3 Surface	0	Saprolegnia
3 Bottom	+ oomycetes	
3 Sediment	0	
7 Surface	0	
7 Bottom	0	
7 Sediment	0	
9 Surface	0	
9 Bottom	0	
9 Sediment	0	
12 Surface	0	
12 Bottom	0	
12 Sediment	0	
17 Surface	0	
17 Bottom	0	
17 Sediment	0	
18 Surface	0	
18 Bottom	0	
18 Sediment	0	
19 Surface	0	
19 Bottom	0	
19 Sediment	+ oomycetes	Saprolegnia
22 Surface	0	
22 Bottom	+ oomycetes	Saprolegnia
22 Sediment	+ oomycetes	Saprolegnia
25 Surface	0	
25 Bottom	0	
25 Sediment	0	
30 Surface	0	
30 Bottom	0	
30 Sediment	0	

Table 21. Heterotrophic Plate Counts and Coliform Bacteria: Event 1 Samples.

Station Designation		Heterotrophic Plate Count	Total Coliforms	Fecal Coliforms
3 Surface water	067D	4820	32	< 3.2
3 Bottom water	0674	5860	64	32
3 Sediment	0683	1.4 x 10^5	164	64
7 Surface water	0676	3251	32	< 3.2
7 Bottom water	0684	6280	32	< 3.2
7 Sediment	0666	1.8 x 10^5	114	< 3.2
9 Surface water	0682	2861	32	< 3.2
9 Bottom water	0675	5376	32	< 3.2
9 Sediment	0667	1.6 x 10^4	64	64
12 Surface water	0673	2112	32	< 3.2
12 Bottom water	0664	4006	32	< 3.2
12 Sediment	0678	1.7 x 10^5	64	64
18 Surface water	0677	1658	32	< 3.2
18 Bottom water	0691	1755	32	< 3.2
18 Sediment	0687	1.1 x 10^3	32	< 3.2
19 Surface water	0662	4183	358	< 3.2
19 Bottom water	0665	6561	651	< 3.2
19 Sediment	0690	1.4 x 10^4	584	64
22 Surface water	0670	3348	3119	< 3.2
22 Bottom water	0685	4111	5221	< 3.2
22 Sediment	0689	1.1 x 10^5	1.6 x 10^4	128
25 Surface water	0668	2248	363	< 3.2
25 Bottom water	0681	3587	828	64
25 Sediment	0680	1.2 x 10^4	1.1 x 10^5	128
30 Surface water	0686	1112	358	< 3.2
30 Bottom water	0669	4118	528	< 3.2
30 Sediment	0671	1.9 x 10^4	1.9 x 10^4	64

Table 22. Bacteria Species Counts: Event 1 Samples.

MPN/100 mls

Station Designation		Vag	Val	Vc	Vd	Vh	Vm	Vp	Vv	Ah	As
3 Surface water	0672	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	124	<3.2	<3.2	32
3 Bottom water	0674	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	64	<3.2	<3.2	<3.2
3 Sediment	0683	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	<3.2	32
7 Surface water	0676	32	32	64	<3.2	<3.2	<3.2	124	16	132	16
7 Bottom water	0684	<3.2	3.2	32	<3.2	<3.2	<3.2	64	16	94	<3.2
7 Sediment	0660	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	<3.2	<3.2
9 Surface water	0682	<3.2	<3.2	<3.2	16	<3.2	16	<3.2	64	<3.2	<3.2
9 Bottom water	0675	<3.2	64	<3.2	16	<3.2	<3.2	<3.2	18	<3.2	<3.2
9 Sediment	0067	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
12 Surface water	0673	<3.2	124	<3.2	<3.2	<3.2	16	<3.2	16	358	<3.2
12 Bottom water	0664	<3.2	34	<3.2	<3.2	<3.2	<3.2	<3.2	16	<3.2	<3.2
12 Sediment	0678	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	<3.2
17 Surface water	0663	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	3.2
17 Bottom water	0679	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	3.2
17 Sediment	0688	<3.2	<3.2.	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
18 Surface water	0677	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	124	<3.2	<3.2	<3.2
18 Bottom water	0691	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	64	<3.2	<3.2	<3.2
18 Sediment	0687	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	412	<3.2	<3.2	<3.2
19 Surface water	0662	<3.2	64	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
19 Bottom water	0665	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
19 Sediment	0690	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
22 Surface water	0670	<3.2	124	<3.2	<3.2	14	<3.2	<3.2	<3.2	<3.2	<3.2
22 Bottom water	0685	<3.2	<3.2	<3.2	<3.2	14	<3.2	<3.2	<3.2	<3.2	<3.2
22 Sediment	0689	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
25 Surface water	0668	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	64	22	354	<3.2
25 Bottom water	0681	<3.2	<3.2	64	<3.2	<3.2	<3.2	32	<3.2	124	<3.2
25 Sediment	0680	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	<3.2	<3.2	<3.2
30 Surface water	0686	<3.2	64	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	164	<3.2
30 Bottom water	0669	<3.2	128	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
30 Sediment	0671	<3.2	32	<3.2	32	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2

Table 23. Fungal analysis, September 1987, St. Johns River (Event 2).

Station Designation		Probable Class of Fungi	Genus
3	0705	ND	
3	2050	+ oomycetes	Saprolegnia
3	2039	ND	
7	0704	ND	
7	2025	ND	
7	2041	ND	
9	2019	ND	
9	2027	ND	
9	2031	ND	
12	2046	ND	
12	2021	ND	
12	2034	ND	
17	2020	ND	
17	2042	ND	
17	2043	ND	
18	0707	ND	
18	2029	ND	
18	2030	ND	
19	0707	ND	
19	2029	ND	
19	2038	+ oomycetes	Saprolegnia
22	2047	ND	
22	2022	ND	
22	2052	ND	
25	2018	ND	
25	2024	ND	
25	2028	ND	
30	0706	ND	
30	2040	ND	
30	2023	ND	

Table 24. Aerobic plate count and coliform bacteria analysis, September 1987, St. Johns River (Event 2).

Station Designation		Aerobic Plate Count	Coliform Total	Coliform Fecal
3	0705	642	128	<3.2
3	2050	952	<3.2	<3.2
3	2039	1.2×10^4	128	<3.2
7	0704	1.1×10^3	64	<3.2
7	2025	1.3×10^2	64	<3.2
7	2041	4.6×10^4	<3.2	<3.2
9	2019	2.1×10^3	<3.2	<3.2
9	2027	1.3×10^3	<3.2	<3.2
9	2031	3.2×10^4	<3.2	<3.2
12	2046	6.1×10^3	128	<3.2
12	2021	5.4×10^2	128	<3.2
12	2034	6.9×10^4	<3.2	<3.2
22	2047	1.7×10^3	264	128
22	2022	2.1×10^2	128	64
22	2052	4.1×10^5	<3.2	<3.2
19	0707	4.1×10^4	<3.2	<3.2
19	2029	3.1×10^2	<3.2	<3.2
19	2038	6.1×10^5	<3.2	<3.2
17	2020	1.1×10^3	<3.2	<3.2
17	2042	1.4×10^3	<3.2	<3.2
17	2043	2.8×10^4	<3.2	<3.2
18	0708	1.2×10^3	128	<3.2
18	2036	1.8×10^3	64	<3.2
18	2045	4.4×10^4	<3.2	<3.2
30	0706	6.4×10^2	<3.2	<3.2
30	2040	1.8×10^3	<3.2	<3.2
30	2023	8.8×10^4	<3.2	<3.2
25	2018	5.1×10^2	<3.2	<3.2
25	2024	4.1×10^3	<3.2	<3.2
25	2028	7.6×10^4	<3.2	<3.2

Table 25. **Potential pathogenic bacteria analysis, September 1987, St. Johns River (Event 2).**

Station Designation		Vibrios								Aeromonas	
		Vag	Val	Vc	Vd	Vh	Vm	Vp	Vv	Ah	As
3	0705	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	13	<3.2	<3.2	<3.2
3	2050	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
3	2039	13	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
7	0704	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
7	2025	<3.2	64	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
7	2041	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
9	2019	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
9	2027	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
9	2031	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
12	2046	<3.2	64	128	<3.2	<3.2	<3.2	128	<3.2	128	<3.2
12	2021	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
12	2034	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
22	2047	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
22	2022	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
22	2052	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
19	0707	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
19	2029	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
19	2038	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
17	2020	64	<3.2	<3.2	<3.2	<3.2	<3.2	164	128	128	<3.2
17	2042	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	64	<3.2	32	<3.2
17	2043	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
18	0708	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
18	2036	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	16	<3.2	<3.2
18	2045	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
30	0706	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	128	<3.2	<3.2	<3.2
30	2040	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	64	<3.2	<3.2	<3.2
30	2023	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
25	2018	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2

Table 26. Fungi Analysis of Event 3 Samples.

Station Designation			Probable Class of Fungi	Genera
129	Surface	0614	ND	ND
129	Bottom	0585	ND	ND
129	Sediment	0599	ND	ND
126	Surface	0581	ND	ND
126	Bottom	0580	ND	ND
126	Sediment	0595	ND	ND
101	Sediment	0604	ND	ND
101	Surface	0609	ND	ND
101	Bottom	0613	ND	ND
104	Sediment	0603	ND	ND
104	Surface	0615	ND	ND
104	Bottom	0607	ND	ND
106	Sediment	0596	ND	ND
106	Surface	0583	oomycetes	Saprolegnia
106	Bottom	0584	ND	ND
108	Surface	0589	oomycetes	Saprolegnia
108	Bottom	0608	ND	ND
108	Sediment	0605	ND	ND
109	Sediment	0602	ND	ND
109	Surface	0587	ND	ND
109	Bottom	0586	ND	ND
116	Sediment	0596	ND	ND
116	Surface	0590	ND	ND
116	Bottom	0588	ND	ND
111	Sediment	0598	ND	ND
111	Surface	0582	oomycetes	Saprolegnia
111	Bottom	0612	ND	ND
112	Sediment	0593	ND	ND
112	Surface	0594	ND	ND
112	Bottom	0592	ND	ND
117	Sediment	0610	ND	ND
117	Surface	0591	ND	ND
117	Bottom	0606	ND	ND

Table 27. Heterotrophic Plate Counts and Coliform Bacteria, Event 3 Samples.

Station Designation			Heterotrophic Plate Count	Total Coliforms MPN/100 mls	Fecal Coliforms
129	Surface	0614	4.3×10^3	64	<3.2
129	Bottom	0595	5.1×10^3	32	<3.2
129	Sediment	0599	6.7×10^5	164	<3.2
126	Surface	0581	1.9×10^3	32	<3.2
126	Bottom	0580	2.6×10^3	32	<3.2
126	Sediment	0595	8.4×10^4	64	<3.2
101	Sediment	0604	1.4×10^5	<3.2	<3.2
101	Surface	0609	8.1×10^3	<3.2	<3.2
101	Bottom	0613	4.1×10^3	<3.2	<3.2
104	Sediment	0603	6.7×10^5	<3.2	32
104	Surface	0615	1.1×10^2	<3.2	64
104	Bottom	0607	1.8×10^3	<3.2	32
106	Sediment	0596	5.8×10^4	<3.2	<3.2
106	Surface	0583	4.8×10^3	<3.2	<3.2
106	Bottom	0584	3.1×10^3	<3.2	<3.2
108	Surface	0589	1.6×10^6	412	358
108	Bottom	0608	7.1×10^3	64	64
108	Sediment	0605	1.8×10^3	32	32
109	Sediment	0602	5.1×10^4	<3.2	<3.2
109	Surface	0587	1.6×10^2	<3.2	<3.2
109	Bottom		1.8×10^3	<3.2	<3.2
116	Sediment	0597	6.1×10^4	124	<3.2
116	Surface	0590	1.9×10^2	124	64
116	Bottom	0588	1.6×10^3	124	<3.2
111	Sediment	0598	4.1×10^4	<3.2	<3.2
111	Surface	0582	9.8×10^3	<3.2	<3.2
111	Bottom	0612	4.1×10^3	<3.2	<3.2
112	Sediment	0593	8.6×10^5	124	<3.2
112	Surface	0594	1.6×10^3	124	<3.2
112	Bottom	0592	7.1×10^3	124	32
117	Sediment	0610	4.5×10^5	<3.2	<3.2
117	Surface	0591	1.3×10^3	<3.2	<3.2
117	Bottom	0606	4.4×10^2	<3.2	<3.2

Table 28. Potential Pathogenic Bacteria Analysis, Event 3.

Station Designation			MPN/100 mls									
			Vag	Val	Vc	Vd	Vh	Vm	Vp	Vv	Ah	As
129	Surface	0614	32	32	<3.2	<3.2	<3.2	<3.2	16	<3.2	124	<3.2
129	Bottom	0585	<3.2	16	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
129	Sediment	0599	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2
126	Surface	0581	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	64	<3.2
126	Bottom	0580	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
126	Sediment	0595	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
101	Sediment	0604	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	16	<3.2	<3.2	<3.2
101	Surface	0609	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	<3.2	<3.2
101	Bottom	0613	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	16	<3.2	<3.2	<3.2
104	Sediment	0603	<3.2	16	<3.2	<3.2	<3.2	<3.2	16	<3.2	<3.2	<3.2
104	Surface	0615	<3.2	32	<3.2	<3.2	<3.2	<3.2	32	<3.2	<3.2	<3.2
104	Bottom	0607	<3.2	32	<3.2	<3.2	<3.2	<3.2	16	<3.2	<3.2	<3.2
106	Sediment	0596	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
106	Surface	0583	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	48*	<3.2	<3.2	<3.2
106	Bottom	0584	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	164*	<3.2	<3.2	<3.2
108	Surface	0589	<3.2	48	16	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
108	Bottom	0608	<3.2	12	32	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
108	Sediment	0605	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
109	Sediment	0602	<3.2	32	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
109	Surface	0587	<3.2	32	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
109	Bottom		<3.2		<3.2	<3.2	<3.2	____	<3.2	<3.2	<3.2	<3.2
116	Sediment	0597	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	64	<3.2
116	Surface	0590	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	64	<3.2
116	Bottom	0588	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	32	<3.2	64	<3.2
111	Sediment	0598	<3.2	16	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	16
111	Surface	0582	<3.2	16	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	16
111	Bottom	0612	<3.2	16	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	16
112	Sediment	0593	<3.2	32	<3.2	<3.2	<3.2	<3.2	64	64*	32	<3.2
112	Surface	0594	<3.2	32	<3.2	<3.2	<3.2	<3.2	64	64*	32	<3.2
112	Bottom	0592	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	64	64*	32	<3.2
117	Sediment	0610	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
117	Surface	0591	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
117	Bottom	0606	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2

V. CONCLUSIONS

1. *In situ* water quality parameters (S ^{o}/oo, T°C, pH, D.O. and transparency) indicated acceptable water quality conditions during the monitoring events.
2. High turbidity in tributaries during the March 1988 sampling revealed a heavy influx of suspended particulates which are generally considered to be a primary source for toxic substances to the river system.
3. Sediment characterization revealed widely diverse sediment types between stations, considering grain size analysis, percent moisture and total organic carbon content (TOC), providing difficulties with interstation comparison of data.
4. Sediment nutrient analyses indicated anomalously high nitrogen concentrations in tributaries to the upper St. Johns River as well as in Lake George.
5. Correlation between TKN and Σ P with TOC indicated organic-derived nutrients (i.e., detritus and sewage as opposed to inorganic fertilizer) in most mid- and down-river areas. Increasing nitrogen:phosphorus ratios with distance upstream indicated a preferential mobilization of nitrogen from sediments.
6. Metal contamination was observed in 16 of the 31 stations monitored, with the heaviest contamination occurring in the Ortega River and Cedar River tributaries and throughout the mid-St. Johns River to the Broward River, indicating metals pollution from specific industrial activities in each area.
7. PNA contamination was most pronounced in tributaries to, and within the mid-St. Johns River areas, exhibiting primarily combustion-derived aromatic compounds as opposed to those derived from petroleum spills.
8. The highest PNA concentrations were found in March 1988, during a period of heavy rains, indicating influx from the contaminated watershed areas.

9. Sediment coprostanol content exhibited high amounts of fecal contamination, most notably throughout the mid-St. Johns River area.
10. The primary Cl-pesticides were chlordane and parent DDT isomers, indicating runoff from residential-industrial areas rather than agricultural input.
11. PCB contamination was prominent in the mid-St. Johns River area, exhibiting elevated concentrations at stations in tributaries and in the River.
12. Microbiological analysis of water and sediment revealed the presence of the suspect oomycetes fungi within the mid-St. Johns River, which was more pronounced during the March 1988 sampling when diseased fish were observed.
13. No unusual pathogenic bacteria occurrence was noted.
14. Fecal coliforms, although present in sediment, did not reflect the high amount of fecal-derived material indicated by coprostanol content and by high nutrient levels at specific sites.
15. The mid-St. Johns River sediment was found to be widely contaminated with toxic metals, polynuclear aromatic hydrocarbons, fecal-derived material, chlorinated pesticides and polychlorinated biphenyls. The greatest threat to aquatic organisms would appear to be from toxic metals (Cd, Cu, Pb, Zn and Hg) and mutagenic/carcinogenic PNA's.

VI. RECOMMENDATIONS

1. Having established the occurrence and general distribution of select toxic substances throughout the St. Johns River, further assessment of contaminant sources and potential areas for impact to aquatic organisms requires targeting a specific tributary and/or a defined area within the River for more intensive analyses.
2. Ten to fifteen stations should be studied within a given tributary e.g., Ortega River-Cedar River area), before and after a substantial rainy period.
3. Additional time and resources would be required to investigate interpretation of toxic substance data normalized relative to sediment characteristics such as % silt-clay and TOC. This information, which would be incorporated within the study recommended above, is essential for establishing sediment remobilization, spatial distribution patterns and common source material for sediment particles containing toxic substances.
4. Additional metals such as Arsenic and Chromium should be studied, as well as organotin complexes.
5. Toxic organic substance analyses should reduce emphasis on Cl-pesticides and PCB's, replacing them with analyses for chlorinated phenols, creosote and associated contaminants.
6. Microbiological studies should reduce emphasis on water column bacterialogy, directing resources to surface sediment and including select v ruses.

VII. LITERATURE CITED

Boehnke, D.N., C.A. Boehnke, K.I. Miller, J.S. Robertson and A.Q. White 1983. Final Report. Survey of hydrocarbons in the lower St. Johns River in Jacksonville, Florida. Prepared for Florida Department of Natural Resources.

Brown, R.C. and T.L. Wade. 1981. Sedimentary coprostanol and hydrocarbon distribution adjacent to a sewage outfall. Water Research. 18(5)621-632.

Dykstra, M.J., E.J. Noga, J.F. Levine and D.W. Moye. 1986. Characterization of the Aphanomyces species involved with ulcerative mycosis (UM) in Menhaden. Mycologia. 78(4):664-672.

Edwards, P.R. and W.H. Ewing. 1972. Identification of Enterobacleriacae. 3rd Ed., Burgess Publ. Co., Minneapolis, MN.

Florida Department of Environmental Regulation. Deepwater Ports Maintenance Dredging and Disposal Manual, Tallahassee.

Folk, R.L. 1974. Petrology of Sedimentary Rocks. Austin, TX.

Hand, J., V. Tauxe and J. Watts. 1986. St. Johns River, lower basin technical report, an appendix of the 305(b) Water Quality Inventory for the State of Florida, Water Quality Monitoring Technical report #82, FDER, June 1986.

Lee, W.H. 1977. Appl. Environ. Microbial. 33:215-216.

Martin, J. and Whitfield. 1983. The significance of river inputs to the ocean, In: Trace Metals in Seawater.

Mills, G.L. and J.G. Quinn. 1979. Determination of organic carbon in marine sediments by persulfate oxidation. Chemical Geology 25:155-162.

NOAA. 1985. NOAA Technical Memorandum NMFS F/NWC-92 Standard Analytical Procedures of the NOAA National Analytical Facility, 1985-1986. Extractable Toxic Organic Compounds, Second Edition.

NOAA - National Ocean Service. 1987. National status and trends program for marine environmental quality: Progress Rept. and Preliminary Assessment of Findings of the Benthic Surveillance Project 1984. p. 91.

Noga, E.J. and M.J. Dykstra. 1986. Oomycete fungi associated with ulcerative mycosis in menhaden, Brevoortia tyrannus (Latrobe). J. of Fish Diseases. 9:47-53.

Pierce, R.H. and R.C. Brown. 1984. Coprostanol distribution from sewage discharged into Sarasota Bay, Florida. Bull. Environ. Contam. Toxicol. 32:75-79.

Plumb, R.H., Jr. 1981. Procedure for handling and chemical analysis of sediment and water samples. Tech. Rept. EPA/CE-81-1.

Richards, G.P. 1978. App. Environ. Microbial. 3b:975-978.

Turekian, K.K. and K.H. Wedepohl. 1961. Distribution of the elements in some major units of the earth's crust. Geol. Soc. Am. Bull. v. 72, p. 175-192.

Walker, R.W., C. Wun and W. Litsky. 1982. Coprostanol as an indicator of fecal pollution. CRC Crit. Rev. Environ. control. 10:91-112.

Wenzel, K.L. and P. McVety. 1986. Water Quality Review, lower St. Johns River, Duval County, Fla. Dept. Environmental Regulation. April.

APPENDIX A

WATER QUALITY, SEDIMENT CHARACTERISTICS, NUTRIENT AND METALS ANALYSIS DATA

Table A-1a. *In situ* Data, May 1987.

DATE MM/DD/YY	TIME EST	DEPTH (M)	SECCHI DEPTH (M)	SALINITY (0/00) SURF	SALINITY MID	SALINITY BOTT	TEMP (C) SURF	TEMP MID	TEMP BOTT	PH SU SURF	PH MID	PH BOTT	D.O. (MG/L) SURF	D.O. MID	D.O. BOTT
** STATION 1															
05/O6/87	1514	3.9	1.1	35.30	35.16	35.09	19.83	19.81	19.80	8.17	8.18	8.19	7.3	7.0	7.2
** STATION 2															
O5/O6/87	1539	1.7	0.9	30.23	.	32.35	20.92	.	19.78	8.16	.	8.14	7.2	.	6.9
** STATION 3															
05/O6/87	1305	3.6	1.1	23.97	25.97	25.71	21.06	20.51	20.55	8.00	8.06	8.06	6.5	6.3	6.2
** STATION 4															
O5/O6/87	1237	3.9	1.1	25.65	27.38	28.83	20.60	20.25	20.10	8.07	8.06	8.05	6.7	6.5	6.4
** STATION 5															
05/06/87	0707	4.1	1.1	31.29	31.53	32.67	19.74	19.73	19.62	8.21	8.08	8.10	6.6	6.6	6.3
** STATION 6															
05/06/87	0737	1.2	0.9	16.11	.	27.87	20.50	.	20.47	7.82	.	7.93	5.6	.	5.3
** STATION 7															
05/06/87	1139	6.9	1.1	13.77	18.72	23.97	21.72	21.24	20.81	8.09	8.06	8.05	7.5	6.5	6.2
** STATION 8															
05/06/87	0806	1.3	0.9	12.44	.	12.52	21.40	.	21.54	7.94	.	7.92	6.2	.	6.1
** STATION 9															
05/06/87	1102	1.4	0.8	11.44	.	14.34	21.55	.	21.43	8.05	.	7.93	7.2	,	5.9
** STATION 10															
05/06/87	0831	1.2	0.6	12.04	.	11.90	20.70	.	20.72	7.97	,	7.92	6.9	.	6.5
** STATION 11															
05/06/87	0853	2.2	1.1	11.66	.	15.61	21.75	.	21.46	7.98	.	7.96	7.0	.	6.5
** STATION 12															
05/06/87	1029	2.7	0.8	8.49	14.38	18.98	22.55	21.84	21.41	7.98	7.96	7.95	6.8	6.5	6.3
** STATION 13															
05/06/87	0923	2.6	0.8	16.77	17.41	17.98	21.83	21.80	21.71	7.96	7.95	7.95	6.5	6.4	6.3
** STATION 14															
05/06/87	0953	2.3	0.9	11.24	12.75	12.70	22.01	22.08	22.03	7.94	7.93	7.93	6.4	6.5	6.5
** STATION 15															
05/07/87	0758	3.4	0.9	3.11	9.05	11.88	21.29	21.90	21.92	7.97	7.72	7.73	7.9	7.0	6.5
** STATION l6															
05/07/87	0828	5.5	0.8	1.70	7.88	9.31	22.40	22.36	22.12	7.90	7.65	7.72	7.6	6.7	6.5

Table A-1a. Continued.

DATE MM/DD/YY	TIME	DEPTH EST (M)	SECCHI DEPTH (M)	SALINITY SURF	(O/O0) MID	 BOTT	TEMP SURF	(C) MID	 BOTT	PH SURF	SU MID	 BOTT	D.0. SURF	(MG/L) MID	 BOTT
** STATION 17															
05/07/87	1157	1.9	0.7	1.48	.	6.78	23.73	I	22.55	8.09	.	7.57	8.1	.	6.8
** STATION 18															
05/07/87	1240	1.6	0.6	0.97	.	0.98	24.57	l	23.52	8.26	.	7.80			8.4
** STATION 19															
05/07/87	1118	2.7	0.8	2.43	.	6.15	24.38	.	23.05	7.73	,	7.47	7.4	I	6.4
** STATION 20															
05/07/87	0919	3.6	0.8	0.27	0.28	0.28	23.74	22.54	22.37	7.96	7.84	7.81	7.5	7.5	7.2
** STATION 21															
05/O7/87	0858	2.6	0.8	0.55	.	1.67	22.30	'	22.46	8.02	I	7.68	7.3	,	6.8
** STATION 22															
05/07/87	1043	2.6	0.9	0.27	,	0.30	25.88	.	23.08	7.95	,	7.74	8.3	.	7.8
** STATION 23															
05/07/87	0943	1.9	0.8	0.28	I	0.29	23.40	I	22.67	7.86	.	7.79	7.6		7.5
** STATION 24															
05/07/87	1007	2.5	0.9	0.19	0.18	0.19	23.32	23.37	23.21	7.40	7.49	7.44	5.6	5.6	5.6
** STATION 25															
05/05/87	1444	2.0	0.8	0.34	I	0.34	24.19	.	24.25	7.44	I	7.48	6.8	l	6.8
** STATION 26															
05/05/87	1530	3.5	0.8	0.34	0.35	0.35	23.68	23.72	23.72	7.48	7.49	7.51	7.0	7.0	7.0
** STATION 27															
05/05/87	1554	3.0	0.8	0.34	0.35	0.35	23.54	23.66	23.69	7.46	7.47	7.44	6.6	6.5	6.3
** STATION 28															
05/05/87	1153	2.5	0.9	0.41	.	0.41	25.49	.	25.49	7.62	,	7.62	7.0	,	7.0
** STATION 29															
05/05/87	1218	1.8	0.9	0.42	.	0.42	25.53	I	25.57	7.61	.	7.58	6.8	.	6.9
** STATION 30															
05/05/87	1237	3.1	1.1	0.42	0.42	0.42	25.45	25.50	25.51	7.60	7.58	7.58	6.8	6.6	6.6

Table A-1b. In situ Data, September, 1987.

DATE MM/DD/YY	TIME EST	DEPTH (M)	SECCHI DEPTH (M)	SALINITY SURF	(O/OO) MID	 BOTT	TEMP SURF	(C) MID	 BOTT	PH SURF	SU MID	 BOTT	D.O. SURF	(MG/L) MID	 BOTT
** STATION 1															
09/22/87	0731	2.0	2.0	36.25	.	36.16	27.22	.	27.26	7.79	.	7.79	5.6	.	5.6
** STATION 2															
09/22/87	0752	1.7	1.1	34.75	I	35.45	27.58	.	27.67	7.83	.	7.86	6.0	.	6.0
** STATION 3															
09/22/87	0636	1.7	1.2	32.21	.	31.64	27.71	.	27.75	7.81	.	7.83	5.6	.	5.7
** STATION 4															
09/22/87	0815	2.9	1.6	28.87	29.43	30.05	27.40	27.52	27.59	7.75	7.78	7.79	5.3	5.4	5.1
** STATION 5															
09/22/87	1416	4.2	1.5	24.25	26.72	27.92	27.89	27.94	27.99	7.82	7.82	7.82	6.2	6.0	5.9
** STATION 6															
09/22/87	1348	1.9	0.8	24.91	.	28.09	27.80	.	28.25	7.64	.	7.76	5.4	.	5.5
** STATION 7															
09/22/87	3908	6.6	1.1	25.25	26.25	28.86	27.67	27.74	27.79	7.76	7.76	7.77	5.3	5.1	5.1
** STATION 8															
05/22/87	0932	3.0	1.1	19.17	22.60	25.32	26.84	27.73	28.02	7.66	7.63	7.66	5.2	4.8	4.8
** STATION 9															
09/22/87	0953	1.6	1.1	20.70	.	21.87	27.64	.	27.91	7.66	.	7.66	4.7	.	4.7
** STATION 10															
09/22/87	1313	0.8	0.5	18.66	.	19.42	27.65	.	27.48	7.96	.	7.88	8.0	.	6.8
** STATION 11															
09/22/87	1251	1.8	1.5	19.08	.	21.29	28.46	.	28.09	7.71	.	7.68	5.1	.	4.9
** STATION 12															
09/22/87	1018	3.1	1.2	15.35	17.71	22.73	27.35	28.03	28.06	7.61	7.56	7.59	4.9	4.7	4.2
** STATION 13															
09/22/87	1043	1.6	1.4	16.42	.	19.10	27.49	.	27.75	7.64	.	7.60	5.0	.	4.5
** STATION 14															
09/22/87	1146	1.7	1.1	10.04	.	15.19	27.88	.	28.37	7.57	.	7.49	5.5	.	4.1
** STATION 15															
09/22/87	1210	2.1	3.9	13.75	.	15.07	28.16	.	28.04	7.49	.	7.45	4.6	.	4.4
** STATION 16															
03/23/87	0708	5.7	0.9	4.36	5.85	7.31	26.58	27.25	27.49	7.32	7.28	7.16	6.1	5.5	5.3

Table A-lb. Continued.

Date MM/DD/YY	TIME EST	DEPTH (M)	SECCHI DEPTH (M)	SALINITY SURF	 MID (O/OO)	 BOTT	TEMP SURF	 MID (C)	 BOTT	PH SURF	 MID SU	 BOTT	D.O. SURF	 MID (MG/L)	 BOTT
** STATION 17															
09/23/87	1036	2.1	0.9	8.00	.	8.30	27.21	.	27.31	7.25	.	7.26	5.3	.	5.2
** STATION 18															
09/23/87	1058	1.8	0.5	3.35		4.00	26.40	.	26.81	7.45	.	7.38	7.4		4.3
** STATION 19															
9/23/87	1007	3.1	0.8	6.95	6.97	7.12	26.74	26.87	26.95	7.29	7.28	7.27	5.8	5.6	5.4
** STATION 20															
9/23/87	0811	4.1	0.6	2.15	2.15	2.15	27.17	27.18	27.21	7.35	7.40	7.37	5.7	5.8	5.8
** STATION 21															
09/23/87	0750	2.4	0.5	2.28	.	2.28	26.74	.	26.83	7.50	.	7.44	6.1	.	6.1
** STATION 22															
09/23/87	0930	2.6	0.8	1.99	.	2.00	27.13	.	27.17	7.41	.	7.43	5.7	.	5.6
** STATION 23															
09/23/87	0834	2.1	0.8	1.46	.	1.45	26.93	.	26.91	7.47	.	7.48	5.9	.	5.9
** STATION 24															
09/23/87	0857	2.5	0.6	1.42	.	1.42	26.90	.	26.89	7.31	.	7.34	5.8	..	5.8
** STATION 25															
09/21/87	1452	2.0	1.1	0.43	.	0.43	29.19	.	28.72	7.86	.	7.80	7.9	.	7.3
** STATION 26															
09/21/87	1516	4.4	1.1	0.45	0.45	0.45	29.11	28.80	28.60	7.76	7.88	7.81	8.7	8.1	6.2
** STATION 27															
09/21/87	1534	2.6	0.9	0.44	.	0.45	29.25	.	28.26	7.84	.	7.70	7.9	.	6.3
** STATION 26															
09/21/87	1224	2.6	1.1	0.54	.		30.02	.	28.63	8.18	.	8.19	8.6	.	7.9
** STATION 27															
09/21/87	1534	2.0	0.9	0.54	.	0.53	28.99	.	28.57	8.19	.	8.19	7.7	.	6.7
** STATION 30															
09/21/87	1256	4.0	0.9	0.52	0.55	0.52	29.24	29.04	28.54	8.21	8.19	8.16	7.5	7.5	7.4

Table A-1c. In situ Data, March 1988.

DATE	TIME	DEPTH	SECCHI	SALINITY			TEMP			PH			D.O.		
MM/DD/YY	EST	(M)	DEPTH	SURF	MID	BOTT	SURF	MID	BOTT	SURF	MID	BOTT	SURF	MID	BOTT
			(M)		(O/00)			(C)			SU			(MG/L)	
** STATION 125															
03/21/88	1650	3.5	0.7	0.12	0.18	0.20	10.99	14.41	13.40	7.21	7.13	6.88	11.0	10.6	5.8
** STATION 126															
03/21/88	1740	10.9	0.2	0.10	0.26	0.40	17.24	15.14	13.54	7.55	7.30	7.26	9.5	9.6	9.9
** STATION 123															
03/24/88	0913	3.2	0.7	0.11	0.11	0.00	17.00	16.68	13.71	6.71	6.64	6.48	7.2	6.8	5.2
** STATION 121															
03/23/80	1155	7.3	0.7	0.72	0.44	0.40	15.66	14.28	14.30	6.09	6.03	6.13	7.7	7.6	7.5
** STATION 101															
03/22/88	0916	1.7	0.5	0.21	.	0.18	14.81	.	14.82	6.56	.	6.69	9.2	.	9.1
** STATION 102															
03/22/88	1015	1.4	0.5	1.70	.	1.69	14.70	.	14.07	7.93	.	7.95	9.1	l	9.1
** STATION 100															
03/22/88	1209	4.5	0.4	0.27	0.20	0.29	16.91	15.01	14.09	8.10	0.00	7.92	9.5	9.5	9.4
** STATION 107															
03/22/88	1421	3.0	0.3	0.31	0.30	0.31	15.78	15.73	15.06	7.93	7.70	7.75	9.2	9.2	9.2
** STATION 130															
03/21/88	1342	3.2	0.7	0.61	0.61	0.51	17.40	15.00	15.00	6.08	7.11	7.17	10.5	10.5	9.6
** STATION 12															
03/22/88	1349	2.0	0.4	0.74	1.10	1.41	15.53	15.22	15.19	7.95	7.70	7.76	9.4	9.2	9.2
** STATION 129															
03/21/88	1410	2.3	0.8	0.21	.	0.14	18.27	,	15.30	6.99	.	7.44	10.0	.	10.0
** STATION 111															
03/23/88	0939	4.1	0.4	0.31	0.31	0.32	15.95	15.59	15.55	7.30	7.20	7.23	9.4	9.3	9.3
** STATION 105															
03/22/88	1051	1.4	0.4	2.60	.	2.69	15.69	.	15.56	7.62	.	7.62	8.3	.	7.7
** STATION 116															
03/23/88	0045	0.9	0.5	0.08	.	0.08	15.64	.	15.59	6.96	.	6.89	7.5	.	7.3
** STATION 104															
03/22/88	1111	0.0	0.4	1.70	.	1.74	15.75	.	15.67	7.70	.	7.76	9.0	.	8.9
** STATION 112															
03/23/88	1014	0.0	0.5	0.28	.	0.29	15.73	.	15.74	7.14	.	7.20	9.3	.	9.2

Table A-1c. Continued.

DATE MM/DD/YY	TIME EST	DEPTH (M)	SECCHI DEPTH (M)	SALINITY (O/00) SURF	SALINITY MID	SALINITY BOTT	TEMP (C) SURF	TEMP MID	TEMP BOTT	PH SU SURF	PH MID	PH BOTT	D.O. (MG/L) SURF	D.O. MID	D.O. BOTT
** STATION 109															
03/22/88	1235	1.6	0.5	0.28	.	0.27	16.23	.	15.82	7.98	.	8.02	9.2	.	9.2
** STATION 110															
03/23/88	1651	1.9	0.6	0.28	.	0.29	16.28	.	16.18	7.38	.	7.36	9.1	.	8.9
** STATION 106															
03/22/88	1145	2.0	0.5	0.33	.	0.30	16.34	.	16.28	8.04	.	8.05	9.6	.	9.8
** STATION 119															
03/23/88	1629	2.2	0.6	0.70	.	0.70	17.19	.	16.29	8.32	.	8.29	11.1	.	10.2
** STATION 124															
03/24/88	0046	1.9	0.7	0.27	.	0.27	16.48	.	16.35	7.49	.	7.44	10.0	.	9.8
** STATION 24															
03/23/88	1516	2.0	0.6	0.10	.	0.11	17.77	.	16.66	6.88	.	6.85	7.9	.	7.6
** STATION 117															
03/23/88	1054	1.2	0.5	0.25	.	0.25	16.81	.	16.78	7.18	.	7.18	9.7	.	9.6
** STATION 122															
03/24/88	0950	1.7	0.6	0.29	.	0.29	17.13	.	16.83	7.18	.	7.19	9.5	.	8.6
** STATION 110															
03/22/88	1450	2.3	0.4	0.37	.	0.36	17.12	.	17.05	8.14	.	8.20	11.1	.	11.2
** STATION 128															
03/24/88	1221	4.1	0.8	0.28	0.29	0.30	17.70	17.27	17.24	7.08	7.07	7.06	8.4	8.3	8.2
** STATION 127															
03/24/88	1144	1.4	0.8	0.26	.	0.27	17.77	.	17.30	7.15	.	7.13	8.3	.	8.3
** STATION 18															
03/22/88	1643	1.1	0.3	0.13	.	0.12	17.89	.	17.42	7.74	.	7.76	9.0	.	8.8
** STATION 131															
03/21/88	1240	1.6	0.8	0.61	.	0.55	18.28	.	17.46	6.83	.	6.89	8.5	.	8.3
** STATION 114															
03/22/88	1629	1.2	0.5	0.12	.	0.11	18.36	.	18.07	7.69	.	7.72	9.6	.	9.6
** STATION 113															
03/22/88	1553	0.8	0.4	0.22	.	0.23	21.35	.	20.49	8.31	.	8.31	11.5	.	11.6

Table A-2a. Sediment Data, May , 1987.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
** **STATION 1**							
05/06/87	2.45	1.66	1.82	-0.57	1.83	0.3	21.1
05/06/87	2.48	2.25	1.26	-0.43	2.51	0.3	21.4
05/06/87	2.44	2.06	1.38	-0.50	2.49	0.1	22.5
** **STATION 2**							
05/06/87	2.33	2.08	1.03	-0.55	1.76	0.1	22.0
05/06/87	2.39	2.29	0.74	-0.43	1.77	0.1	23.4
05/06/87	2.39	2.29	0.68	-0.39	1.53	0.1	23.0
** **STATION 3**							
05/06/87	2.97	3.04	0.79	0.21	0.88	12.0	36.1
05/06/87	2.92	3.06	0.85	0.28	0.85	16.3	38.5
05/06/87	3.39	3.34	0.85	-0.04	0.99	19.9	40.1
** **STATION** 4							
05/06/87	3.25	3.27	1.55	-0.24	1.34	32.3	52.0
05/06/87	3.70	3.59	1.10	-0.28	1.02	40.4	53.2
05/06/87	3.32	3.33	1.20	-0.15	1.09	28.3	50.4
** **STATION 5**							
05/06/87	2.44	2.44	0.50	-0.12	1.19	0.6	19.2
05/06/87	2.47	2.47	0.64	0.07	1.77	5.3	25.6
05/06/87	2.39	2.33	0.57	-0.22	1.12	0.4	23.9
** **STATION 6**							
05/06/87	2.52	2.52	0.58	0.01	1.51	2.2	25.5
05/06/87	2.58	2.60	0.52	0.24	1.30	4.9	29.8
05/06/87	2.57	2.57	0.47	0.20	1.21	2.8	26.6
** **STATION 7**							
05/06/87	2.33	2.42	1.16	0.15	1.24	12.8	32.2
05/06/87	1.72	1.65	1.78	-0.06	1.07	12.0	41.3
05/06/87	2.56	2.70	1.56	0.03	0.77	28.6	45.5
** **STATION 8**							
05/06/87	2.33	2.23	0.60	-0.28	0.98	1.6	25.9
05/06/87	2.35	2.25	0.60	-0.31	1.14	0.5	23.9
05/06/87	3.06	2.68	1.52	-0.52	1.61	6.6	23.9
** **STATION 9**							
05/06/87	3.38	3.34	1.35	-0.24	1.14	32.8	68.0
05/06/87	3.21	3.27	1.20	-0.08	0.99	29.0	65.5
05/06/87	3.36	3.33	1.30	-0.21	1.06	32.8	64.6
** **STATION 10**							
05/06/87	2.79	2.88	0.79	0.05	1.03	5.3	47.0
05/06/87	2.90	3.03	0.88	0.23	0.92	15.2	45.4
05/06/87	2.90	3.03	0.87	0.23	0.92	15.2	45.3

Table A-2a. Continued.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
** STATION 11							
05/06/87	3.43	3.34	1.41	-0.32	1.44	26.5	62.9
05/06/87	2.36	2.27	0.79	-0.02	1.61	6.2	67.0
05/06/87	3.55	3.41	1.30	-0.33	1.36	32.3	66.4
** STATION 12							
05/06/87	3.66	3.44	1.40	-0.40	1.26	39.3	73.0
05/06/87	3.20	2.69	1.79	-0.42	0.90	24.8	71.2
05/06/87	3.63	3.50	1.20	-0.30	1.27	35.5	68.6
** STATION 13							
05/06/87	2.85	3.03	0.86	0.34	0.86	16.3	41.8
05/06/87	2.85	3.02	0.84	0.34	0.87	15.8	41.8
05/06/87	2.71	2.94	0.86	0.39	1.05	14.7	41.3
** STATION 14							
05/06/87	2.79	2.94	0.79	0.34	0.93	11.7	38.0
05/06/87	2.73	2.90	0.82	0.31	1.06	10.9	40.8
05/06/87	2.71	2.88	0.80	0.35	1.07	11.1	42.9
** STATION 15							
05/07/87	2.40	1.71	1.61	-0.55	1.96	4.0	23.5
05/07/87	2.28	1.31	1.93	-0.57	0.67	4.0	24.3
05/07/87	2.28	1.30	1.95	-0.56	0.64	4.7	22.7
** STATION 16							
05/07/87	2.32	2.59	1.51	0.17	0.69	26.0	87.0
05/07/87	2.37	2.59	1.49	0.15	0.72	23.9	86.7
05/07/87	3.43	2.89	1.83	-0.44	0.72	44.4	86.7
** STATION 17							
05/07/87	2.85	2.69	1.72	-0.26	1.38	21.6	72.8
05/07/87	2.95	2.59	1.94	-0.34	1.29	27.1	74.4
05/07/87	2.71	2.31	2.05	-0.30	0.77	25.4	74.8
** STATION 18							
05/07/87	4.26	3.25	1.90	-0.77	1.10	67.8	83.2
05/07/87	4.27	3.59	1.53	-0.72	1.19	68.4	84.0
05/07/87	4.28	3.48	1.65	-0.75	1.20	69.9	84.1
** STATION 19							
05/07/87	2.68	2.48	1.90	-0.20	0.73	29.9	69.6
05/07/87	3.32	2.72	1.95	-0.45	0.78	39.6	82.2
05/07/87	3.44	2.93	1.82	-0.46	1.01	38.9	66.7
** STATION 20							
05/07/87	1.85	2.23	1.84	0.21	0.60	33.5	85.6
05/07/87	3.77	3.19	1.59	-0.51	0.67	47.7	84.5
05/07/87	1.63	2.08	1.69	0.33	0.68	21.1	86.1

Table A-2a. Continued.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
** STATION 21							
05/07/87	3.05	2.71	1.95	-0.34	0.78	39.6	84.0
05/07/87	0.60	1.23	2.51	0.29	0.51	33.9	82.1
05/07/87	3.61	2.99	1.78	-0.51	0.70	45.8	84.2
** STATION 22							
05/07/87	2.49	2.48	0.59	-0.03	1.51	1.8	29.5
05/07/87	2.50	2.49	0.58	0.00	1.50	2.3	33.5
05/67/87	2.49	2.49	0.56	-0.04	1.46	1.2	29.3
** STATION 23							
05/07/87	4.05	3.08	1.92	-0.71	0.74	52.7	86.4
05/07/87	2.78	2.69	1.70	-0.11	0.62	38.2	85.5
05/07/87	3.85	2.98	1.93	-0.63	0.68	49.2	86.3
** STATION 24							
05/07/87	2.71	2.74	1.62	-0.04	0.64	38.0	89.8
05/07/87	2.28	2.41	1.78	0.04	0.69	29.4	89.9
05/07/87	2.95	2.72	1.78	-0.23	0.70	37.4	89.3
** STATION 25							
05/05/87	2.41	1.49	1.91	-0.54	2.05	7.4	39.1
05/05/87	2.56	2.64	1.15	-0.08	3.07	7.7	51.3
05/05/87	2.52	2.35	1.47	-0.31	2.97	8.5	43.2
** STATION 26							
05/05/87	2.91	2.96	0.66	0.11	0.74	4.3	36.9
05/05/87	2.75	2.86	0.64	0.26	0.85	4.6	37.2
05/05/87	2.77	2.87	0.64	0.23	0.81	3.7	36.3
** STATION 27							
05/05/87	0.84	1.25	2.51	0.20	0.51	29.0	88.0
05/05/87	0.19	1.00	2.49	0.40	0.51	25.4	89.2
05/05/87	3.09	2.28	2.37	-0.46	0.62	42.6	87.7
** STATION 28							
05/05/87	2.60	2.72	1.43	0.02	1.11	20.1	83.9
05/05/87	2.51	2.44	1.74	-0.15	1.06	19.3	89.4
05/05/87	2.54	2.55	1.67	-0.13	1.30	18.2	87.5
** STATION 29							
05/05/87	2.17	1.86	2.34	-0.19	0.68	27.7	88.8
05/05/87	3.18	2.84	1.84	-0.37	0.92	33.6	86.2
05/05/87	2.87	2.43	2.08	-0.33	0.76	32.1	86.9
** STATION 30							
05/05/87	2.57	2.63	0.72	0.09	1.66	5.0	51.7
05/05/87	2.55	2.59	0.70	0.05	1.65	4.4	52.2
05/05/87	2.53	2.54	0.68	0.01	1.65	4.2	49.0

Table A-2b. Sediment Data, September, 1987.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
** STATION 1							
09/22/87	2.25	1.40	1.95	-0.52	0.69	0.2	19.9
09/22/87	1.17	1.04	1.72	-0.10	0.79	0.2	19.1
09/22/87	1.86	1.21	1.80	-0.43	0.72	0.1	19.0
** STATION 2							
09/22/87	2.41	2.28	0.90	-0.25	1.50	0.1	22.8
09/22/87	2.42	2.32	0.82	-0.25	1.70	0.5	23.1
09/22/87	2.09	1.71	1.21	-0.51	1.00	0.2	21.9
** STATION 3							
09/22/87	3.32	3.23	0.76	-0.10	1.02	12.0	37.1
09/22/87	3.19	3.17	0.83	0.05	0.88	16.1	45.8
09/22/87	3.33	3.24	0.77	-0.09	1.01	13.9	37.3
** STATION 4							
09/22/87	2.20	1.50	2.07	-0.42	0.58	2.8	27.0
09/22/87	2.43	1.63	1.90	-0.53	1.23	3.3	27.6
09/22/87	2.23	1.54	1.85	-0.46	0.73	3.5	28.3
** STATION 5							
09/22/87	2.49	2.49	0.59	-0.03	1.58	2.5	24.4
09/22/87	2.52	2.52	0.56	0.06	1.49	3.4	26.6
09/22/87	2.51	2.51	0.56	0.03	1.49	2.7	26.5
** STATION 6							
09/22/87	2.97	3.08	0.98	0.12	1.02	17.4	52.8
09/22/87	2.94	3.08	0.87	0.25	0.85	16.9	48.8
09/22/87	2.87	3.00	0.85	0.26	0.91	14.3	45.7
** STATION 7							
09/22/87	2.63	2.72	0.60	0.31	1.19	4.8	33.4
09/22/87	2.74	2.95	0.87	0.35	1.01	14.5	38.7
09/22/87	2.67	2.86	0.91	0.29	1.29	13.0	39.0
** STATION 8							
09/22/87	2.58	2.73	1.12	0.06	2.63	10.9	37.3
09/22/87	2.50	2.27	1.57	-0.29	2.84	11.0	36.8
09/22/87	2.60	2.80	1.18	0.07	2.63	12.8	36.0
** STATION 9							
09/22/87	3.70	3.56	1.14	-0.30	1.14	39.4	68.2
09/22/87	3.57	3.46	1.12	-0.22	0.93	35.3	67.7
09/22/87	2.89	3.21	1.16	0.24	0.73	39.4	72.0
** STATION 10							
09/22/87	2.63	2.75	0.68	0.40	1.51	9.0	35.9
09/22/87	2.70	2.85	0.72	0.38	1.13	8.7	37.0
09/22/87	2.68	2.86	0.75	0.42	1.23	10.8	37.7

Table A-2b. Continued.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURT0SIS	% SILT-% Clay	MOISTURE
**** STATION 11**							
09/22/87	3.58	3.46	1.20	-0.30	1.38	32.4	65.0
09/22/87	3.54	3.41	1.22	-0.30	1.43	29.8	64.0
09/22/87	3.54	3.46	1.16	-0.26	1.44	29.5	64.9
**** STATION 12**							
09/22/87	3.69	3.63	0.98	-0.20	1.09	37.0	67.1
09/22/87	3.72	3.61	1.06	-0.27	1.16	38.9	69.4
09/22/87	3.65	3.58	1.05	-0.23	1.24	34.6	68.1
**** STATION 13**							
09/22/87	2.69	2.83	0.72	0.37	1.11	8.2	41.8
09/22/87	2.67	2.80	0.69	0.37	1.19	7.4	38.3
09/22/87	2.69	2.85	0.75	0.38	1.09	9.7	41.6
**** STATION 14**							
09/22/87	2.79	2.99	0.83	0.39	0.91	15.0	44.2
09/22/87	2.89	3.04	0.83	0.30	0.86	15.3	44.1
09/22/87	2.83	2.97	0.92	0.20	1.06	13.9	51.7
**** STATION 15**							
09/22/87	3.00	2.98	0.65	-0.05	0.74	0.7	26.2
09/22/87	2.58	2.59	0.48	0.19	1.11	0.5	26.4
09/22/87	2.50	2.50	1.01	-0.28	3.08	0.8	26.4
**** STATION 16**							
09/23/87	4.28	4.04	0.99	-0.55	1.51	69.2	71.7
09/23/87	4.18	3.67	1.33	-0.63	1.29	60.9	69.1
09/23/87	4.26	4.02	1.00	-0.54	1.44	67.1	73.0
**** STATION 17**							
09/23/87	2.99	2.75	1.66	-0.25	0.86	27.1	76.2
09/23/87	3.41	3.34	1.23	-0.19	0.87	36.0	74.0
09/23/87	3.06	2.98	1.46	-0.16	0.93	29.9	74.4
**** STATION 18**							
09/23/87	4.03	3.52	1.29	-0.55	0.72	51.6	83.5
09/23/87	4.36	4.09	0.95	-0.59	2.24	78.5	84.6
09/23/87	4.34	3.95	1.09	-0.64	2.37	76.3	83.5
**** STATION 19**							
09/23/87	4.39	4.31	0.77	-0.47	2.22	82.5	75.0
09/23/87	4.24	3.95	1.00	-0.54	1.21	66.1	74.1
09/23/87	4.21	3.68	1.38	-0.66	1.11	63.1	70.0
**** STATION 20**							
09/23/87	4.04	3.58	1.24	-0.54	0.76	52.2	84.7
09/23/87	3.50	3.26	1.32	-0.26	0.67	43.9	85.1
09/23/87	2.68	2.86	1.31	0.16	0.68	27.9	85.9

Table A-2b. Continued.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
## STATION 21							
09/23/87	2.32	2.34	1.96	-0.04	0.59	38.8	86.1
09/23/87	3.84	3.29	1.51	-0.52	0.71	47.6	85.4
09/23/87	4.07	3.74	1.06	-0.48	0.63	53.9	85.5
## STATION 22							
09/23/87	2.51	2.51	0.55	0.02	1.45	2.0	32.5
09/23/87	2.50	2.50	0.55	0.01	1.46	2.1	31.3
09/23/87	2.49	2.49	0.54	-0.01	1.44	2.2	33.3
## STATION 23							
09/23/87	3.29	2.70	2.03	-0.46	0.74	38.9	84.2
09/23/87	3.73	3.32	1.36	-0.40	0.65	47.2	84.8
09/23/87	3.70	3.26	1.48	-0.47	0.79	40.6	85.6
## STATION 24							
09/23/87	2.27	2.55	1.45	0.20	0.77	21.4	89.8
09/23/87	2.44	2.64	1.46	0.13	0.74	23.7	90.4
09/23/87	3.07	2.97	1.50	-0.15	0.69	37.7	90.0
## STATION 25							
09/21/87	2.70	2.91	0.81	0.43	1.08	13.5	52.3
09/21/87	2.23	2.32	1.03	0.24	1.18	12.8	55.1
09/21/87	2.67	2.82	0.82	0.29	1.34	9.7	55.6
## STATION 26							
09/21/87	2.74	2.60	1.28	-0.17	0.92	9.8	74.9
09/21/87	2.98	2.86	1.25	-0.16	1.00	17.0	76.5
09/21/87	3.13	3.04	0.97	-0.16	1.05	11.7	71.6
## STATION 27							
09/21/87	3.63	3.43	1.20	-0.28	0.76	42.0	85.8
09/21/87	3.42	3.30	1.22	-0.19	0.77	36.0	86.9
09/21/87	3.47	3.36	1.19	-0.19	0.76	38.2	88.3
## STATION 28							
09/21/87	2.96	3.04	1.17	0.05	0.85	25.5	90.4
09/21/87	2.49	2.54	1.33	0.03	1.01	14.6	89.5
09/21/87	2.87	2.97	1.20	0.06	0.94	21.2	88.0
## STATION 29							
09/21/87	1.81	2.01	1.43	0.22	0.92	10.9	88.2
09/21/87	2.25	2.38	1.56	0.04	0.94	16.4	87.7
09/21/87	1.57	1.79	1.39	0.27	0.96	9.2	89.4
## STATION 30							
09/21/87	2.79	2.90	0.91	0.12	1.13	9.7	68.4
09/21/87	2.86	2.93	0.87	0.07	1.07	8.4	69.1
09/21/87	2.69	2.82	0.85	0.16	1.24	7.5	66.2

Table A-2c. Sediment Data, March, 1988.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
## STATION 12							
03/22/88	3.73	3.53	1.20	-0.35	1.20	40.6	64.7
03/22/88	3.57	3.50	1.05	-0.19	1.02	33.2	68.3
03/22/88	3.90	3.80	0.91	-0.26	0.99	46.4	67.0
## STATION 18							
03/22/88	4.04	3.42	1.40	-0.59	0.67	52.1	79.8
03/22/88	3.33	3.14	1.39	-0.21	0.64	41.8	78.6
03/22/88	3.07	2.87	1.63	-0.21	0.64	41.6	78.5
## STATION 24							
03/23/88	2.91	2.72	1.67	-0.21	0.75	27.7	88.2
03/23/88	2.77	2.67	1.71	-0.16	0.80	28.2	88.3
03/23/88	3.34	3.22	1.26	-0.17	0.75	34.9	88.7
## STATION 101							
03/22/88	3.14	3.28	1.09	0.09	0.78	31.9	60.7
03/22/88	3.12	3.28	1.09	0.12	0.75	33.3	58.0
03/22/88	2.96	3.15	0.99	0.23	0.85	22.6	49.2
## STATION 102							
03/22/88	3.21	3.08	0.74	-0.31	0.92	3.4	29.5
03/22/88	3.39	3.28	0.66	-0.35	1.39	5.2	30.4
03/22/88	2.88	2.92	0.74	0.02	0.85	4.6	30.4
## STATION 104							
03/22/88	4.28	3.88	1.14	-0.62	1.32	69.6	79.3
03/22/88	4.32	4.04	0.88	-0.54	1.55	74.1	80.0
03/22/88	4.31	4.02	0.92	-0.55	1.41	72.3	79.9
## STATION 105							
03/22/88	3.35	3.33	1.18	-0.13	0.84	34.4	72.8
03/22/88	4.13	3.77	1.09	-0.52	0.88	57.4	51.1
03/22/88	4.17	4.02	0.87	-0.42	1.17	60.5	73.5
## STATION 106							
03/22/88	2.56	2.56	0.49	0.21	1.27	3.9	33.7
03/22/88	2.59	2.60	0.50	0.23	1.23	3.5	33.0
03/22/88	2.54	2.54	0.47	0.22	1.31	4.2	34.3
## STATION 107							
03/22/88	3.62	3.57	0.93	-0.10	0.81	35.9	60.5
03/22/88	3.67	3.72	0.80	-0.02	1.00	33.8	61.5
03/22/88	3.56	3.51	0.95	-0.09	0.79	34.2	63.6
## STATION 108							
03/22/88	3.00	3.08	0.79	0.21	0.87	13.3	39.4
03/22/88	3.58	3.58	0.44	0.17	1.11	14.4	43.9
03/22/88	3.18	3.16	0.77	0.06	0.90	13.3	40.2

Table A-2c. Continued.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
## STATION 109							
03/22/88	3.57	3.45	1.21	-0.25	0.90	39.8	73.4
03/22/88	3.91	3.60	1.17	-0.43	0.84	48.1	76.3
03/22/88	3.65	3.36	1.37	-0.38	0.86	43.7	78.5
## STATION 110							
03/22/88	2.66	2.78	0.64	0.33	1.14	5.6	37.4
03/22/88	2.73	2.85	0.67	0.30	0.92	5.8	37.8
03/22/88	2.70	2.85	0.74	0.36	1.05	8.8	43.9
## STATION 111							
03/23/88	2.70	2.85	0.74	0.36	1.05	8.9	39.1
03/23/88	3.51	3.51	0.63	-0.19	1.98	8.8	36.9
03/23/88	2.63	2.81	1.28	0.01	2.58	11.8	41.1
## STATION 112							
03/23/88	2.59	2.67	0.69	0.28	1.59	7.7	37.2
03/23/88	2.61	2.70	0.61	0.32	1.28	5.6	34.5
03/23/88	2.58	2.64	0.62	0.24	1.44	5.8	33.3
## STATION 113							
03/22/88	4.32	4.16	0.75	-0.45	1.39	73.0	80.9
03/22/88	4.29	4.13	0.74	-0.42	1.16	70.0	78.5
03/22/88	4.27	4.14	0.86	-0.46	1.53	68.8	82.1
## STATION 114							
03/22/88	4.34	4.07	0.84	-0.53	1.71	75.9	77.3
03/22/88	4.38	4.22	0.76	-0.49	1.86	80.6	78.5
03/22/88	4.30	3.93	1.06	-0.60	1.36	71.1	79.1
## STATION 116							
03/23/88	3.49	3.12	1.49	-0.37	0.68	38.0	81.1
03/23/88	3.51	3.16	1.50	-0.36	0.68	44.4	80.8
03/23/88	3.41	3.18	1.39	-0.26	0.67	41.7	77.1
## STATION 117							
03/23/88	3.03	3.23	1.04	0.19	0.77	28.3	72.7
03/23/88	3.10	3.26	0.99	0.20	0.73	28.2	76.7
03/23/88	2.99	3.12	1.16	0.08	0.84	26.4	76.0
## STATION 118							
03/23/88	4.01	3.32	1.54	-0.62	0.70	50.5	80.7
03/23/88	3.72	3.29	1.40	-0.42	0.66	46.5	82.1
03/23/88	3.14	2.98	1.53	-0.20	0.68	39.3	84.3
## STATION 119							
03/23/88	2.89	2.92	1.34	-0.04	0.89	24.2	81.4
03/23/88	2.93	3.04	1.05	0.10	0.97	18.3	75.8
03/23/88	3.05	3.00	1.30	-0.12	0.98	22.8	82.1

Table A-2c. Continued.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
## STATION 121							
03/23/88	3.56	3.44	1.19	-0.25	0.85	39.5	82.4
03/23/88	2.99	2.94	1.70	-0.23	1.07	31.0	82.4
03/23/88	3.25	3.13	1.35	-0.17	0.72	36.3	81.0
## STATION 122							
03/24/88	4.13	3.74	1.10	-0.53	0.80	57.7	85.3
03/24/88	4.05	3.64	1.18	-0.52	0.78	52.7	85.7
03/24/88	3.87	3.63	1.08	-0.36	0.78	47.2	87.5
## STATION 123							
03/24/88	2.76	2.81	1.28	-0.03	1.15	17.2	80.2
03/24/88	2.77	2.78	1.53	-0.07	0.80	27.4	89.7
03/24/88	2.85	3.05	1.11	0.17	0.90	22.4	85.3
## STATION 124							
03/24/88	3.59	3.55	0.95	-0.09	0.73	37.3	74.4
03/24/88	3.62	3.61	0.88	-0.08	0.96	33.0	71.8
03/24/88	3.61	3.56	0.92	-0.08	0.78	36.1	70.3
## STATION 125							
03/21/88	4.21	3.91	0.92	-0.49	0.90	63.1	88.4
03/21/88	3.90	3.41	1.44	-0.54	1.29	47.2	90.5
03/21/88	3.75	3.57	1.08	-0.29	0.78	44.1	89.3
## STATION 126							
03/21/88	2.97	2.43	1.83	-0.45	0.97	15.5	90.6
03/21/88	2.27	1.93	1.98	-0.25	1.04	14.2	89.2
03/21/88	2.76	2.89	1.22	0.11	0.88	21.2	90.0
## STATION 127							
03/24/88	3.90	3.53	1.22	-0.45	0.73	48.5	90.9
03/24/88	3.70	3.38	1.27	-0.37	0.78	42.2	90.3
03/24/88	4.04	3.90	0.86	-0.32	0.94	52.0	91.3
## STATION 128							
03/24/88	2.57	2.57	0.44	0.17	1.12	0.3	28.8
03/24/88	2.58	2.58	0.46	0.17	1.13	0.6	29.3
03/24/88	2.56	2.56	0.43	0.17	1.10	0.3	27.4
## STATION 129							
03/21/88	2.48	2.48	0.42	-0.15	1.02	0.4	25.8
03/21/88	2.49	2.49	0.40	-0.10	0.99	0.7	26.3
03/21/88	2.49	2.49	0.39	-0.07	0.95	0.6	26.4
## STATION 130							
03/21/88	2.21	2.19	1.19	0.01	1.27	9.3	60.9
03/21/88	2.18	2.10	1.08	-0.08	1.29	6.5	56.9
03/21/88	2.21	2.09	1.14	-0.11	1.32	8.1	66.8

Table A-2c. Continued.

DATE MM/DD/YY	MEDIAN PHI	MEAN PHI	SORTCOEFF	SKEWNESS	KURTOSIS	% SILT-CLAY	% MOISTURE
## STATION 131							
03/21/88	2.51	2.51	0.44	0.08	1.12	0.7	26.4
03/21/88	2.51	2.51	0.43	0.09	1.09	0.8	27.6
03/21/88	2.54	2.54	0.44	0.17	1.11	1.1	28.5

Table A-3a. Nutrient Data, May 1987.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT-CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 1						
05/06/87	0.06	0.48	0.5	0.3	0.1188	8.6264
05/06/87	0.04	0.50	0.5	0.3	0.0895	11.8532
05/06/87	0.03	0.41	0.2	0.1	0.0787	7.1605
## STATION 2						
05/06/87	0.02	0.38	0.5	0.1	0.0624	22.0856
05/06/87	0.02	0.44	0.4	0.1	0.0402	23.1432
05/06/87	0.01	0.34	0.3	0.1	0.0356	28.0499
## STATION 3						
05/06/87	0.57	0.79	4.4	12.0	0.7230	7.7423
05/06/87	0.55	0.78	6.1	16.3	0.7035	11.1777
05/06/87	0.70	0.86	6.2	19.9	0.8083	8.9037
## STATION 4						
05/06/87	1.81	0.71	20.2	32.3	2.5628	11.1336
05/06/87	4.09	1.27	23.5	40.4	3.2192	5.7501
05/06/87	0.81	0.35	15.1	28.3	2.3493	18.6645
## STATION 5						
05/06/87	0.01	0.08	0.2	0.6	0.1512	15.5270
05/06/87	0.07	0.11	1.3	5.3	0.6321	18.5083
05/06/87	0.01	0.12	0.2	0.4	0.0667	26.3192
## STATION 6						
05/06/87	0.19	0.15	2.4	2.2	1.2148	12.6158
05/06/87	0.31	0.19	3.4	4.9	1.6730	11.0102
05/06/87	0.19	0.14	3.1	2.8	1.3554	15.9966
## STATION 7						
05/06/87	0.61	0.22	12.3	12.8	2.8045	20.2165
05/06/87	1.48	0.39	14.7	12.0	3.8038	9.9203
05/06/87	0.96	0.36	19.9	28.6	2.6706	20.6825
## STATION 8						
05/06/87	0.08	0.04	0.7	1.6	1.7508	8.6330
05/06/87	0.06	0.04	1.4	0.5	1.4950	23.4926
05/06/87	0.06	0.04	0.6	6.6	1.3591	11.1506
## STATION 9						
05/06/87	3.07	0.76	28.6	32.8	4.0258	9.3181
05/06/87	3.55	0.68	32.8	29.0	5.1899	9.2377
05/06/87	2.78	0.83	36.6	32.8	3.3303	13.8734
## STATION 10						
05/06/87	1.37	0.52	19.6	5.3	2.6263	14.3222
05/06/87	1.24	0.54	19.9	15.2	2.2877	16.1164
05/06/87	1.25	0.49	19.8	15.2	2.5459	15.6877

Table A-3a. Continued.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	MG/G TOTAL ORGANIC CARBON MG/G	% SILT- CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 11						
05/06/87	2.44	0.96	31.5	26.5	2.5419	12.9517
05/06/87	3.06	0.97	34.4	6.2	3.1445	11.2422
05/06/87	2.35	0.78	31.8	32.3	3.0238	13.5317
## STATION 12						
05/06/87	4.99	1.48	32.0	39.3	3.3803	6.4150
05/06/87	3.44	0.89	37.3	24.8	3.8821	10.8478
05/06/87	2.85	0.84	36.7	35.5	3.3896	12.8648
## STATION 13						
05/06/87	0.86	0.30	10.3	16.3	2.8222	12.0200
05/06/87	0.99	0.35	22.9	15.8	2.7947	23.1971
05/06/87	1.09	0.36	8.3	14.7	3.0237	7.6798
## STATION 14						
05/06/87	0.81	0.37	14.6	11.7	2.2214	18.0196
05/06/87	0.98	0.33	17.8	10.9	2.9637	18.1795
05/06/87	1.02	0.36	21.0	11.1	2.8069	20.5576
## STATION 15						
05/07/87	0.16	0.36	1.7	4.0	0.4395	11.2074
05/07/87	0.14	0.29	2.6	4.0	0.4676	19.1265
05/07/87	0.16	0.33	2.8	4.7	0.4835	17.1717
## STATION 16						
05/07/87	12.21	1.39	78.5	26.0	8.7772	6.4309
05/07/87	11.23	1.29	91.5	23.9	8.7257	8.1520
05/07/87	5.92	0.71	84.3	44.4	8.2848	14.2506
## STATION 17						
05/07/87	4.36	0.58	44.7	21.6	7.5047	10.2607
05/07/87	4.61	0.66	45.4	27.1	6.9864	9.8432
05/07/87	4.69	0.66	45.9	25.4	7.1175	9.7866
## STATION 18						
05/07/87	9.94	2.00	74.4	67.8	4.9691	7.4848
05/07/87	9.49	1.73	80.8	68.4	5.4852	8.5114
05/07/87	9.39	1.92	73.5	69.9	4.9004	7.8246
## STATION 19						
05/07/87	4.33	0.55	42.2	29.9	7.9349	9.7629
05/07/87	7.08	1.04	54.8	39.6	6.7868	7.7422
05/07/87	3.97	0.51	48.0	38.9	7.7403	12.0976
## STATION 20						
05/07/87	9.23	1.08	74.5	33.5	8.5276	8.0797
05/07/87	8.60	1.01	78.8	47.7	8.4981	9.1639
05/07/87	9.01	1.04	71.6	21.1	8.7044	7.9498

Table A-3a. Continued.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT-CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 21						
05/07/87	9.11	0.92	82.2	39.6	9.9564	9.0255
05/07/87	7.53	0.87	57.2	33.9	8.6114	7.5970
05/07/87	9.83	1.02	70.6	45.8	9.6174	7.1821
## STATION 22						
05/07/87	0.61	0.10	5.7	1.8	6.0447	9.2771
05/07/87	0.70	0.12	6.4	2.3	5.8451	9.1245
05/07/87	0.47	0.09	6.9	1.2	5.2959	14.6174
## STATION 23						
05/07/87	11.28	1.10	81.0	52.7	10.2433	7.1805
05/07/87	11.09	1.05	82.9	38.2	10.5678	7.4717
05/07/87	11.77	1.08	80.3	49.2	10.9349	6.8183
## STATION 24						
05/07/87	17.32	1.46	72.2	38.0	11.8887	4.1673
05/07/87	16.92	1.50	111.6	29.4	11.2713	6.5919
05/07/87	17.40	1.39	88.6	37.4	12.4852	5.0921
## STATION 25						
05/05/87	1.17	0.28	14.2	7.4	4.1571	12.1894
05/05/87	1.90	0.40	21.9	7.7	4.7630	11.5624
05/05/87	1.08	0.24	24.6	8.5	4.6046	22.6819
## STATION 26						
05/05/87	0.80	0.12	7.5	4.3	6.6539	9.3556
05/05/87	0.90	0.14	9.2	4.6	6.5011	10.2133
05/05/87	0.77	0.11	11.6	3.7	6.8581	15.1643
## STATION 27						
05/05/87	14.33	1.23	85.9	29.0	11.6563	5.9930
05/05/87	13.86	1.33	98.8	25.4	10.4163	7.1296
05/05/87	12.18	1.12	81.4	42.6	10.8382	6.6824
## STATION 28						
05/05/87	11.98	0.54	57.5	20.1	22.0629	4.8029
05/05/87	16.87	0.52	50.3	19.3	32.2821	2.9797
05/05/87	13.17	1.39	62.3	18.2	9.4864	4.7285
## STATION 29						
05/05/87	14.91	1.29	75.7	27.7	11.5242	5.0735
05/05/87	12.01	1.20	73.8	33.6	10.0315	6.1485
05/05/87	13.23	1.16	61.7	32.1	11.3724	4.6599
## STATION 30						
05/05/87	2.19	0.38	25.2	5.0	5.8372	11.4795
05/05/87	2.36	0.35	24.9	4.4	6.7998	10.5785
05/05/87	1.89	0.41	16.5	4.2	4.6255	8.6984

Table A-3b. Nutrient Data, September, 1987.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT-CLAY	N:P RATIO MG/MG	C:N RATIO MG /MG
## STATION 1						
09/22/87	0.06	0.62	0.5	0.2	0.1033	7.2451
09/22/87	0.08	0.61	0.6	0.2	0.1355	6.7713
09/22/87	0.07	0.60	0.4	0.1	0.1206	5.8662
## STATION 2						
09/22/87	0.02	0.49	0.4	0.1	0.0485	15.6998
09/22/87	0.03	0.63	0.3	0.5	0.0514	10.0342
09/22/87	0.03	0.33	0.4	0.2	0.1033	13.2494
## STATION 3						
09/22/87	0.58	0.78	5.2	12.0	0.7353	9.1059
09/22/87	0.87	0.73	6.9	16.1	1.2009	7.9254
09/22/87	0.72	1.04	6.1	13.9	0.6968	8.4192
## STATION 4						
09/22/87	0.34	0.42	3.2	2.8	0.8105	9.3013
09/22/87	0.31	0.50	2.6	3.3	0.6191	8.2956
09/22/87	0.38	0.11	2.7	3.5	3.4535	7.0337
## STATION 5						
09/22/87	0.05	0.21	0.6	2.5	0.2435	10.8204
09/22/87	0.04	0.15	0.7	3.4	0.2881	14.6636
09/22/87	0.06	0.23	0.6	2.7	0.2699	9.6719
## STATION 6						
09/22/87	1.38	0.50	13.3	17.4	2.7836	9.6525
09/22/87	0.91	0.35	9.6	16.9	2.5808	10.5020
09/22/87	1.01	0.45	8.4	14.3	2.2191	8.3006
## STATION 7						
09/22/87	0.25	0.15	2.8	4.8	1.6471	11.2888
09/22/87	1.07	0.27	5.7	14.5	3.9813	5.3428
09/22/87	0.61	0.22	6.3	13.0	2.7570	10.2940
## STATION 8						
09/22/87	0.54	0.18	5.5	10.9	3.0484	10.2145
09/22/87	0.83	0.25	7.3	11.0	3.3297	8.8174
09/22/87	0.31	0.21	7.8	12.8	1.5091	25.2282
## STATION 9						
09/22/87	3.33	0.74	30.7	39.4	4.5282	9.2077
09/22/87	3.60	0.94	33.3	35.3	3.8161	9.2511
09/22/87	5.64	0.76	44.0	39.4	4.8034	12.0917
## STATION 10						
09/22/87	0.68	0.25	6.8	9.0	2.6863	9.9863
09/22/87	0.69	0.26	13.4	8.7	2.6245	19.5475
09/22/87	0.75	0.24	13.0	10.8	3.1784	17.2348

Table A-3b. Continued.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT-CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 11						
09/22/87	2.83	0.94	27.1	32.4	3.0085	9.5556
09/22/87	2.76	1.00	26.7	29.8	2.7483	9.6729
09/22/87	2.77	1.08	27.4	29.5	2.5705	9.8656
## STATION 12						
09/22/87	3.33	1.10	37.6	37.0	3.0198	11.2842
09/22/87	3.68	0.97	27.9	38.9	3.7780	7.5919
09/22/87	3.38	1.09	27.6	34.6	3.0916	8.1856
## STATION 13						
09/22/87	0.98	0.31	13.3	8.2	3.1694	13.6085
09/22/87	0.80	0.29	6.9	7.4	2.7798	8.6610
09/22/87	0.83	0.28	12.5	9.7	2.9198	15.1177
## STATION 14						
09/22/87	1.08	0.31	21.9	15.0	3.5105	20.2578
09/22/87	0.96	0.26	23.0	15.3	3.6499	23.9158
09/22/87	1.36	0.38	28.1	13.9	3.6011	20.6925
## STATION 15						
09/22/87	0.08	0.10	1.1	0.7	0.7597	13.3292
09/22/87	0.08	0.12	1.1	0.5	0.6551	13.5441
09/22/87	0.09	0.13	1.3	0.8	0.6576	15.2519
## STATION 16						
09/23/87	4.31	0.52	43.1	69.2	8.3518	9.9930
09/23/87	4.29	0.60	29.3	60.9	7.1319	6.8424
09/23/87	4.52	0.65	40.2	67.1	6.9994	8.9024
## STATION 17						
09/23/87	5.48	0.63	40.9	27.1	8.6833	7.4764
09/23/87	4.92	0.62	35.9	36.0	7.9040	7.2908
09/23/87	4.38	0.57	37.9	29.9	7.6317	8.6576
## STATION 18						
09/23/87	9.48	1.61	64.5	51.6	5.8947	6.8091
09/23/87	9.44	1.76	46.6	78.5	5.3620	4.9370
09/23/87	9.67	1.91	63.0	76.3	5.0717	6.5141
## STATION 19						
09/23/87	4.84	0.67	44.6	82.5	7.2129	9.2133
09/23/87	4.04	0.50	39.5	66.1	8.1395	9.7899
09/23/87	3.50	0.68	25.1	63.1	5.1335	7.1674
## STATION 20						
09/23/87	9.48	0.99	54.3	52.2	9.6011	5.7255
09/23/87	10.19	1.16	44.1	43.9	8.7897	4.3233
09/23/87	9.71	1.18	62.9	27.9	8.2035	6.4797

Table A-3b. Continued.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT--CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 21						
09/23/87	9.75	1.32	54.5	38.8	7.3582	5.5889
09/23/87	8.56	1.15	45.6	47.6	7.4218	5.3325
09/23/87	8.85	1.21	48.7	53.9	7.3385	5.4989
## STATION 22						
09/23/87	0.46	0.06	4.3	2.0	7.5856	9.3749
09/23/87	0.51	0.11	5.0	2.1	4.5091	9.8199
09/23/87	0.47	0.07	8.3	2.2	6.5237	17.4734
## STATION 23						
09/23/87	10.03	0.97	58.1	38.9	10.3233	5.7943
09/23/87	10.73	0.99	46.7	47.2	10.7877	4.3506
09/23/87	11.23	1.00	71.7	40.6	11.2099	6.3837
## STATION 24						
09/23/87	17.59	1.45	59.0	21.4	12.1476	3.3569
09/23/87	13.12	1.14	85.6	23.7	11.4986	6.5207
09/23/87	16.70	1.31	62.5	37.7	12.7653	3.7418
## STATION 25						
09/21/87	1.56	0.23	15.2	13.5	6.7107	9.7345
09/21/87	1.43	0.20	16.9	12.8	7.2452	11.8619
09/21/87	1.92	0.23	22.3	9.7	8.2268	11.6071
## STATION 26						
09/21/87	5.16	0.48	48.1	9.8	10.7436	9.3096
09/21/87	6.50	0.51	48.8	17.0	12.6372	7.5156
09/21/87	5.04	0.55	33.4	11.7	9.2191	6.6353
## STATION 27						
09/21/87	10.75	0.95	66.4	42.0	11.3663	6.1726
09/21/87	12.70	1.07	72.7	36.0	11.8172	5.7269
09/21/87	11.61	1.04	66.9	38.2	11.1974	5.7654
## STATION 28						
09/21/87	12.53	0.36	58.2	23.5	34.9159	4.6427
09/21/87	15.24	0.40	49.3	14.6	38.1357	3.2335
09/21/87	13.65	0.76	47.2	21.2	18.0099	3.4580
## STATION 29						
09/21/87	11.01	1.06	67.1	10.9	10.4014	6.0951
09/21/87	12.30	1.17	65.5	16.4	10.5327	5.3287
09/21/87	13.58	1.20	72.4	9.2	11.3075	5.3309
## STATION 30						
09/21/87	3.67	0.50	26.6	9.7	7.3574	7.2432
09/21/87	4.33	0.69	24.0	8.4	6.2885	5.5433
09/21/87	4.05	0.60	19.8	7.5	6.7065	4.8875

Table A-3c. Nutrient Data, March, 1988.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT-CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 12						
03/22/88	2.36	0.84	40.8	40.6	2.8015	17.2638
03/22/88	2.99	1.01	46.0	33.2	2.9514	15.3710
03/22/88	3.30	0.91	34.7	46.4	3.6288	10.5432
## STATION 18						
03/22/88	7.73	1.50	75.8	52.1	5.1526	9.8098
03/22/88	7.40	1.43	94.4	41.8	5.1689	12.7629
03/22/88	7.26	1.40	80.0	41.6	5.1649	11.0270
## STATION 24						
03/23/88	14.24	1.00	78.0	27.7	14.2268	5.4746
03/23/88	14.94	1.02	83.2	28.2	14.6010	5.5673
03/23/88	15.00	1.12	82.6	34.9	13.4206	5.5023
## STATION 101						
03/22/88	1.89	0.61	20.1	31.9	3.0780	10.6629
03/22/88	1.56	0.91	27.9	33.3	1.7184	17.8725
03/22/88	1.26	0.38	14.2	22.6	3.2989	11.3228
## STATION 102						
03/22/88	0.39	0.10	2.3	3.4	4.0087	5.8826
03/22/88	0.44	0.14	3.9	5.2	3.1004	8.9564
03/22/88	0.31	0.15	2.4	4.6	2.1120	7.8744
## STATION 104						
03/22/88	5.69	1.37	64.0	69.6	4.1423	11.2604
03/22/88	5.99	1.32	70.1	74.1	4.5353	11.7037
03/22/88	5.89	1.33	60.5	72.3	4.4127	10.2702
## STATION 105						
03/22/88	4.24	0.89	39.3	34.4	4.7629	9.2589
03/22/88	2.30	0.42	49.7	57.4	5.4696	21.6481
03/22/88	4.37	0.82	44.8	60.5	5.3177	10.2524
## STATION 106						
03/22/88	0.56	0.15	5.9	3.9	3.6055	10.6198
03/22/88	0.51	0.16	4.8	3.5	3.2639	9.4780
03/22/88	0.63	0.15	5.2	4.2	4.1579	8.3453
## STATION 107						
03/22/88	2.38	0.81	19.9	35.9	2.9268	8.3449
03/22/88	2.55	0.79	22.9	33.8	3.2255	8.9704
03/22/88	2.7:	0.84	24.6	34.2	3.2467	9.0651
## STATION 108						
03/22/88	0.90	0.37	11.8	13.3	2.4645	13.1465
03/22/88	1.02	0.38	8.6	14.4	2.7139	8.4252
03/22/88	0.88	0.36	8.8	13.3	2.4301	9.9794

Table A-3c. Continued.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT-CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 109						
03/22/88	4.71	0.79	63.9	39.8	5.9719	13.5749
03/22/88	5.40	0.84	65.9	48.1	6.4355	12.1962
03/22/88	5.38	0.92	76.4	43.7	5.8668	14.1944
## STATION 110						
03/22/88	1.05	0.24	11.5	5.6	4.3120	10.8658
03/22/88	0.86	0.19	7.5	5.8	4.6279	8.6825
03/22/88	1.33	0.25	14.8	8.8	5.3606	11.1038
## STATION 111						
03/23/88	0.92	0.36	11.7	8.9	2.5671	12.6435
03/23/88	0.82	0.46	9.6	8.8	1.7921	11.7255
03/23/88	1.11	0.45	15.5	11.8	2.4442	13.9577
## STATION 112						
03/23/88	0.95	0.20	11.5	7.7	4.6724	12.2114
03/23/88	0.78	0.13	10.1	5.6	5.9790	12.9921
03/23/88	0.68	0.14	9.0	5.8	4.7960	13.1387
## STATION 113						
03/22/88	7.77	1.24	86.0	73.0	6.2802	11.0774
03/22/88	7.13	1.07	79.0	70.0	6.6431	11.0836
03/22/88	8.05	1.20	82.8	68.8	6.6845	10.2790
## STATION 114						
03/22/88	5.76	1.81	85.2	75.9	3.1803	14.8083
03/22/88	5.91	2.04	92.0	80.6	2.9005	15.5696
03/22/88	6.33	1.91	69.5	71.1	3.3071	10.9780
## STATION 116						
03/23/88	8.03	1.03	65.9	38.0	7.8194	8.2034
03/23/88	8.50	1.22	92.4	44.4	6.9846	10.8702
03/23/88	6.72	0.99	75.5	41.7	6.7504	11.2409
## STATION 117						
03/23/88	5.16	0.69	63.1	28.3	7.4822	12.2401
03/23/88	5.87	0.67	58.7	28.2	8.7091	10.0009
03/23/88	6.07	0.76	41.4	26.4	7.9770	6.8226
## STATION 118						
03/23/88	7.56	0.95	65.4	50.5	7.9608	8.6507
03/23/88	8.74	0.95	61.0	46.5	9.1715	6.9819
03/23/88	9.86	1.09	67.6	39.3	9.0692	6.8591
## STATION 119						
03/23/88	8.22	0.75	52.8	24.2	10.9993	6.4228
03/23/88	5.95	0.55	54.4	18.3	10.8275	9.1424
03/23/88	8.23	0.76	50.1	22.8	10.7579	6.0875

Table A-3c. Continued.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT-CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 121						
03/23/88	6.01	0.78	66.2	39.5	7.6640	11.0201
03/23/88	7.94	1.13	77.5	31.0	7.0237	9.7634
03/23/88	8.22	1.21	59.3	36.3	6.8094	7.2121
## STATION 122						
03/24/88	10.57	0.99	63.2	57.7	10.7187	5.9812
03/24/88	11.16	1.00	69.2	52.7	11.1722	6.1961
03/24/88	11.63	1.17	81.1	47.2	9.9177	6.9768
## STATION 123						
03/24/88	7.34	0.63	62.4	17.2	11.6865	8.4984
03/24/88	14.59	1.35	113.8	27.4	10.8493	7.7971
03/24/88	9.84	0.80	62.8	22.4	12.2786	6.3824
## STATION 124						
03/24/88	5.26	0.52	46.7	37.3	10.0763	8.8815
03/24/88	4.58	0.58	23.8	33.0	7.9698	5.2024
03/24/88	3.99	0.44	25.8	36.1	9.0229	6.4628
## STATION 125						
03/21/88	13.83	1.27	84.4	63.1	10.8693	6.1037
03/21/88	14.76	1.58	85.5	47.2	9.3455	5.7949
03/21/88	14.52	1.52	77.7	44.1	9.5606	5.3526
## STATION 126						
03/21/88	14.54	2.51	174.5	15.5	5.8020	12.0044
03/21/88	12.54	2.36	145.3	14.2	5.3156	11.5950
03/21/88	14.80	2.57	159.2	21.2	5.7546	10.7590
St STATION 127						
03/24/88	19.07	2.07	96.0	48.5	9.2325	5.0351
03/24/88	17.28	1.31	107.3	42.2	13.2170	6.2123
03/24/88	18.84	1.33	94.0	52.0	14.1843	4.9901
## STATION 128						
03/24/88	0.15	0.05	1.4	0.3	3.2157	9.2760
03/24/88	0.31	0.08	1.4	0.6	3.8392	4.4828
03/24/88	0.25	0.05	1.2	0.3	4.7473	5.0454
## STATION 129						
03/21/88	0.22	0.08	1.6	0.4	2.6969	7.1528
03/21/88	0.27	0.06	1.8	0.7	4.1667	6.6563
03/21/88	0.27	0.06	1.9	0.6	4.4000	6.9793
## STATION 130						
03/21/88	3.40	0.39	24.3	9.3	8.7901	7.1414
03/21/88	2.89	0.29	19.1	6.5	10.0153	6.5843
03/21/88	3.58	0.33	31.4	8.1	10.7922	8.7764

Table A-3c. Continued.

DATE MM/DD/YY	TKN MG/G	TOTAL P MG/G	TOTAL ORGANIC CARBON MG/G	% SILT-CLAY	N:P RATIO MG/MG	C:N RATIO MG/MG
## STATION 131						
03/21/88	0.30	0.08	1.9	0.7	3.6949	6.3834
03/21/88	0.33	0.10	1.9	0.8	3.2402	5.8010
03/21/88	0.49	0.12	2.3	1.1	3.9752	4.6638

Table A-4a. Metals Data, May, 1987.

DATE MM/DD/YY	ALUMINUM MG/G	CADMIUM UG/G	COPPER UG/G	LEAD UG/G	MERCURY UG/G	ZINC UG/G	TOTAL ORGANIC CARBON MG/G	% SILT CLAY
## STATION 3								
05/06/87	16.07	0.19	2.8	8.0	0.020	13.1	4.4	12.0
05/06/87	16.86	0.09	2.9	6.0	0.020	14.5	6.1	16.3
05/06/87	26.47	<0.05	3.0	7.7	0.020	19.1	6.2	19.9
## STATION 7								
05/06/87	11.83	<0.05	2.3	5.4	0.038	13.9	12.3	12.8
05/06/87	15.17	<0.05	2.6	6.2	0.011	19.6	14.7	12.0
05/06/87	33.55	0.09	4.3	6.3	0.031	27.0	19.9	28.6
## STATION 9								
05/06/87	22.62	0.50	14.8	26.8	0.098	78.3	28.6	32.8
05/06/87	30.42	0.13	12.3	28.6	0.082	94.4	32.8	29.0
05/06/87	37.52	0.20	15.3	26.5	0.088	92.3	38.6	32.8
## STATION 12								
05/06/87	42.51	0.20	18.6	31.3	0.109	105.1	32.0	39.3
05/06/87	18.91	0.20	14.8	38.9	0.080	105.5	37.3	24.8
05/06/87	27.53	0.32	19.4	26.2	0.216	90.1	36.7	35.5
## STATION 14								
05/06/87	11.22	0.13	6.9	16.7	0.058	39.4	14.6	11.7
05/06/87	10.36	<0.05	7.5	24.0	0.060	40.1	17.8	10.9
05/06/87	11.72	0.16	7.3	20.2	0.036	41.6	21.0	11.1
## STATION 16								
05/07/87	44.44	0.52	24.7	52.6	0.309	169.3	78.5	26.0
05/07/87	43.67	0.59	22.5	49.9	0.308	167.1	91.5	23.9
05/07/87	39.88	0.39	24.1	51.8	0.241	160.8	84.3	44.4
## STATION 17								
05/07/87	23.71	0.27	14.1	32.4	0.157	91.6	44.7	21.6
05/07/87	20.82	0.57	18.5	33.9	0.200	78.4	45.4	27.1
05/07/87	23.02	0.61	17.1	25.4	0.191	79.6	45.9	25.4
## STATION 18								
05/07/87	32.79	2.14	64.6	215.0	0.821	467.8	74.4	67.8
05/07/87	47.97	2.01	58.4	195.5	0.816	511.0	80.8	68.4
05/07/87	47.15	1.72	60.8	230.3	1.078	491.1	73.5	69.9
## STATION 19								
05/07/87	23.34	0.48	11.9	24.4	0.088	64.3	42.2	29.9
05/07/87	34.63	0.80	12.4	29.1	0.105	61.1	54.8	39.6
05/07/87	32.62	0.41	9.7	26.7	0.077	69.1	48.0	38.9
## STATION 22								
05/07/87	3.35	0.07	2.0	3.0	0.009	6.2	5.7	1.8
05/07/87	0.99	0.07	1.9	3.5	0.012	6.8	6.4	2.3
05/07/87	1.02	0.13	1.7	3.4	0.013	6.5	6.9	1.2

Table A-4a. Continued.

DATE MM/DD/YY	ALUMINUM MG/G	CADMIUM UG/G	COPPER UG/G	LEAD UG/G	MERCURY UG/G	ZINC UG/G	TOTAL ORGANIC CARBON MG/G	% SILT CLAY
## STATION 24								
05/07/87	28.87	0.59	14.0	45.1	0.219	105.2	72.2	38.0
05/07/87	30.39	0.69	16.3	40.9	0.309	102.4	111.6	29.4
05/07/87	31.88	0.69	14.0	47.1	0.204	109.0	88.6	37.4
## STATION 25								
05/05/87	9.57	<0.05	1.2	4.7	0.033	13.3	14.2	7.4
05/05/87	12.01	0.08	2.5	4.2	0.041	13.2	21.9	7.7
05/05/87	14.00	<0.05	1.9	6.1	0.025	12.7	24.6	8.5
## STATION 27								
05/05/87	23.33	0.38	11.5	26.2	0.190	69.7	85.9	29.0
05/05/87	23.56	0.45	12.8	27.6	0.196	70.5	98.8	25.4
05/05/87	26.69	0.50	11.6	28.6	0.187	68.5	81.4	42.6
## STATION 28								
05/05/87	8.46	<0.05	2.7	5.8	0.052	8.9	57.5	20.1
05/05/87	8.55	<0.05	3.3	6.0	0.054	8.8	50.3	19.3
05/05/87	7.87	<0.05	3.2	6.0	0.194	8.7	62.3	18.2
## STATION 29								
05/05/87	22.52	0.27	11.6	26.2	0.060	36.6	75.7	27.7
05/05/87	19.12	0.28	9.8	22.5	0.021	36.7	73.8	33.6
05/05/87	20.13	0.34	9.4	21.3	0.048	27.8	61.7	32.1
## STATION 30								
05/05/87	3.29	0.19	1.8	4.9	0.034	9.5	25.2	5.0
05/05/87	3.62	0.15	1.7	3.4	0.040	9.0	24.9	4.4
05/05/87	2.50	0.19	1.4	4.3	0.021	6.7	16.5	4.2

Table A-4b. Metals Data, September, 1987.

DATE MM/DD/YY	ALUMINUM MG/G	CADMIUM UG/G	COPPER UG/G	LEAD UG/G	MERCURY UG/G	ZINC UG/G	TOTAL ORGANIC CARBON MG/G	% SILT CLAY
## STATION 3								
09/22/87	13.22	0.24	3.7	7.5	0.015	9.6	5.2	12.0
09/22/87	19.52	0.31	2.9	6.9	0.025	16.1	6.9	16.1
09/22/87	14.20	0.21	2.3	7.4	0.012	12.1	6.1	13.9
## STATION 7								
09/22/87	5.32	0.19	10.4	8.8	0.007	5.6	2.8	4.8
09/22/87	6.40	0.22	1.8	5.3	0.013	10.3	5.7	14.5
09/22/87	11.22	0.14	1.7	4.8	0.015	10.7	6.3	13.0
## STATION 9								
09/22/87	29.29	0.62	19.4	36.6	0.182	106.0	30.7	39.4
09/22/87	23.67	0.66	17.4	29.2	0.152	96.5	33.3	35.3
09/22/87	21.22	0.35	18.9	33.0	0.135	101.8	44.0	39.4
## STATION 12								
09/22/87	28.29	0.13	18.7	35.1	0.116	98.1	37.6	37.0
09/22/87	22.17	0.43	17.6	31.8	0.157	95.4	27.9	38.9
09/22/87	28.64	0.12	15.7	23.4	0.136	81.4	27.6	34.6
## STATION 14								
O9/22/87	10.10	0.19	8.9	20.5	0.053	42.3	21.9	15.0
09/22/87	9.48	0.29	7.3	20.5	0.059	42.3	23.0	15.3
09/22/87	12.65	0.34	8.5	20.6	0.065	43.2	28.1	13.9
## STATION 16								
09/23/87	32.89	0.27	6.3	4.1	0.025	34.3	43.1	69.2
09/23/87	20.38	0.25	8.7	3.4	0.039	38.7	29.3	60.9
09/23/87	16.46	0.19	6.5	10.2	0.067	37.2	40.2	67.1
## STATION 17								
09/23/87	20.49	0.68	25.0	44.0	0.351	114.2	40.9	27.1
09/23/87	18.32	1.04	20.9	46.9	0.274	91.0	35.9	36.0
09/23/87	18.26	0.77	21.9	46.8	0.273	106.9	37.9	29.9
## STATION 18								
09/23/87	36.37	3.01	57.5	169.9	1.594	434.0	64.5	51.6
09/23/87	35.42	2.38	56.2	173.0	1.480	476.4	46.6	78.5
09/23/87	41.01	2.95	55.9	161.4	1.042	398.3	63.0	76.3
## STATION 19								
09/23/87	34.47	0.77	10.3	13.1	0.112	52.5	44.6	82.5
09/23/87	36.95	1.08	11.5	25.4	0.258	68.7	39.5	66.1
09/23/87	49.08	0.33	10.9	16.4	0.098	50.2	25.1	63.1
## STATION 22								
09/23/87	2.12	0.16	1.2	3.4	0.011	6.2	4.3	2.0
09/23/87	2.05	0.10	1.1	4.1	0.010	5.9	5.0	2.1
09/23/87	2.51	<0.05	1.8	3.3	0.009	5.9	8.3	2.2

Table A-4b. Continued.

DATE MM/DD/YY	ALUMINUM MG/G	CADMIUM UG/G	COPPER UG/G	LEAD UG/G	MERCURY UG/G	ZINC UG/G	TOTAL ORGANIC CARBON MG/G	% SILT CLAY
## STATION 24								
09/23/87	33.26	0.78	18.1	41.3	0.246	108.0	59.0	21.4
09/23/87	23.44	0.86	16.5	43.2	0.375	97.4	85.6	23.7
09/23/87	20.25	0.92	15.0	45.8	0.451	102.6	62.5	37.7
## STATION 25								
09/21/87	11.44	0.13	1.5	6.7	0.033	9.0	15.2	13.5
09/21/87	10.76	0.19	1.4	7.0	0.020	9.2	16.9	12.8
09/21/87	7.16	0.19	1.7	6.2	0.030	7.8	22.3	9.7
## STATION 27								
09/21/87	18.98	0.12	12.9	24.7	0.244	54.3	66.4	42.0
09/21/87	18.50	0.15	13.6	24.2	0.317	63.2	72.7	36.0
09/21/87	24.66	0.60	12.4	24.9	0.274	58.7	66.9	38.2
## STATION 28								
09/21/87	7.95	<0.05	6.1	7.6	0.107	12.2	58.2	23.5
09/21/87	5.42	0.19	4.1	5.6	0.062	9.0	49.3	14.6
09/21/87	6.02	0.24	6.1	10.6	0.099	12.4	47.2	21.2
## STATION 30								
09/21/87	4.76	0.19	2.4	7.9	0.036	7.1	26.6	9.7
09/21/87	6.09	0.26	2.8	9.7	0.069	8.4	24.0	8.4
09/21/87	4.62	0.21	2.3	8.3	0.040	8.5	19.8	7.5

Table A-4c. Metals Data, March, 1988.

DATE MM/DD/YY	ALUMINUM MG/G	CADMIUM UG/G	COPPER UG/G	LEAD UG/G	MERCURY UG/G	ZINC UG/G	TOTAL ORGANIC CARBON MG/G	% SILT CLAY
## STATION 18								
03/22/88	67.96	2.05	62.2	181.8	0.687	430.2	75.8	52.1
03/22/88	68.67	1.97	57.8	170.1	0.723	433.1	94.4	41.8
03/22/88	74.44	1.72	66.3	186.7	0.785	447.5	80.0	41.6
## STATION 101								
03/22/88	32.24	0.15	7.2	10.3	0.054	40.3	20.1	31.9
03/22/88	39.40	<0.05	4.9	7.5	0.045	43.5	27.9	33.3
03/22/88	17.95	0.13	5.6	10.9	0.045	36.6	14.2	22.6
## STATION 104								
03/22/88	59.19	1.08	275.2	134.2	0.267	313.1	64.0	69.6
03/22/88	65.02	1.18	290.9	107.7	0.322	269.9	70.1	74.1
03/22/88	65.05	1.00	322.2	120.3	0.322	287.2	60.5	72.3
## STATION 105								
03/22/88	36.52	0.58	34.5	63.6	0.106	118.3	39.3	34.4
03/22/88	50.47	0.73	37.9	62.5	0.094	136.9	49.7	57.4
03/22/88	50.76	0.62	40.3	64.0	0.132	172.1	44.8	60.5
## STATION 106								
03/22/88	6.24	<0.05	2.8	6.4	0.020	15.4	5.9	3.9
03/22/88	6.29	0.08	6.7	9.8	0.016	17.9	4.8	3.5
03/22/88	7.35	0.07	3.4	9.6	0.020	17.7	5.2	4.2
## STATION 107								
03/22/88	47.54	0.12	24.4	34.4	0.090	99.9	19.9	35.9
03/22/88	36.43	0.16	26.4	32.2	0.094	106.5	22.9	33.8
03/22/88	46.50	0.17	36.6	36.4	0.088	117.9	24.6	34.2
## STATION 108								
03/22/88	11.90	0.41	6.6	15.0	0.027	24.8	11.8	13.3
03/22/88	11.94	0.24	18.3	15.0	0.033	27.1	8.6	14.4
03/22/88	15.64	0.24	7.4	14.0	0.030	22.3	8.8	13.3
## STATION 109								
03/22/88	38.34	0.43	21.8	42.7	0.190	123.5	63.9	39.8
03/22/88	47.33	0.56	27.8	53.8	0.184	155.9	65.9	48.1
03/22/88	45.85	0.55	27.8	54.0	0.199	146.1	76.4	43.7
## STATION 111								
03/23/88	9.35	0.14	15.3	82.8	0.041	57.4	11.7	8.9
03/23/88	12.25	0.22	15.5	80.8	0.048	54.1	9.6	8.8
03/23/88	15.27	0.27	17.3	66.2	0.112	56.9	15.5	11.8
## STATION 112								
03/23/88	6.18	0.10	6.5	33.0	0.030	36.8	11.5	7.7
03/23/88	6.09	0.06	4.8	19.0	0.022	23.9	10.1	5.6
03/23/88	5.92	0.42	4.6	17.9	0.022	22.2	9.0	5.8

Table A-4c. Continued.

DATE MM/DD/YY	ALUMINUM MG/G	CADMIUM UG/G	COPPER UG/G	LEAD UG/G	MERCURY UG/G	ZINC UG/G	TOTAL ORGANIC CARBON MG/G	% SILT CLAY
## STATION 113								
03/22/88	52.60	2.03	58.3	428.3	0.344	418.5	86.0	73.0
03/22/88	49.67	2.06	59.4	441.6	0.390	412.0	79.0	70.0
03/22/88	48.64	1.91	54.4	406.1	0.367	334.3	82.8	68.8
## STATION 114								
03/22/88	66.15	2.58	90.1	358.1	0.533	742.0	85.2	75.9
03/22/88	62.96	2.69	90.2	348.0	0.584	683.8	92.0	80.6
03/22/88	68.49	3.12	84.3	369.5	0.487	681.9	69.5	71.1
## STATION 116								
03/23/88	45.71	0.89	27.7	100.7	0.356	162.7	65.9	38.0
03/23/88	60.80	1.08	30.3	121.6	0.325	201.2	92.4	44.4
03/23/88	50.72	1.22	33.4	110.6	0.242	208.8	75.5	41.7
## STATION 117								
03/23/88	32.41	0.57	33.7	67.7	0.182	123.8	63.1	28.3
03/23/88	28.78	0.43	21.7	80.4	0.230	90.6	58.7	28.2
03/23/88	36.19	0.49	29.9	60.4	0.345	125.3	41.4	26.4
## STATION 126								
03/21/88	27.31	0.59	20.0	15.5	0.338	100.7	174.5	15.5
03/21/88	23.16	0.52	16.0	15.6	0.258	83.1	145.3	14.2
03/21/88	23.49	0.62	20.3	20.3	0.197	96.6	159.2	21.2
## STATION 128								
03/24/88	1.89	<0.05	1.2	8.0	0.005	2.4	1.4	0.3
03/24/88	1.92	<0.05	1.2	4.4	0.006	1.0	1.4	0.6
03/24/88	1.56	<0.05	0.8	2.2	0.005	1.0	1.2	0.3
## STATION 129								
03/21/88	0.53	0.06	0.6	1.2	0.004	0.5	1.6	0.4
03/21/88	0.43	0.15	1.1	1.1	0.004	0.5	1.8	0.7
03/21/88	0.61	0.08	0.5	<0.2	0.004	0.4	1.9	0.6

APPENDIX B

TOXIC ORGANIC ANALYSIS DATA

Table B-la. Individual PNA Concentration in St. Johns River Sediment.

Event 1 (May, 1987)

Compound	St.3	St.7	St.9	St.12	St.14
naphthalene	0.00	0.00	0.00	0.04	0.00
2-methylnaphthalene	0.00	0.00	0.00	0.01	0.00
1-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00
acenaphthene	0.00	0.00	0.00	0.00	0.00
fluorene	0.00	0.00	0.00	0.02	0.00
phenanthrene	0.00	0.05	0.79	0.13	0.18
anthracene	0.00	0.00	0.42	0.06	0.06
1-methylphenanthrene	0.00	0.00	0.40	0.01	0.09
flouranthene	0.02	0.05	2.30	0.56	0.36
pyrene	0.02	0.06	2.10	0.76	0.41
benz(a)anthracene	0.00	0.00	0.38	0.26	0.16
chrysene	0.00	0.00	0.99	0.30	0.25
benzo(e)pyrene	0.00	0.00	1.00	0.21	0.17
benzo(a)pyrene	0.00	0.00	0.86	0.20	0.13
perylene	0.00	0.00	0.70	0.14	0.10
dibenz(a,h)anthracene	0.00	0.00	0.00	0.01	0.00
TOTAL (ug/g dry sed)	0.04	0.16	9.94	2.71	1.91

Table B-1a. Continued. Individual PNA Concentration in St. Johns River Sediment.

Event 1 (May, 1987)

Compound	St.16	St.17	St.18	St.19	St.22
naphthalene	0.00	0.00	0.00	0.00	0.00
2-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
1-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00
acenaphthene	0.00	0.00	0.00	0.00	0.00
fluorene	0.00	0.00	0.00	0.00	0.00
phenanthrene	1.30	0.12	1.50	0.40	0.02
anthracene	0.23	0.00	0.66	0.04	0.00
1-methylphenanthrene	0.00	0.00	1.00	0.48	0.00
flouranthene	2.30	0.53	3.40	0.21	0.04
pyrene	2.20	0.65	3.60	0.53	0.03
benz(a)anthracene	0.30	0.05	1.80	1.25	0.00
chrysene	1.70	0.15	1.70	0.06	0.00
benzo(e)pyrene	2.20	0.22	2.00	1.35	0.00
benzo(a)pyrene	1.80	0.19	2.00	1.78	0.00
perylene	2.90	0.35	7.40	1.00	0.00
dibenz(a,h)anthracene	0.00	0.00	0.19	0.00	0.00
TOTAL (ug/g dry sed)	14.93	2.26	25.25	7.10	0.09

Table B-1a. Continued. Individual PNA Concentration in St. Johns River Sediment.

Event 1 (May, 1987)

Compound	St.24	St.25	St.27	St.28	St.30
naphthalene	0.00	0.00	0.00	0.00	0.00
2-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
1-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00
acenaphthene	0.00	0.00	0.00	0.00	0.00
fluorene	0.00	0.00	0.00	0.00	0.00
phenanthrene	0.01	0.00	0.27	0.00	0.15
anthracene	0.00	0.00	0.04	0.00	0.00
1-methylphenanthrene	0.00	0.00	0.00	0.00	0.06
fluoranthene	0.18	0.04	0.52	0.18	0.44
pyrene	0.31	0.04	0.38	0.14	0.28
benz(a)anthracene	0.20	0.00	0.01	0.00	0.37
chrysene	0.27	0.00	0.19	0.00	0.31
benzo(e)pyrene	0.17	0.00	0.16	0.00	0.45
benzo(a)pyrene	0.19	0.00	0.16	0.00	0.50
perylene	2.00	0.00	0.45	0.00	0.60
dibenz(a,h)anthracene	0.00	0.00	0.00	0.00	0.00
TOTAL (ug/g dry sed)	3.33	0.08	2.02	0.32	2.96

Table B-1b. Individual PNA Concentration in St. Johns River Sediment.

Event 2 (September, 1987)

Compound	St.3	St.7	St.9	St.12	St.14
naphthalene	0.00	0.00	0.00	0.00	0.00
2-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
1-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00
acenaphthene	0.00	0.00	0.00	0.00	0.00
fluorene	0.00	0.00	0.00	0.00	0.00
phenanthrene	0.00	0.07	0.34	0.38	0.18
anthracene	0.00	0.00	0.08	0.09	0.02
1-methylphenanthrene	0.00	0.00	0.14	0.07	0.08
flouranthene	0.01	0.06	0.32	0.60	0.34
pyrene	0.02	0.11	0.72	0.70	0.61
benz(a)anthracene	0.01	0.06	0.29	0.32	0.34
chrysene	0.00	0.00	0.15	0.46	0.20
benzo(e)pyrene	0.00	0.00	0.26	0.20	0.16
benzo(a)pyrene	0.00	0.00	0.17	0.19	0.14
perylene	0.00	0.00	0.21	0.16	0.09
dibenz(a,h)anthracene	0.00	0.00	0.00	0.00	0.00
TOTAL (ug/g dry sed.)	0.04	0.30	2.68	3.17	2.16

Table B-1b. Continued. Individual PNA Concentration in St. Johns River Sediment.

Event 2 (September, 1987)

Compound	St. 16	St. 17	St. 18	St. 19	St. 22
naphthalene	0.00	0.00	0.00	0.00	0.00
2-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
1-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00
acenaphthene	0.00	0.00	0.00	0.00	0.00
fluorene	0.00	0.00	0.00	0.00	0.00
phenanthrene	0.63	0.09	1.62	0.25	0.02
anthracene	0.12	0.07	0.39	0.04	0.00
1-methylphenanthrene	0.00	0.00	0.55	0.00	0.00
flouranthene	1.99	0.51	3.24	0.21	0.03
pyrene	1.52	0.81	3.10	0.48	0.02
benz(a)anthracene	1.03	0.04	1.00	1.51	0.06
chrysene	0.55	0.15	0.85	0.60	0.00
benzo(e)pyrene	2.00	0.29	3.45	1.47	0.01
benzo(a)pyrene	1.40	0.27	3.52	1.55	0.03
perylene	2.50	0.31	6.10	0.70	0.04
dibenz(a,h)anthracene	0.00	0.00	0.00	0.00	0.00
TOTAL (ug/g dry sed.)	11.74	2.54	23.82	6.81	0.21

Table B-1b. Continued. Individual PNA Concentration in St. Johns River Sediment.

Event 2 (September, 1987)

Compound	St. 24	St. 25	St. 27	St. 28	St. 30
naphthalene	0.00	0.00	0.00	0.00	0.00
2-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
1-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00
acenaphthene	0.00	0.00	0.00	0.00	0.00
fluorene	0.00	0.00	0.00	0.00	0.00
phenanthrene	0.06	0.10	0.16	0.20	0.09
anthracene	0.05	0.00	0.02	0.00	0.00
1-methylphenanthrene	0.00	0.00	0.00	0.00	0.00
flouranthene	0.08	0.05	0.42	0.30	0.34
pyrene	0.43	0.42	0.51	0.32	0.26
benz(a)anthracene	0.39	0.50	0.02	0.00	0.36
chrysene	0.09	0.00	0.14	0.00	0.21
benzo(e)pyrene	0.20	0.21	0.16	0.00	0.40
benzo(a)pyrene	0.22	0.19	0.14	0.00	0.45
perylene	2.00	0.60	0.62	0.10	0.72
dibenz(a,h)anthracene	0.00	0.00	0.00	0.00	0.00
TOTAL (ug/g dry sed.)	3.52	2.07	2.19	0.92	2.83

Table B-1c. Individual PNA Concentration in St. Johns River Sediment.

Event 3 (March, 1988)

Compound	St. 18	St. 101	St. 104	St. 105	St. 106
naphthalene	0.00	0.00	0.10	0.00	0.00
2-methylnaphthalene	0.00	0.00	0.06	0.00	0.00
1-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.08	0.00	0.00
acenaphthene	0.00	0.00	0.07	0.10	0.00
fluorene	0.15	0.38	0.10	0.14	0.00
phenanthrene	0.38	0.50	0.48	0.61	0.21
anthracene	1.26	0.16	0.18	0.28	0.17
1-methylphenanthrene	0.68	0.56	0.74	0.52	0.31
flouranthene	2.72	10.9	1.10	2.23	0.20
pyrene	4.16	1.24	1.40	2.32	0.35
benz(a)anthracene	2.48	1.86	1.90	1.37	0.41
chrysene	1.83	0.68	0.72	1.59	0.37
benzo(e)pyrene	2.80	0.59	0.57	2.75	0.12
benzo(a)pyrene	2.68	0.64	0.62	2.37	0.11
perylene	3.06	0.48	0.50	1.04	0.06
dibenz(a,h)anthracene	0.18	0.00	0.00	0.13	0.00
TOTAL (ug/g dry sed.)	22.38	8.18	8.62	15.45	2.31

Table B-1c. Continued. Individual PNA Concentration in St. Johns River Sediment.

	Event 3 (March, 1988)				
Compound	St. 108	St. 109	St. 111	St. 112	St. 113
naphthalene	0.00	0.00	0.02	0.00	0.04
2-methylnaphthalene	0.00	0.00	0.00	0.00	0.00
l-methyl naphthalene	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00
acenaphthene	0.00	0.03	0.03	0.02	0.11
fluorene	0.02	0.02	0.05	0.06	0.11
phenanthrene	0.23	0.74	0.47	0.26	1.00
anthracene	0.17	0.25	0.14	0.16	0.30
1-methylphenanthrene	0.08	0.11	0.14	0.25	0.38
flouranthene	0.31	0.30	0.16	0.40	3.30
pyrene	0.59	0.45	0.84	0.43	3.50
benz(a)anthracene	0.21	0.15	1.30	0.18	4.50
chrysene	0.19	0.18	0.47	0.13	2.10
benzo(e)pyrene	0.16	0.17	0.60	0.30	2.30
benzo(a)pyrene	0.14	0.16	0.46	0.26	2.40
perylene	0.09	0.12	0.22	0.13	1.60
dibenz(a,h)anthracene	0.00	0.00	0.09	0.00	0.32
TOTAL (ug/g dry sed.)	2.19	2.68	8.62	2.58	21.96

Table B-1c. Continued. Individual PNA Concentration in St. Johns River Sediment.

Event 3 (March, 1988)

Compound	St. 114	St. 116	St. 117	St. 126	St. 128	St. 129
naphthalene	0.00	0.00	0.00	0.00	0.00	0.00
2-methylnaphthalene	0.00	0.00	0.00	0.00	0.00	0.00
1-methylnaphthalene	0.00	0.00	0.00	0.00	0.00	0.00
biphenyl	0.00	0.00	0.00	0.00	0.00	0.00
2,6-dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00	0.00
acenaphthene	0.14	0.06	0.06	0.00	0.03	0.04
fluorene	0.14	0.12	0.06	0.00	0.00	0.00
phenanthrene	1.30	0.30	0.26	0.15	0.04	0.00
anthracene	0.37	0.27	0.11	0.09	0.06	0.00
methylphenanthrene	0.32	0.73	0.33	0.09	0.13	0.10
flouranthene	5.40	1.35	1.40	0.40	0.18	0.06
pyrene	6.50	3.51	8.47	0.55	0.10	0.00
benz(a)anthracene	6.80	1.70	0.89	0.38	0.00	0.00
chrysene	2.80	0.90	0.81	0.35	0.00	0.00
benzo(e)pyrene	3.00	2.95	2.15	0.15	0.00	0.00
benzo(a)pyrene	3.20	2.81	2.04	0.06	0.00	0.00
perylene	2.00	1.63	1.21	0.29	0.00	0.00
dibenz(a,h)anthracene	0.48	0.00	0.10	0.00	0.00	0.00
TOTAL (ug/g dry sed.)	32.45	16.33	17.89	2.51	0.54	0.20

Table B-2a. Individual Cl-Pest/PCB concentration in St. Johns River sediment.

	Event 1 (May, 1987)			
Compound	Sta. 3	Sta.7	Sta.9	Sta.12
hexachlorobenzene	ND[1]	ND	ND	ND
liNDane (gamma-BHC)	ND	ND	ND	ND
heptachlor	1.1	ND	ND	30.0
heptachlor epoxide	ND	ND	ND	1.0
aldrin	ND	ND	ND	ND
alpha-chlordane	ND	ND	3.3	6.0
trans-nanochlor	ND	ND	2.2	5.0
dieldrin	ND	ND	ND	ND
mirex	ND	ND	ND	ND
o,p'-DDE	ND	ND	ND	2.0
p,p'-DDE	ND	ND	7.0	5.0
o,p'-DDD	1.1	ND	ND	2.0
p,p'-DDD	2.1[2]	ND	19.0	8.0
o,p'-DDT	--	ND	--	--
p,p'-DDT	ND	ND	5.3	1.0
TOTAL (ng/g dry sed.)	4.3	0.0	36.8	60.0
2,4'-DCB	ND	ND	ND	1.0
2,5,4'-TCB	ND	ND	ND	32.0
2,4,2',4'-TCB	ND	2.0	ND	12.0
2,4,5,2',5'-PCB	1.2	2.0	21.0	42.0
2,4,5,2',4',5'-HCB	1.4	2.0	37.0	34.0
2,3,4,5,6,2',5'-HCB	3.0	ND	6.1	1.0
2,3,4,5,2',3',4',5'-OCB	ND	ND	6.0	1.0
2,3,4,5,6,2',3',4',5'-NCB	ND	ND	16.0	3.0
TOTAL (ng/g dry sed.)	5.6	6.0	86.1	126.0

[1] ND = not detected.

[2] = sum of p,p'-DDD and o,p'-DDT (co-elute)

Table B-2a. Continued. Individual Cl-Pest/PCB concentration in St. Johns River sediment.

Event 1 (May, 1987)

Compound	Sta. 14	Sta. 16	Sta. 17	Sta. 18
hexachlorobenzene	ND[1]	ND	ND	ND
liNDane (gamma-BHC)	ND	ND	ND	ND
heptachlor	ND	10.0	ND	30.0
heptachlor epoxide	ND	ND	ND	1.0
aldrin	ND	ND	ND	ND
alpha-chlordane	3.7	7.3	4.0	37.0
trans-nanochlor	2.5	3.2	4.0	21.0
dieldrin	ND	ND	ND	ND
mirex	ND	ND	ND	9.0
o,p'-DDE	1.3	9.3	1.5	5.4
p,p'-DDE	8.0	10.0	7.6	22.0
o,p'-DDD	5.4	9.3	3.0	15.0
p,p'-DDD	24.0[2]	18.0	14.0	47.0
o,p'-DDT		ND	--	
p,p'-DDT	11.0	9.3	ND	9.0
TOTAL (ng/g dry sed.)	55.9	76.4	34.1	165.4
2,4'-DCB	ND	ND	ND	ND
2,5,4'-TCB	16.0	ND	7.4	230.0
2,4,2',4'-TCB	2.6	6.9	13.0	130.0
2,4,5,2',5'-PCB	30.0	47.0	22.0	180.0
2,4,5,2',4',5'-HCB	55.0	90.0	62.0	210.0
2,3,4,5,6,2',5'-HCB	12.0	18.0	ND	9.0
2,3,4,5,2',3',4',5'-OCB	86.0	15.0	10.0	19.0
2,3,4,5,6,2',3',4',5'-NCB	14.0	ND	8.9	9.6
TOTAL (ng/g dry sed.)	215.6	176.9	123.3	787.6

[1] ND = not detected.

[2] = sum of p,p'-DDD and o,p,-DDT (co-elute)

Table B-2a. Continued. Individual Cl-Pest/PCB concentration in St. Johns River sediment.

Event 1 (May, 1987)

Compound	Sta. 19	Sta. 22	Sta. 24	Sta. 25
hexachlorobenzene	ND[1]	ND	ND	ND
liNDane (gamma-BHC)	ND	ND	ND	ND
heptachlor	ND	1.5	ND	ND
heptachlor epoxide	ND	ND	2.0	ND
aldrin	ND	ND	ND	ND
alpha-chlordane	5.1	1.5	10.0	1.5
trans-nanochlor	5.0	ND	5.0	1.5
dieldrin	ND	ND	ND	ND
mirex	ND	ND	ND	ND
o,p'-DDE	ND	ND	ND	1.5
p,p'-DDE	13.0	1.5	ND	1.5
o,p'-DDD	6.5	ND	ND	ND
p,p'-DDD	20.0[2]	ND	ND	ND
o,p'-DDT		--	--	--
p,p'-DDT	ND	ND	ND	ND
TOTAL (ng/g dry sed.)	49.6	4.5	17.0	6.0
2,4’-DCB	ND	ND	1.0	ND
2,5,4'-TCB	ND	ND	10.0	1.5
2,4,2',4'-TCB	ND	ND	5.0	1.5
2,4,5,2',5'-PCB	28.0	1.2	4.0	1.2
2,4,5,2',4',5'-HCB	72.0	2.6	17.0	1.6
2,3,4,5,6,2',5'-HCB	15.0	ND	1.0	ND
2,3,4,5,2',3',4',5'-OCB	9.0	4.3	4.0	ND
2,3,4,5,6,2',3',4',5'-NCB	ND	ND	ND	ND
TOTAL (ng/g dry sed.)	124.0	8.1	42.0	5.8

[1] ND = not detected.

[2] = sum of p,p'-DDD and o,p'-DDT (co-elute)

Table B-2a. Continued Individual Cl-Pest/PCB concentration in St. Johns River sediment.

Event 1 (May, 1987)

Compound	Sta. 27	Sta. 28	Sta. 30
hexachlorobenzene	ND[1]	ND	ND
liNDane (gamma-BHC)	ND	ND	ND
heptachlor	88.0	ND	ND
heptachlor epoxide	ND	ND	ND
aldrin	ND	ND	ND
alpha-chlordane	ND	3.3	2.4
trans-nanochlor	ND	ND	ND
dieldrin	ND	ND	ND
mirex	ND	ND	ND
o,p'-DDE	ND	ND	ND
p,p'-DDE	3.8	ND	2.0
o,p'-DDD	ND	ND	2.0
p,p'-DDD	14.02	ND	5.0
o,p'-DDT	--	--	--
p,p'-DDT	ND	ND	6.3
TOTAL (ng/g dry sed.)	105.8	3.3	17.7
2,4'-DCB	ND	ND	ND
2,5,4'-TCB	ND	ND	ND
2,4,2',4'-TCB	ND	ND	2.4
2,4,5,2',5'-PCB	9.5	6.7	3.4
2,4,5,2',4',5'-HCB	15.0	9.0	5.6
2,3,4,5,6,2',5'-HCB	ND	ND	ND
2,3,4,5,2',3',4',5'-OCB	12.0	ND	4.4
2,3,4,5,6,2',3',4',5'-NCB	ND	ND	ND
TOTAL (ng/g dry sed.)	36.5	15.7	15.8

[1] ND = not detected.
[2] = sum of p,p'-DDD and o,p'-DDT (co-elute)

Table B-2b. Individual Cl-Pest/PCB Concentration in St. Johns River Sediment.

Event 2 (September, 1987)

Compound	Sta. 3	Sta. 7	Sta. 9	Sta. 12
hexachlorobenzene	nd[1]	nd	nd	nd
lindane (gamma-BHC)	nd	nd	nd	nd
heptachlor	nd	nd	nd	nd
heptachlor epoxide	nd	nd	nd	nd
aldrin	nd	nd	nd	nd
alpha-chlordane	1.0	1.0	6.0	3.1
trans-nanochlor	1.0	1.0	2.0	3.0
dieldrin	nd	nd	nd	nd
mirex	nd	nd	nd	nd
o,p'-DDE	nd	nd	1.0	4.6
p,p'-DDE	1.0	1.0	5.0	7.2
o,p'-DDD	nd	nd	nd	nd
p,p'-DDD	nd[2]	nd	11.0	7.9
o,p'-DDT	--	--	--	--
p,p'-DDT	nd	nd	3.0	nd
TOTAL (ng/g dry sed.)	3.0	3.0	28.0	25.8
2,4'-DCB	nd	nd	nd	nd
2,5,4'-TCB	nd	nd	nd	24.0
2,4,2',4'-TCB	nd	nd	2.0	4.0
2,4,5,2',5'-PCB	1.0	1.0	16.0	25.0
2,4,5,2',4',5'-HCB	2.0	3.0	28.0	42.0
2,3,4,5,6,2',5'-HCB	1.0	2.0	12.0	3.0
2,3,4,5,2',3',4',5'-OCB	nd	nd	3.0	3.1
2,3,4,5,6,2',3',4',5'-NCB	nd	nd	nd	8.0
TOTAL (ng/g dry sed.)	4.0	6.0	61.0	109.1

[1] nd = not detected.

[2] = sum of p,p'-DDD and o,p'-DDT (co-elute)

Table B-2b. Continued Individual Cl -Pest/PCB Concentration in St. Johns River Sediment.

Event 2 (September, 1987)

Compound	Sta. 14	Sta. 16	Sta. 17	Sta. 18
hexachlorobenzene	nd[1]	nd	nd	nd
lindane (gamma-BHC)	nd	nd	nd	nd
heptachlor	nd	nd	nd	nd
heptachlor epoxide	nd	nd	nd	nd
aldrin	nd	nd	nd	nd
alpha-chlordane	8.0	20.0	3.2	100.0
trans-nanochlor	2.0	13.5	2.8	33.0
dieldrin	nd	nd	nd	nd
mirex	nd	nd	nd	nd
o,p'-DDE	8.7	11.3	5.0	31.0
p,p'-DDE	6.0	3.0	6.8	77.0
o,p'-DDD	7.0	14.7	nd	nd
p,p'-DDD	9.0[2]	22.5	6.5	69.0
o,p'-DDT	--	--	--	--
p,p'-DDT	nd	nd	nd	nd
TOTAL (ng/g dry sed.)	40.7	85.0	24.3	310.0
2,4'-DCB	nd	nd	nd	120.0
2,5,4'-TCB	16.0	nd	23.0	91.0
2,4,2',4'-TCB	45.0	12.0	4.0	470.0
2,4,5,2',5'-PCB	57.0	57.0	26.0	470.0
2,4,5,2',4',5'-HCB	92.0	110.0	48.0	560.0
2,3,4,5,6,2',5'-HCB	12.0	24.0	2.3	14.0
2,3,4,5,2',3',4',5'-OCB	30.0	11.0	4.0	22.0
2,3,4,5,6,2',3',4',5'-NCB	20.0	nd	nd	29.0
TOTAL (ng/g dry sed.)	272.0	214.0	107.0	1776.0

[1] nd = not detected.

[2] = sum of p,p'-DDD and o,p'-DDT (co-elute)

Table B-2b. Continued Individual Cl-Pest/PCB Concentration in St. Johns River Sediment.

Event 2 (September, 1987)

Compound	Sta. 19	Sta. 22	Sta. 24	Sta. 25
hexachlorobenzene	nd[1]	nd	nd	nd
lindane (gamma-BHC)	nd	nd	nd	nd
heptachlor	nd	nd	nd	nd
heptachlor epoxide	nd	nd	nd	nd
aldrin	nd	nd	nd	nd
alpha-chlordane	75.0	1.0	20.0	2.1
trans-nanochlor	32.0	1.0	8.8	2.1
dieldrin	nd	nd	nd	nd
mirex	nd	nd	nd	nd
o,p'-DDE	9.0	nd	nd	nd
p,p'-DDE	19.0	1.0	16.0	1.7
o,p'-DDD	nd	nd	35.0	nd
p,p'-DDD	32.0[2]	1.0	35.0	nd
o,p'-DDT	--	--	--	--
p,p'-DDT	nd	nd	nd	nd
TOTAL (ng/g dry sed.)	167.0	5.5	114.0	5.9
2,4'-DCB	nd	nd	nd	nd
2,5,4'-TCB	nd	nd	nd	nd
2,4,2',4'-TCB	42.0	1.0	4.6	2.1
2,4,5,2',5'-PCB	61.0	1.5	57.0	3.5
2,4,5,2',4',5'-HCB	102.0	2.5	110.0	3.5
2,3,4,5,6,2',5'-HCB	37.0	1.0	21.0	1.2
2,3,4,5,2',3',4',5'-OCB	8.0	1.0	nd	1.2
2,3,4,5,6,2',3',4',5'-NCB	nd	nd	nd	nd
TOTAL (ng/g dry sed.)	250.0	7.0	192.6	14.8

[1] nd = not detected.

[2] = sum of p,p'-DDD and o,p'-DDT (co-elute)

Table B-2b. Continued. Individual Cl-Pest/PCB Concentration in St. Johns River Sediment.

Event 2 (September, 1987)

Compound	Sta. 27	Sta. 28	Sta. 30
hexachlorobenzene	nd[1]	nd	nd
lindane (gamma-BHC)	nd	nd	nd
heptachlor	nd	nd	nd
heptachlor epoxide	nd	nd	nd
aldrin	nd	nd	nd
alpha-chlordane	4.6	3.6	4.0
trans-nanochlor	3.0	2.5	1.0
dieldrin	nd	nd	nd
mirex	nd	nd	nd
o,p'-DDE	nd	nd	nd
p,p'-DDE	19.0	3.0	6.0
o,p'-DDD	nd	nd	6.0
p,p'-DDD	11.0[2]	3.0	9.0
o,p'-DDT		--	--
p,p'-DDT	7.0	nd	nd
TOTAL (ng/g dry sed.)	44.6	12.1	26.0
2,4'-DCB	nd	nd	nd
2,5,4'-TCB	nd	nd	nd
2,4,2',4'-TCB	7.0	1.0	1.0
2,4,5,2',5'-PCB	23.0	2.0	1.0
2,4,5,2',4',5'-HCB	61.0	5.0	7.0
2,3,4,5,6,2',5'-HCB	13.0	2.0	2.0
2,3,4,5,2',3',4',5'-OCB	7.0	nd	nd
2,3,4,5,6,2',3',4',5'-NCB	nd	nd	nd
TOTAL (ng/g dry sed.)	111.0	10.0	11.0

[1] nd = not detected.
[2] = sum of p,p'-DDD and o,p'-DDT (co-elute)

Table B-2c. Individual Cl-Pest/PCB concentration in St. Johns River sediment.

Event 3 (March 1988)

Compound	St. 18	St. 101	St. 104	St. 105
hexachlorobenzene	ND[1]	ND	ND	ND
lindane (gamma-BHC)	ND	ND	ND	ND
heptachlor	ND	ND	ND	ND
heptachlor epoxide	ND	ND	ND	ND
aldrin	ND	ND	ND	ND
alpha-chlordane	45.7	26.8	4.9	8.1
trans-nanochlor	30.0	25.4	5.5	8.3
dieldrin	ND	ND	ND	ND
mirex	ND	ND	ND	ND
o,p'-DDE	ND	ND	ND	ND
p,p'-DDE	3.5	3.8	5.7	2.4
o,p'-DDD	5.6	4.7	9.6	5.8
p,p'-DDD	ND	ND	ND	ND
o,p'-DDT	--[2]		--	--
p,p'-DDT	ND	ND	ND	ND
TOTAL (ng/g dry sed.)	84.8	60.7	25.7	24.6
2,4'-DCB	ND	ND	ND	ND
2,5,4'-TCB	53.3	31.3	160.0	ND
2,4,2',4'-TCB	27.8	16.5	17.0	ND
2,4,5,2',5'-PCB	15.6	5.3	39.0	1.9
2,4,5,2',4',5'-HCB	3.5	6.7	22.0	2.0
2,3,4,5,6,2',5'-HCB	3.3	ND	ND	ND
2,3,4,5,2',3',4',5'-OCB	8.4	10.2	9.1	2.1
2,3,4,5,6,2',3',4',5'-NCB	7.2	ND	ND	ND
TOTAL (ng/g dry sed.)	119.1	70.0	247.1	6.0

[1] ND = not detected.
[2] = sum of p,p'-DDD and o,p'-DDT (co-elute)

Table B-2c. Continued. Individual Cl-Pest/PCB concentration in St. Johns River sediment.

Event 3 (March, 1988)

Compound	St. 106	St. 108	St. 109	St. 111
hexachlorobenzene	ND	ND	ND	ND
lindane (gamma-BHC)	ND	ND	ND	ND
heptachlor	ND	ND	ND	ND
heptachlor epoxide	ND	ND	ND	ND
aldrin	ND	ND	ND	ND
alpha-chlordane	7.1	10.8	6.4	22.0
trans-nanochlor	7.7	11.2	6.1	25.0
dieldrin	ND	ND	ND	ND
mirex	ND	ND	ND	ND
o,p'-DDE	ND	ND	ND	ND
p,p'-DDE	3.2	2.7	1.6	2.3
o,p'-DDD	6.8	5.2	ND	ND
p,p'-DDD	3.1	ND	3.0	6.0
o,p'-DDT	--	--	--	--
p,p'-DDT	ND	ND	ND	ND
TOTAL (ng/g dry sed.)	27.9	29.9	17.1	55.3
2,4'-DCB	ND	ND	ND	ND
2,5,4'-TCB	ND	ND	ND	ND
2,4,2',4'-TCB	2.2	15.3	ND	ND
2,4,5,2',5'-PCB	3.4	10.9	2.2	3.6
2,4,5,2',4',5'-HCB	2.8	4.2	2.0	2.5
2,3,4,5,6,2',5'-HCB	ND	2.7	ND	ND
2,3,4,5,2',3',4',5'-OCB	1.0	9.9	1.3	1.1
2,3,4,5,6,2',3',4',5'-NCB	ND	6.3	ND	ND
TOTAL (ng/g dry sed.)	9.4	47.3	5.5	7.2

Table B-2c. Continued. Individual Cl-Pest/PCB concentration in St. Johns River sediment.

Event 3 (March, 1988)

Compound	St. 112	St. 113	St. 114	St. 116
hexachlorobenzene	ND	ND	ND	ND
lindane (gamma-BHC)	ND	ND	ND	ND
heptachlor	ND	ND	ND	ND
heptachlor epoxide	ND	1.9	ND	ND
aldrin	ND	ND	ND	ND
alpha-chlordane	3.9	38.0	13.0	26.6
trans-nanochlor	3.6	31.0	10.0	14.2
dieldrin	ND	ND	ND	ND
mirex	ND	ND	ND	ND
o,p'-DDE	ND	ND	ND	ND
p,p'-DDE	2.3	22.0	8.6	13.2
o,p'-DDD	ND	4.1	ND	6.2
p,p'-DDD	3.7	16.0	ND	3.3
o,p'-DDT	--	--		--
p,p'-DDT	ND	ND	ND	ND
TOTAL (ng/g dry sed.)	13.5	113.0	31.6	63.5
2,4'-DCB	ND	ND	ND	ND
2,5,4'-TCB	ND	ND	74.0	ND
2,4,2',4'-TCB	ND	3.2	47.0	11.5
2,4,5,2',5'-PCB	4.1	8.1	54.0	29.5
2,4,5,2',4',5'-HCB	1.6	9.4	38.0	11.0
2,3,4,5,6,2',5'-HCB	ND	ND	2.0	ND
2,3,4,5,2',3',4',5'-OCB	0.6	6.7	20.0	3.5
2,3,4,5,6,2',3',4',5'-NCB	ND	4.1	8.6	ND
TOTAL (ng/g dry sed.)	6.3	31.5	243.6	55.5

Table B-2c. Continued. Individual Cl-Pest/PCB concentration in St. Johns River sediment.

Event 3 (March, 1988)

Compound	St. 117	St. 126	St. 128	St. 129
hexachlorobenzene	ND	ND	ND	ND
lindane (gamma-BHC)	ND	ND	ND	ND
heptachlor	ND	ND	ND	ND
heptachlor epoxide	ND	ND	ND	ND
aldrin	ND	ND	ND	ND
alpha-chlordane	18.6	ND	ND	ND
trans-nanochlor	16.9	ND	ND	ND
dieldrin	ND	ND	ND	ND
mirex	ND	ND	ND	ND
o,p'-DDE	ND	ND	ND	ND
p,p'-DDE	19.7	ND	ND	ND
o,p'-DDD	10.2	ND	ND	ND
p,p'-DDD	3.7	ND	ND	ND
o,p'-DDT	--	--	--	
p,p'-DDT	ND	ND	ND	ND
TOTAL (ng/g dry sed.)	69.1	ND	ND	ND
2,4'-DCB	ND	ND	ND	ND
2,5,4'-TCB	ND	ND	ND	ND
2,4,2',4'-TCB	4.2	ND	ND	ND
2,4,5,2',5'-PCB	15.8	7.9	9.8	2.1
2,4,5,2',4',5'-HCB	8.3	4.8	6.8	ND
2,3,4,5,6,2',5'-HCB	ND	ND	ND	ND
2,3,4,5,2',3',4',5'-OCB	2.7	ND	2.9	ND
2,3,4,5,6,2',3',4',5'-NCB	ND	ND	ND	ND
TOTAL (ng/g dry sed.)	31.0	12.7	19.56	2.1