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Albemarle - Pamlico Estuarine Study Synoptic Survey Data Review July 25, 1989

Water Quality Technical Reports

N.C. Department of Environment, Health, and Natural Resources
Division of Environmental Management • Water Quality Section

ALBEMARLE-PAMLICO ESTUARINE STUDY
SYNOPTIC SURVEY DATA REVIEW
JULY 25, 1989.

NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT, HEALTH
AND NATURAL RESOURCES
Division of Environmental Management
Water Quality Section

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Date: July 2, 1990

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SUMMARY

As part of the Albemarle/Pamlico (A/P) Baseline Monitoring Plan, the Division of Environmental Management (DEM) conducted a synoptic water quality study of the A/P Study area. **On July 25, 1989, one hundred and twenty-eight stations were sampled by personnel from both DEM and the Division of Marine Fisheries (DMF) within a 5 hour time frame.** A total of 33 water quality parameters were sampled at each station from the surface, photic zone, bottom and throughout the water column. The Synoptic Study was designed to provide an indication of the spatial heterogeneity of selected water quality parameters within the A/P study area.

The sampling time frame was set to coincide with a satellite fly-over, allowing the water quality data to be utilized for ground-truthing and calibrating models using NOAA AVHRR and Landsat TM satellite images. Similar synoptic studies have been conducted in the Neuse in 1982(Khorram and Cheshire 1983) and the Albemarle Sound, Chowan, Alligator and Pamlico Rivers in 1985. Data from these studies is available for between year comparisons and further calibration of models developed from the 1989 data. All the water quality data has been entered into the Center for Geographic Information and Analysis' (CGIA) computer system and is available to any interested parties for use with the satellite data.

Results from the Synoptic Study indicated that contraventions of water quality standards and elevated concentrations of most parameters were found in areas of greatest human activity, the Pamlico River, the Neuse River, and the western Albemarle Sound near the mouth of the Chowan River. Each of these basins have been designated nutrient sensitive waters (NSW) by the Environmental Management Commission resulting in more stringent nutrient controls for permitted dischargers. DEM has expanded its sampling effort and has developed nutrient management strategies for all three basins.

In the other areas, ambient water quality stations are located in every river and sound except for the Pamlico Sound and the Currituck Sound. Conclusions drawn from the results are bound by the fact that all information was gathered within a few hours on one day. The spatial patterns throughout the area and within specific portions of the area did provide insight as to adequacy of the existing sampling network with certain areas being identified as needing additional information.

Overall the results indicate that present ambient water quality monitoring by DEM is covering the most impacted locations in the A/P Estuarine area. However, results in the Roanoke Sound suggests that additional evaluations are needed to determine enrichment sources. DEM has coordinated with United States Geological Survey (USGS) to include

some extra parameters at three of their continuous monitoring stations in the Pamlico and Roanoke Sounds.

The following conclusions are presented for each sound or river:

- *Albemarle Sound.* The upper or western Albemarle Sound, near the mouth of the Chowan River, is experiencing eutrophication as evidenced by elevated chlorophyll-a concentrations and phytoplankton populations. Dissolved oxygen concentrations and pH values were high reflecting the increased algal activity in this area of the sound. No metals taken in the Albemarle Sound were above state standards.
- *Currituck Sound.* Total nitrogen concentrations in the Currituck Sound were similar to concentrations found in the Pamlico and Neuse Rivers, while phosphorus concentrations were much lower. Suspended solids were elevated in the Currituck Sound as the area is shallow and wind mixing results in suspension of bottom sediments. All other parameters were within state standards and within normal ranges except pH. Values for pH were above the state standard of 8.5 SU for tidal saltwaters at two stations. Dissolved oxygen concentrations and chlorophyll-a concentrations were not excessive indicating that phytoplankton activity was probably not the cause of the high pH values.
- *Roanoke Sound.* This report refers to both the Roanoke and Croatan Sounds as the Roanoke Sound. Phytoplankton populations in the Roanoke Sound indicate that enrichment is occurring on the ocean side of Roanoke Island. Phytoplankton populations were at or above bloom levels at both stations with chlorophyll-a concentrations of 38 and 50 ug/l. The dominant species present were two small filamentous blue-green algae, Anabaenopsis raciborski and Lyngbya species. Both of these species are common summer dominants in the Albemarle Sound. Further sampling in this area is warranted to determine the extent and sources of enrichment.
- *Pamlico Sound.* Most parameters were within state standards or expected ranges with the exception of a few stations. Phosphorus concentrations in the lower Pamlico Sound near the mouths of the Neuse and Pamlico Rivers were elevated due to the inputs from both rivers. The nutrient sensitive Neuse and Tar-Pamlico basins have high loadings of phosphorus which result in increases in phosphorus in the sound. Lowest chlorophyll-a concentrations were seen in the Pamlico Sound. One sample containing a lead concentration of 32 ug/l (state standard 25 ug/l) was obtained in the Pamlico Sound near Wysocking Bay.

- *Pamlico River*. The Pamlico River was declared nutrient sensitive in 1989 as a result of information documenting elevated phosphorus levels, algal blooms, dissolved oxygen depletion and recurring fish kills. Data collected during the Synoptic Study supports this designation. Dissolved oxygen concentrations were depressed in the upper Pamlico River near Washington throughout the water column. pH values were also low with a surface reading of 5.8 SU. Downstream from Chocowinity Bay to Bath Creek, percent saturations were above 110 percent and dissolved oxygen concentrations ranged from 9.6 to 11.0 mg/l. Phytoplankton population estimates and chlorophyll-a concentrations indicate that phytoplankton activity was probably responsible for the supersaturation. The high phytoplankton populations also contributed to the elevated turbidity in this area of the river. There was a high total organic carbon concentration at the mouth of South Creek. Elevated concentrations of aluminum and manganese were found; however, these metals are common to the soils of the Tar-Pamlico Basin and indicative of freshwater inputs to the estuary. Phosphorus concentrations were highest in the Pamlico River with values well above the optimal level for algal growth.
- *Neuse River*. The Neuse River was declared nutrient sensitive in 1988 due to many of the same problems identified in the Pamlico River. At New Bern, dissolved oxygen concentrations were below 5.3 mg/l and percent saturation estimates were below 70%. Further downstream dissolved oxygen concentrations increased with a high of 10.6 mg/l or 136% saturation. These measurements were from the mouth of Upper Broad Creek, where the chlorophyll-a concentration was 250 ug/l, far in excess of the state standard of 40 ug/l. Phosphorus concentrations were slightly less than those of the Pamlico River. Of the metals sampled, only manganese was elevated in the upper Neuse River. As in the Pamlico River, manganese occurs naturally in the sediments of the Neuse River and is indicative of freshwater inflow.
- *Alligator River*. Three stations were sampled in the Alligator River. Conductivity and salinity for these stations indicate the influence of the Pungo River through the intracoastal waterway canal. No water quality problems were observed. The lack of water quality impacts within the Alligator River was identified in its designation as Outstanding Resource Waters.
- *Pungo River*. Chlorophyll-a concentrations and phytoplankton populations were high near Belhaven and at marker 4 near the mouth of the Pungo River. The upper station on the Pungo had lower phytoplankton populations; however,

nutrient concentrations were slightly higher. All other parameters were within normal ranges.

INTRODUCTION

The Albemarle-Pamlico Estuarine Study (A/P Study) was initiated in 1987 under the administration of the United States Environmental Protection Agency (EPA), with funding through the National Estuarine Program (NEP). The goals of the A/P Study include determining the environmental problems facing North Carolina's estuarine areas and protection and management of those estuaries to provide for recreational, industrial, and commercial uses (EHNR 1989a). Several projects were identified as essential to the success of the program. Among them was the development of a baseline water quality monitoring plan to supplement information gaps from existing monitoring efforts and to provide a basis for evaluating the long-term effectiveness of management strategies implemented as a result of the A/P Study.

The baseline water quality monitoring plan was developed by DEM with assistance from DMF and USGS. Using DEM's existing ambient monitoring program, 20 new water quality stations were added to the 74 existing ambient stations in the A/P Study area. Other components of the baseline monitoring plan included fish tissue analysis at 26 stations, sediment oxygen demand (SOD) sampling in critical areas, and a synoptic water quality study. Implementation of the baseline monitoring plan began in October 1988. This report presents the results of the synoptic water quality study.

While the amount of water quality data available in the major rivers of the A/P study area is large, little information is available from the open water areas of the system. The synoptic water quality study was designed to provide researchers with some indication of the spatial heterogeneity of a wide variety of water quality parameters throughout most of the A/P study area. Data collected during the Synoptic Study may also be used in conjunction with National Oceanic and Atmospheric Administration (NOAA) AVHRR satellite images and Landsat TM images. These satellites create images utilizing reflected energy in both visible and reflected bands. These bands have been associated with specific water quality parameters. Calibration using the real-time synoptic data will allow 30 meter resolution for water quality parameters such as temperature, suspended sediment, chlorophyll-a, and salinity. Once a model is developed which determines the concentrations of a specific parameter associated with the various bands detected, earlier or later satellite imagery can be used with the model to provide information on the spatial heterogeneity of selected parameters within and between dates. Previous synoptic studies on the Albemarle Sound, Chowan, Alligator and Pamlico Rivers and on the Neuse River (Khorram and Cheshire 1983) could provide further data for refining models and determining water quality trends. Khorram and Cheshire's work is a good example of how Landsat data can be used.

One hundred and twenty-eight stations were sampled on July 25, 1989 between 10:00 AM and 3:00 PM. This sampling coincided with a satellite fly-over to allow use of the data for Landsat calibration. A special thanks goes to DMF which assisted with the synoptic sampling by providing personnel and boats. Without the assistance of DMF, DEM would not have been able to sample all the stations within one day.

STATION LOCATIONS

The A/P Study area encompasses five major river basins: Chowan, Neuse, Pasquotank, Roanoke, and Tar-Pamlico. For comparative purposes, Table 1 presents the surface area and the number of permitted surface water dischargers in each basin. An estimation of drainage area is also provided for the Albemarle, Pamlico, and Currituck Sounds.

Table 1. Number of square miles and permitted surface water dischargers within the A/P Study area by river basin and sounds.

		# OF PERMITTED DISCHARGERS		
RIVER BASIN*	DRAINAGE AREA square miles	TOTAL	MUNICIPAL	NONMUNICIPAL
Chowan	1,315	29	3	26
Neuse	6,192	317	39	278
Pasquotank	3,697	53	7	46
Roanoke	3,603	249	24	225
Tar-Pamlico	5,401	128	21	107
SOUNDS**				
Albemarle	500			
Pamlico	2,060			
Currituck	153			

* Estimates from NRCD 1988.
** Estimates from Giese, et al. 1979.

Stations were located to provide coverage for most of the A/P Study area (Figure 1). Stations were established in transects for increased efficiency and coverage. Due to fiscal constraints, stations were not located in the upper Currituck Sound, upper Chowan River, Perquimans River, Pasquotank River, or North River.

Table 2 lists the stations and the segments to which they were assigned. Appendix II provides station locations and their latitudes and longitudes. Figure 2 graphically depicts

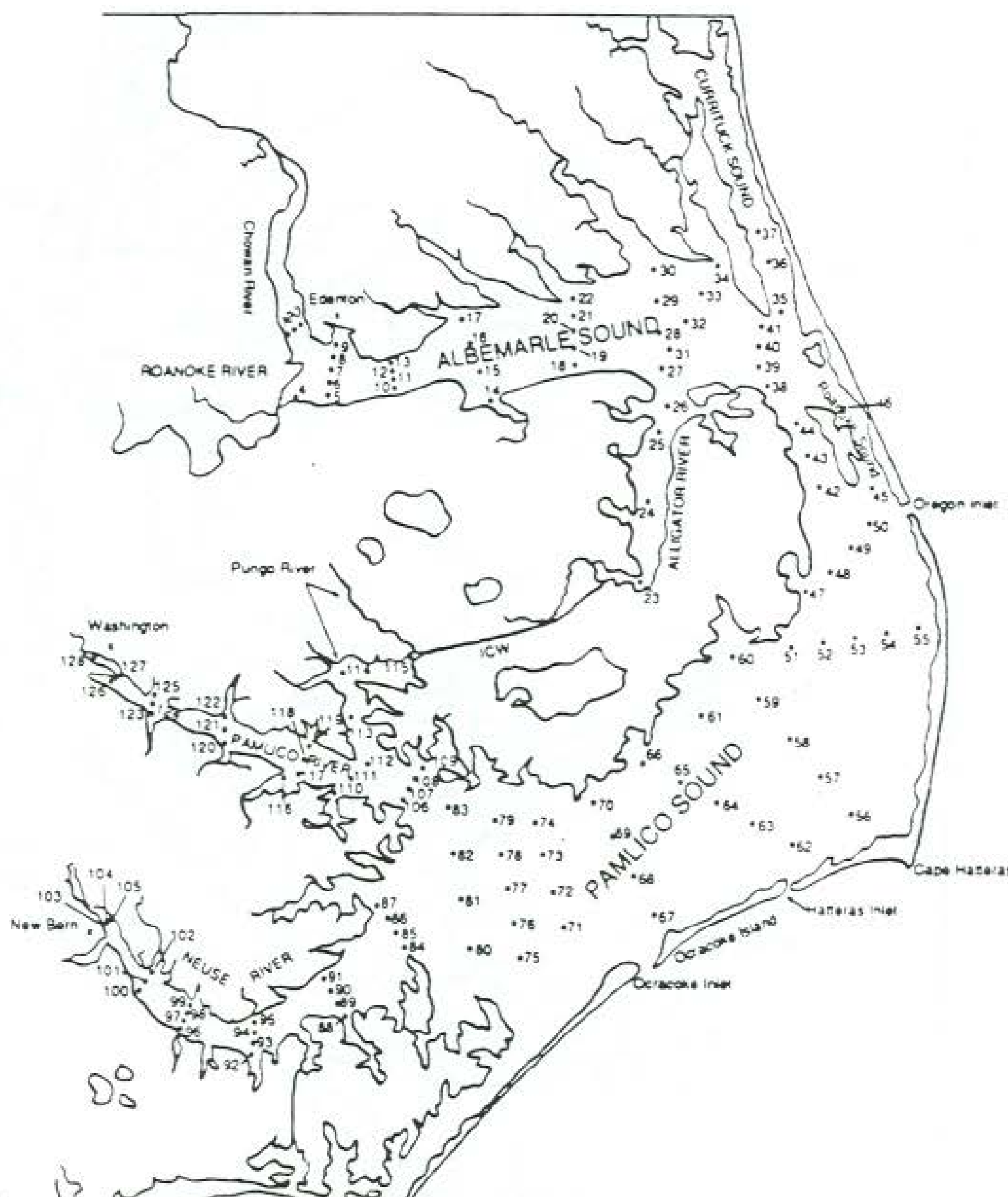

Figure 1. Station locations for the A/P Synoptic Study - July 25, 1989. See Appendix II for station location information. Original map produced by DEHNR Center for Geographic Information and Analysis.

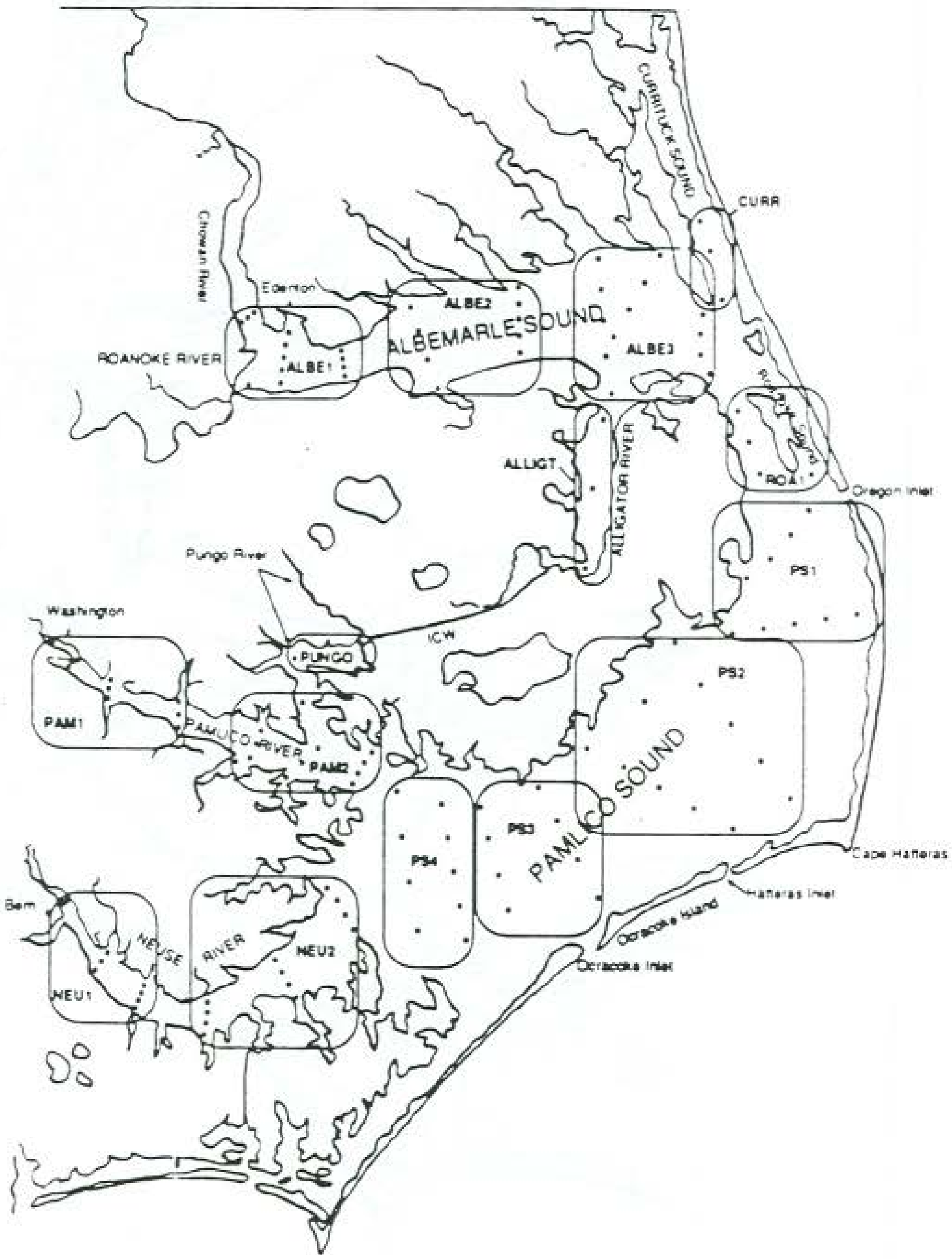

Figure 2. Segments used for analysis of A/P synoptic data. See Figure 1 and Table 2 for station groupings and numbers.

the segments. For ease of analysis, stations were grouped into segments after review of the data indicated which stations were similar.

Table 2. Grouping of stations by segment as depicted in Figure 2.

MAJOR AREA	SEGMENT	STATIONS
ALBEMARLE SOUND	ALBE1	APES1-13
	ALBE2	APES14-22
	ALBE3	APES26-34, 38-41
CURRITUCK SOUND	CURR	APES35-37
ROANOKE SOUND	ROA1	APES42-46
PAMLICO SOUND	PS1	APES47-55
	PS2	APES56-66
	PS3	APES67-74
	PS4	APES75-83
PAMLICO RIVER	PAM1	APES120-128
	PAM2	APES106-113,116-119
PUNGO RIVER	PUNGO	APES113-115
ALLIGATOR RIVER	ALLIGATOR	APES23-25
NEUSE RIVER	NEU1	APES96-105
	NEU2	APES84-95

METHODS

Table 3 lists the water quality parameters collected at each site. Each boat had at least one person from DEM experienced in water quality sampling. This person was responsible for insuring quality control and correct sampling technique as described in DEM's Standard Operating Procedures Manual for Chemical and Physical Sampling (EHNR 1989b). All equipment was calibrated prior to sampling. Sample tags, bottles, calibration sheets, field sheets and lab sheets were prepared in the lab and distributed to each boat.

Table 3. Water quality parameters collected at each synoptic station. See text for additional explanation.

DEPTH PROFILE (1 meter increments)	SURFACE (grab samples)	PHOTIC ZONE (composite samples)	BOTTOM (grab samples)
Dissolved Oxygen	Fecal Coliform	Residue, Total	Total Organic Carbon
Temperature	Chlorides	Residue, Suspended	Sulfides
Conductivity	Sulfate	Chlorophyll-a trichromatic	
Salinity	Cadmium	Chlorophyll-a corrected	
	Chromium	Pheophytin	
	Copper	Ammonia as N	
	Nickel	Total Kjeldahl Nitrogen	
	Lead	Nitrate/Nitrite	
	Zinc	Total Phosphorus	
	Aluminum	Orthophosphorus	
	Beryllium	Phytoplankton	
	Cobalt		
	Iron		
	Manganese		
	Arsenic		
	Mercury		

All boats were at the location of their first station and prepared to begin sampling at 10:00 AM. Sampling was completed by 3:00 PM in order to collect the samples during the satellite fly-over.

Dissolved oxygen, pH, temperature, conductivity and salinity were measured from the surface to the bottom at one meter intervals. Secchi depth was taken as described in the DEM's Standard Operating Procedures Manual for Chemical and Physical Sampling (EHNR 1989b).

Photic zone sampling was done using a Labline or Van Dorn bottles which were lowered to twice the Secchi depth and then slowly raised allowing the bottle to fill. Bottom samples were taken at approximately one foot from the bottom using a Labline or Van Dorn bottle. Grab samples were taken by leaning over the gunwale and dipping a bottle in at a depth of approximately 0.15 meters. The bottle was held so that no water entered until the correct depth was reached.

All samples were placed on ice and taken to DEM's Cary Laboratory within 24 hours. At the lab all samples were logged in and prepared for analysis. Analyses were performed using EPA approved standard methods (American Public Health Association 1985). All data collected were entered into a spreadsheet for statistical analysis on MacIntosh SE and II using StatView II™ or StatView 512+™. Data were also transferred to the Department of Environment, Health and Natural Resources (EHNR) Center for Geographic Information and Analysis for mapping purposes and inclusion in the A/P Study database.

Phytoplankton samples were preserved using a modified Lugol's solution. Samples were identified and counted using a modification of Utermohl's (1958) inverted microscope technique as described in DEM's Standard Operating Procedure's Manual for Biological Assessment (EHNR 1990).

Data for all parameters are tabulated in Appendices II through IV. Appendix I contains maps of selected parameters.

RESULTS AND DISCUSSION

Physical and Chemical Parameters

Temperature. Surface water temperatures ranged from 25.7 to 31°C (Figure 3). These values were within the normal range for the coastal areas of North Carolina (Giese et al. 1979). Thermal stratification was slight with a maximum surface to bottom difference of only 2.5°C.

The box and whisker chart shown in Figure 3 provides details of the full distribution of the temperature data collected for each segment. The horizontal line crossing the box is the sample median or point at which 50% of the data falls above and 50% falls below. The notch around the median indicates the 95% confidence interval and the upper and lower ends of the boxes are the 75 and 25 percentiles. This range provides a graphic indication of where the bulk of the data are distributed. The upper and lower whiskers indicate the 90th and 10th percentiles and the dots depict extreme values.

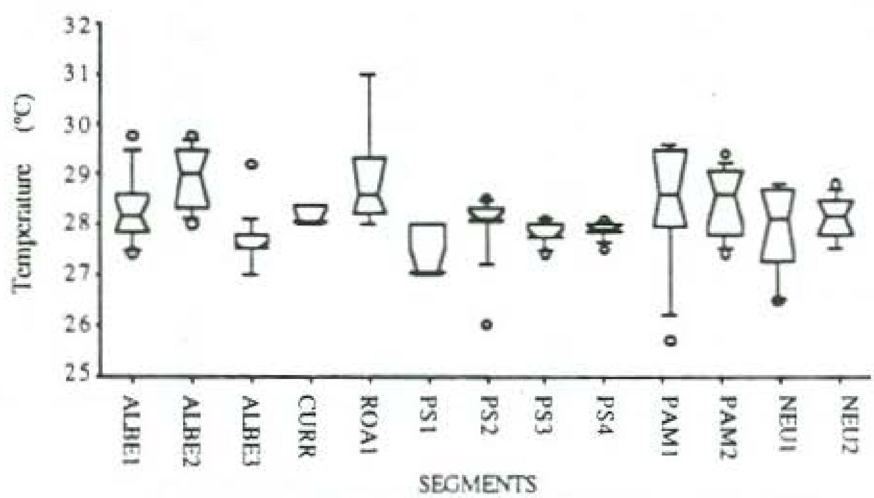

Figure 3. Surface water temperatures by segments for the A/P Synoptic Study. See Table 2 for definition of segment abbreviations.

Dissolved Oxygen. Surface dissolved oxygen (DO) measurements ranged from 4 to 11 mg/l with surface saturation of 49 to 141%. Figure AI.1 in Appendix I gives the complete distribution of surface DO concentrations. The Neuse River had the highest incidence of low DO and saturation with surface DO concentrations of 4.7 mg/l (58% saturation) to 5.3 mg/l (67% saturation) at New Bern (APES103-105) and Thurman (APES100-101). DO concentrations throughout the water column were low (less than or equal to 5 mg/l) at these stations (Table 4).

DO concentrations and saturation were also low in the upper Pamlico River at Washington (APES128) and marker 16 (APES127). The water columns at these two stations were well mixed with DO, temperature, and salinity fairly uniform throughout.

Highest DO concentrations were recorded in the Neuse River at the mouth of Upper Broad Creek (APES102), and in the Pamlico River at the Bath Creek to Durham Creek transect (APES120-122), at the Broad Creek to Blounts Bay transect (APES123), and at the mouth of Chocowinity Bay (APES126). Table 5 presents DO, percent saturation, and chlorophyll-a concentrations for these stations. Surface waters at all six stations were supersaturated and chlorophyll-a concentrations were elevated. Samples were taken near midday when phytoplankton photosynthesis would be high, releasing oxygen into the water.

Table 4. Surface and bottom dissolved oxygen (DO), percent saturation, temperature, and salinity for stations with low dissolved oxygen concentrations.

LOCATION	DEPTH meters	DO mg/l	% SATURATION	TEMPERATURE °C	SALINITY ppt
NEUSE RIVER					
APES100	0.15	5.2	64	27.5	0.5
	5	0.0	0	26.5	10
APES101	0.15	5.3	66	27.8	1
	3	0.3	4	26.9	6
APES103	0.15	4.9	60	27.2	4
	5	0.1	1	26.5	7.5
APES104	0.15	4.8	59	26.5	0
	4	0.2	2	26.5	7
APES105	0.15	4.7	58	26.6	0
	2.5	0.2	2	25.1	0
PAMLICO RIVER					
APES127	0.15	4.9	60	27.0	0
	3	4.1	50	26.1	0
APES128	0.15	4.0	49	25.7	0
	5	3.9	46	25.4	0

Table 5. Surface dissolved oxygen (DO), percent saturation (% SAT), and chlorophyll-a (CHLA) for stations with elevated dissolved oxygen concentrations.

LOCATION	DO mg/l	% SAT	CHLA ug/l
Neuse River			
APES102	10.6	136	250
Pamlico River			
APES120	9.9	130	58
APES121	11.0	141	54
APES122	9.6	126	21
APES123	10.0	128	42
APES126	9.8	126	48
Albemarle Sound			
APES14	9.0	115	94
APES16	8.8	113	25
APES17	8.8	113	27

The state standard (15 NCAC 2B.0211 & .0212 (b)) for dissolved gases states that "saturation shall not be greater than 110 percent". In addition to the supersaturation in the Neuse and Pamlico, three other stations were above the 110 percent saturation standard. APES17 and APES16 in the Albemarle Sound off Harvey Point, both had 113 percent saturation and a DO of 8.8 mg/l. APES14 located in Bull Bay on the Albemarle Sound had

115 percent saturation and a DO of 9.0 mg/l. Chlorophyll-a concentrations at these stations were elevated indicating that phytoplankton activity was probably responsible for the supersaturation.

pH. The standard for pH is 6.0 to 9.0 SU for freshwater and 6.8 to 8.5 SU for tidal saltwaters. Surface pH values in this study ranged from 5.4 to 9.4 standard units (SU). Most of the high pH values were seen in the Albemarle Sound area (Table 6) with values ranging from 9.2 to 9.4 SU. The 9.4 reading was taken at the mouth of the North River (APES34). Dissolved oxygen concentrations at this station were slightly elevated with a percent saturation of 105, indicating that the elevated pH was probably due to algal activity. Phytoplankton density was 10,394 units/ml and chlorophyll-a was 94 ug/l. The state standard for chlorophyll-a is 40 ug/l.

Table 6. Surface pH, dissolved oxygen (DO), percent saturation (SAT), and chlorophyll-a (CHLA) for A/P synoptic Stations with elevated pH measurements (>8.5 SU).

STATION	MAIN WATERBODY	pH SU	DO mg/l	SAT %	CHLA ug/l
APES34	Albemarle Sound	9.4	8.4	105	94
APES35	Currituck Sound	9.2	7.8	99	26
APES36	Currituck Sound	9.3	7.7	97	27
APES46	Roanoke Sound	9.2	7.5	95	50

Lowest surface pH values were from the Pamlico Sound off Sandy Point (APES47) and the Pamlico River at Washington (APES128). pH readings were 5.4 and 5.8 SU, respectively. Only surface values were taken at the Sandy Point station; however, depth profile pH readings were made at Washington. Those readings indicated the pH decreased throughout the water column. Dissolved oxygen concentrations were also very low at this station with values ranging from 4.0 mg/l at the surface to 3.9 mg/l at bottom. These values did not meet the state standards of 5.0 mg/l for dissolved oxygen and 6.8 SU for pH. Figure AI.2 in Appendix I depicts all the surface pH readings.

Conductance, Salinity, and Chlorides. As expected, spatial patterns for specific conductance, salinity, and chlorides were similar (Appendix I, Figures AI.3-5). Lowest concentrations were seen in the Albemarle Sound where freshwater inflow is a major factor. From the Albemarle Sound water moves down into the upper Pamlico Sound (Giese et al. 1979). Seawater entering through the Oregon Inlet is diluted by the Pamlico Sound waters resulting in lower concentrations of all three parameters at the Sandy Point and Long Shoal Point transects (PS1).

Highest values were measured in the Pamlico Sound from the Pingleton Point to Hatteras transect (PS2) down to the Great Island to West Bay tránsect (PS4) (Figure 4). The proximity of these stations to both the Hatteras and Ocracoke Inlets results in the increased concentrations in this area of the Pamlico Sound.

The net movement of water within the A/P system, as indicated by conductance, salinity, and chlorides, appears to be in a clockwise fashion from the Albemarle Sound down into the Pamlico Sound and up into the Neuse and Pamlico Rivers. Within the Pamlico it appears that sufficient water is moved up into the Pungo and into the Alligator River to increase salinities and conductivities in these waterbodies.

The highest chloride value found was 15,000 mg/l near the mouth of the North River (APES33). This value is so much greater than the conductivity and salinity readings obtained at and near this station that we will assume a sampling or analysis error was made and disregard this sample.

Comparisons were also made across the transects within the Pamlico Sound. While there appeared to be a slight increase from west to east in salinity, conductance, and chlorides, only chloride concentrations were significantly higher ($p=0.05$) on the east side (Figure 5). The stations used in each grouping are indicated in Figure 6.

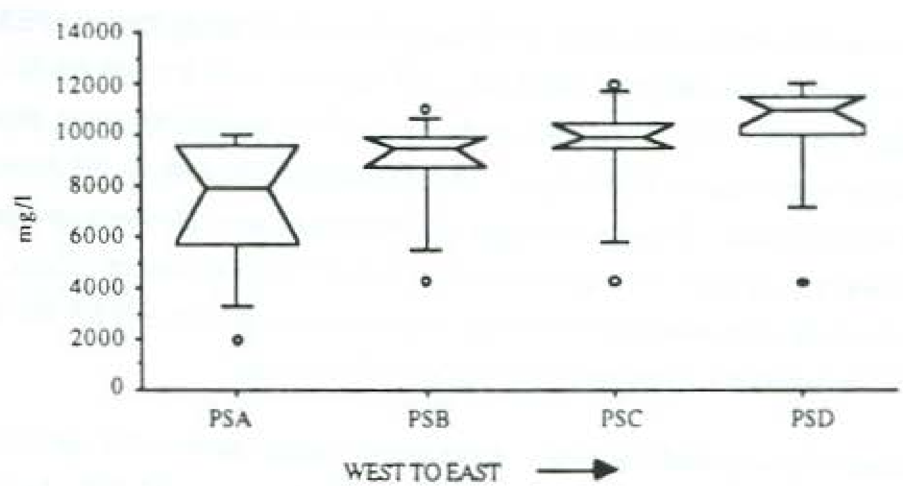

Figure 5. Chloride concentrations for the Pamlico Sound from west to east. Groupings for each box plot are depicted in Figure 6.

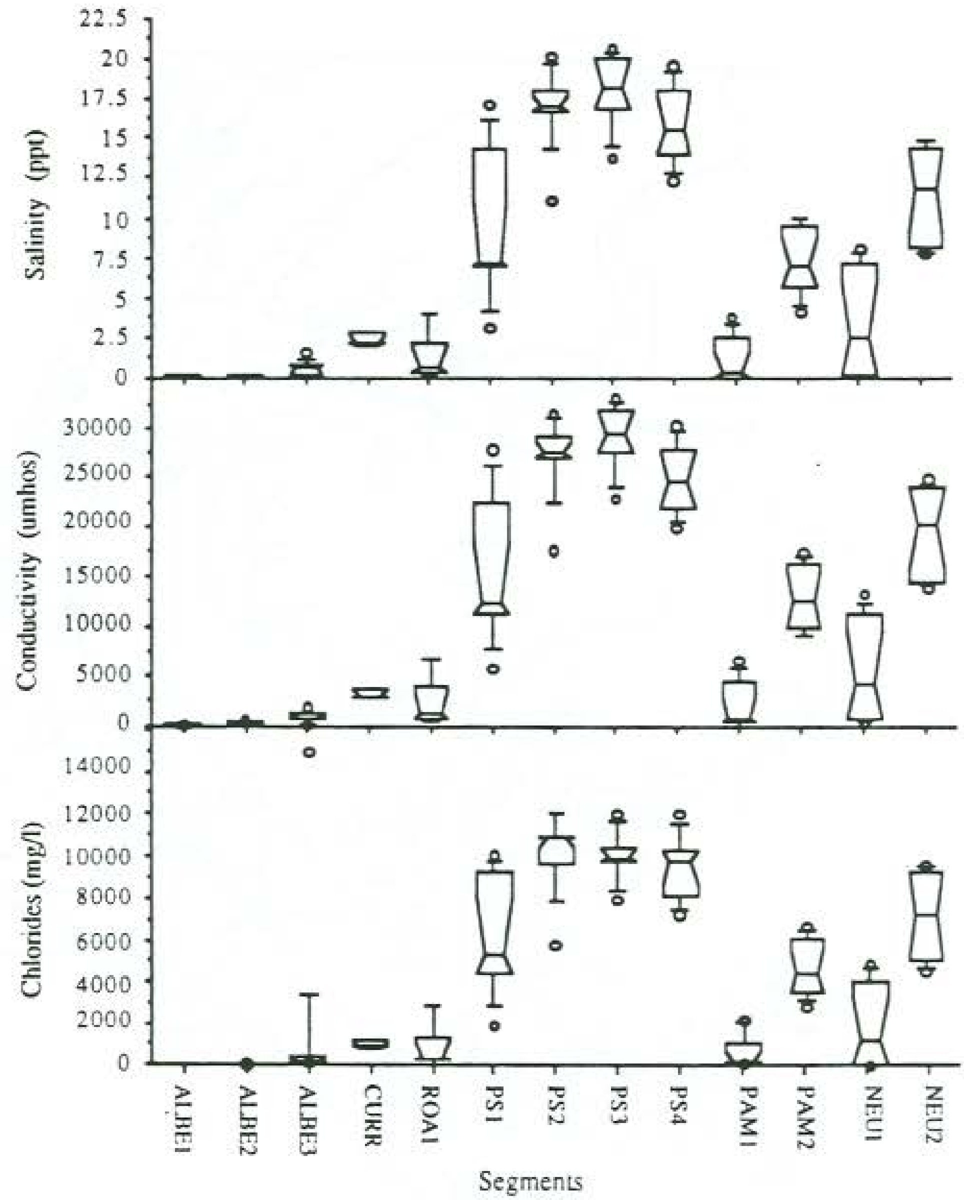

Figure 4. Surface salinity, conductivity, and chlorides by segment for the A/P Synoptic study.

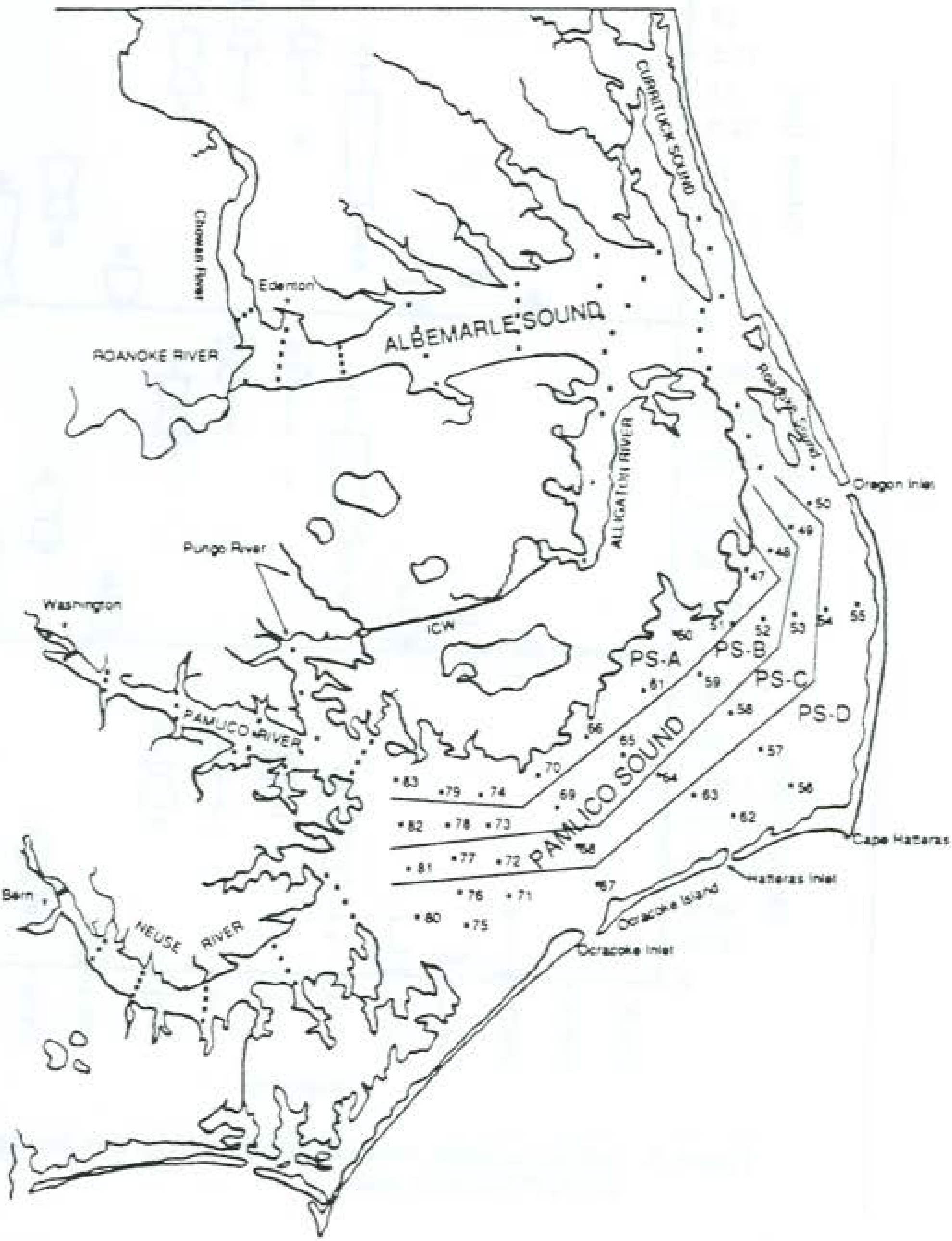

Figure 6. Pamlico Sound stations grouped for west to east comparisons.

Total and Suspended Solids. Total solids levels ranged from 79 mg/l to 37,000 mg/l (Figure 7 & Appendix I, Figure AI.6). The lowest levels of total solids were at the western end of Albemarle Sound and at the most upstream stations on the Pamlico and

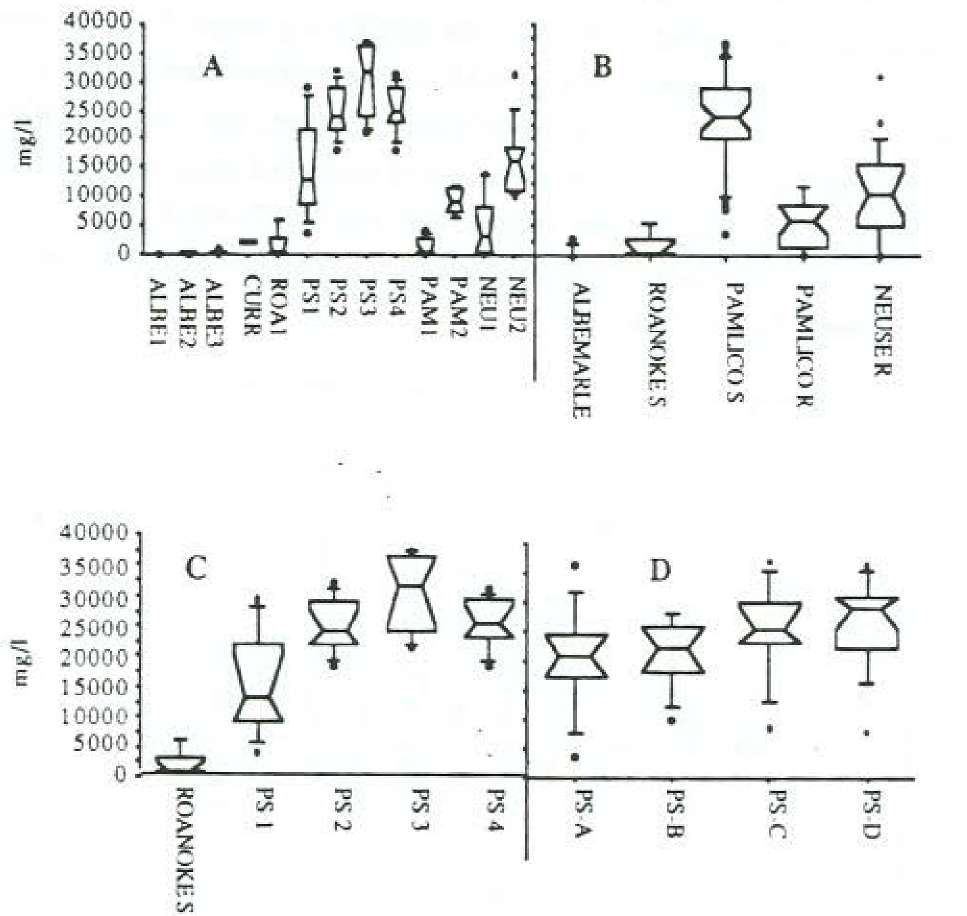

Figure 7. Total solid concentrations by segment for the A/P Synoptic Study. (A) All the stations grouped into thirteen different segments, (B) All the stations grouped into five main segments by sound or river, (C) The Pamlico Sound, including Roanoke Sound, grouped from north to south, and (D) The Pamlico Sound grouped from west to east.

Neuse rivers. The highest levels were in Pamlico Sound encompassing the area between Ocracoke and Portsmouth Islands to mainland between Swanquarter and Engelhard. Levels were higher in this area due to a greater concentration of seawater and its dissolved mineral salts. Within the Pamlico Sound there was no difference from west to east in total solid concentrations (Figure 7, graph D).

In an estuary, the concentration of suspended or particulate matter is considerably higher than that found in rivers or the ocean (Postma 1967). Particles flowing down a river have a tendency to be circulated: first downstream in the surface waters, second settling to the bottom waters, third moving upstream with the saltwedge, and finally being mixed again with the surface waters. This process occurs many times before the particle is pushed out to the ocean or deposited in the sediments.

The levels of suspended solids during the APES study ranged from less then 1 mg/l to 45 mg/l (Figure 8 & Appendix I, Figure AI.7). The highest concentration was found in the Pamlico River in Blounts Bay; however, adjacent stations had levels which were much lower. The area with the highest concentrations of suspended solids among adjacent stations was Currituck Sound where concentrations of 35, 37, and 38 mg/l were observed. The shallowness of Currituck Sound (1-2 meters) and wind mixing contribute to its high levels of suspended solids in this area.

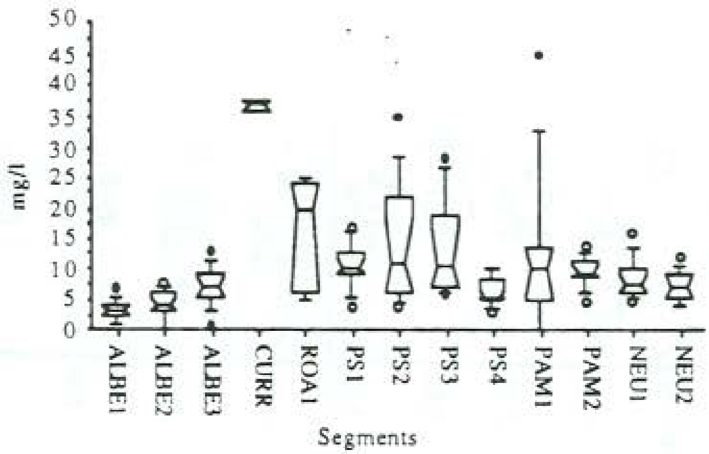

Figure 8. Suspended solids by segments for the A/P Synoptic Study.

Turbidity. Turbidity depends on the amount of suspended materials, the production of organic matter, and the tidal currents and storms which can resuspend sediments (Guilcher 1967). Turbidity in estuaries is variable and higher than in neighboring marine waters (Darnell 1967). High turbidity limits the growth of most phytoplankton and rooted vegetation (Day 1952) and promotes the growth of surface algae such as Anabaena and Microcystis (Darnell 1961).

Turbidity concentrations ranged from 1.6 to 19 NTU (Figure 9 & Appendix I, Figure AI.8). None of the turbidity concentrations were above the state water quality standard of 25 NTU's. Highest turbidities were seen in the upper Pamlico River. Elevated phytoplankton densities probably contributed to the turbidity in this segment of the Pamlico River (PAM1).

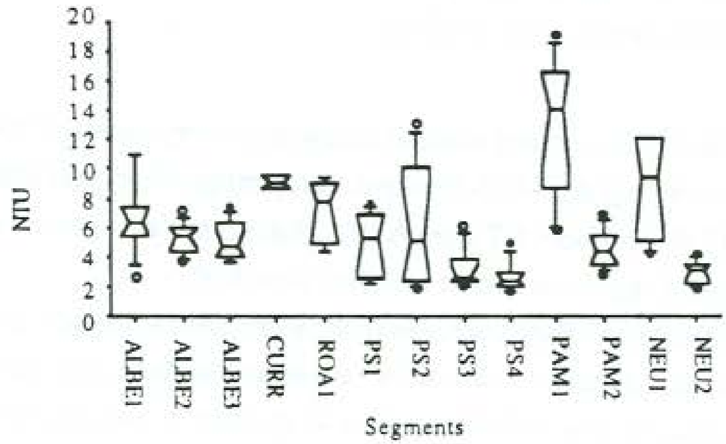

Figure 9. Turbidity concentrations by segment for the A/P Synoptic Study.

Secchi Depth. Secchi depth readings are used as a measure of water transparency. Secchi depth readings ranged from 0.3 m in the Pamlico River at Blounts Bay (APES123) to 1.8 m in the Pamlico Sound near Buxton (APES56). Overall, the lowest Secchi depth readings were from the upper Pamlico River (PAM1) (Figure 10). Secchi depths ranged from 0.3 to 0.45 m in this portion of the study area. Turbidity, phytoplankton densities, and chlorophyll-a concentrations, factors which affect Secchi depth, were elevated in this area resulting in the lower Secchi depths.

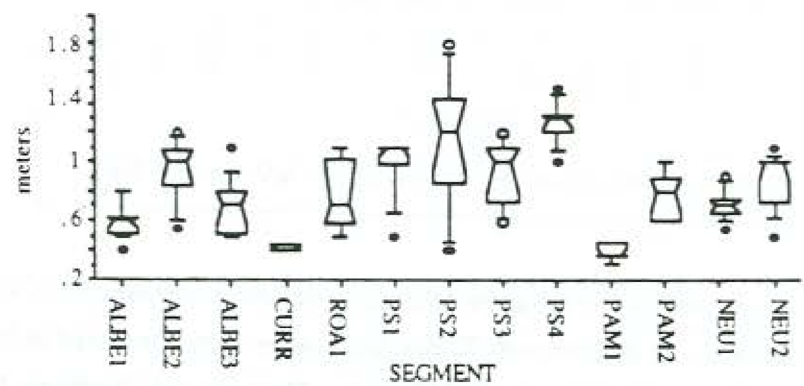

Figure 10. Secchi depth readings by segment for the A/P Synoptic Study.

Secchi depths from the Currituck Sound were also low, ranging from 0.4 to 0.45 m. This area is shallow with bottom depths of 1 to 2 m. During sampling, winds were out of the north at approximately 15 knots. Wind mixing at these stations resulted in high suspended solids which reduced Secchi depth readings.

Sulfate/Sulfides. Sulfide concentrations were all below laboratory standard reporting limits. Sulfate concentrations during the APES Synoptic Study ranged from less than 5 mg/l to 1600 mg/l (Figure 11 & Appendix I, Figure AI.9). Highest sulfate concentrations were seen in the Pamlico Sound segments, where salinities were high.

During a study of the Neuse and Pamlico River in the early 1980's, Matson and Brinson (1985) found that sulfate concentrations in the mesohaline surface waters of the estuarine portions of these systems were enriched by 5 to 43 percent. It was also noted that these levels decreased in the late summer, presumably due to sulfate reduction in the anoxic bottom waters and sediments. These authors stated that the sulfate enrichment of these systems was the result of the biological oxidation of pyrite in the subsurface sediments.

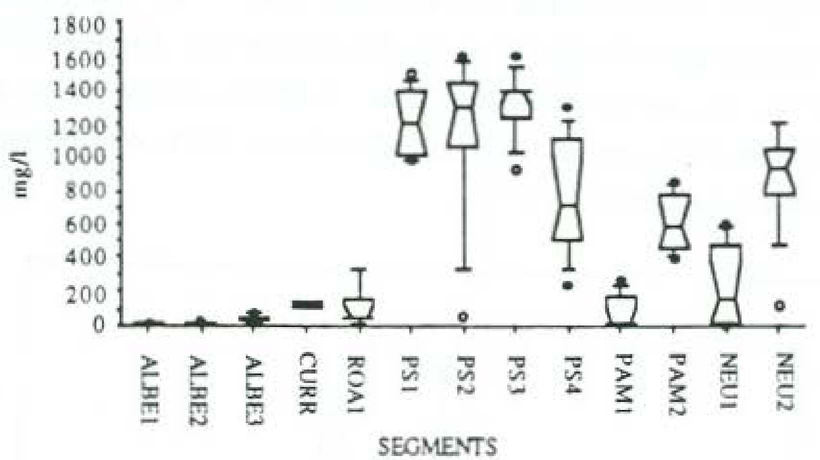

Figure 11. Sulfate concentratons by segment for the A/P Synoptic Study.

To analyze the synoptic sulfate data, the laboratory results were converted to moles and a sulfate/chloride ratio was determined. These ratios were then compared to the molar sulfate/chloride ratio of seawater which is 0.0517 moles (Dryssen and Wedburg 1980). The sulfate/chloride ratio was used to determine what kinds of sulfate processes were occurring within the estuary. A sulfate/chloride ratio which was higher than that found in seawater indicates that sulfates are precipitating out of solution and being deposited into the sediments. A sulfate/chloride ratio which is lower than that found in seawater indicates that sulfates are being released into solution from the sediments (E.J. Kuenzler, personal communication). Ratios which were greater than 0.0517 were considered "enriched" relative to seawater. This enrichment should not be confused with nutrient enrichment since it is solely based on the sulfate ratio. Furthermore, this ratio is considered enriched only in comparison to ocean waters. Ratios were not determined for stations which reported no salinity and for station APES120 which had a positive salinity, but a questionable chloride result.

When the APES sulfate and chloride concentrations were converted to the sulfate/chloride ratio (Figure 12), they showed that 77 percent of the stations were not enriched, since ratios were equal to or less than that found in seawater. Nine percent were between 0-5 percent enriched, while another fourteen percent of the stations were more than 5 percent enriched. The highest percentage of enrichment found in this study was 27 percent. These results agree with Matson and Brinson's finding that sulfate levels are low during the summer. The levels of sulfate enrichment found during this sampling event are not indicative of any environmental problems.

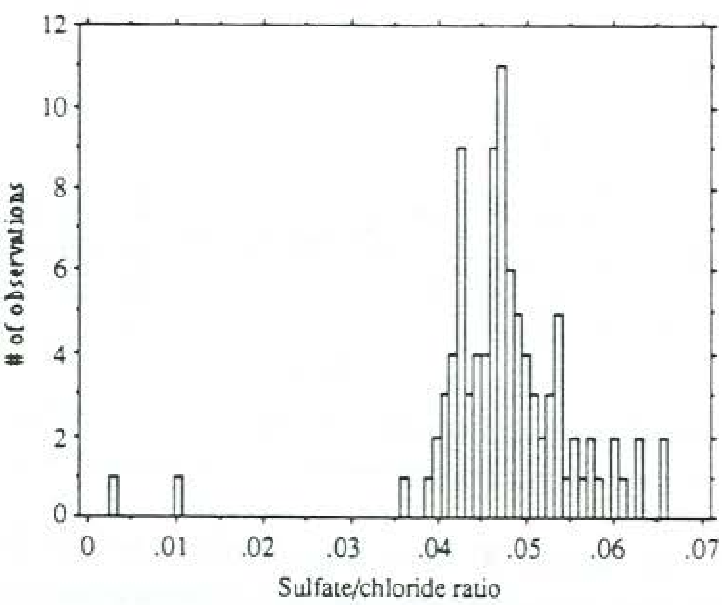

Figure 12. Sulfate/chloride ratios for all stations with salinities greater than zero. Ratios greater than 0.0517 were considered to be "enriched" with sulfate relative to seawater.

Total Organic Carbon. The amount of total organic carbon (TOC) in a natural body of water is the result of interactions between the net productivity of the system, the exudation of organic substances from phytoplankton, and the import and export of organic matter from the surrounding waters and sediments (Stumm and Morgan 1981). Total organic carbon concentrations of 2.6 to 9.1 mg/l have been reported from the Patuxent River in Virginia (Sigleo and Macko 1985), and TOC concentrations of 5.2 to 7.0 mg/l have been reported from New Bedford Harbor, Massachusetts (Brownawell and Farrington 1985). Copeland et al. (1984) reported average TOC concentrations of 7.3 to 9.3 mg/l for the Pamlico River.

Concentrations of TOC in the Albemarle Pamlico Estuary ranged from less than 5 mg/l to 300 mg/l (Figure 13 & Appendix I, Figure AI.10). The Pamlico Sound area had very low TOC with 89 percent of the stations having concentrations less than 5 mg/l. Positive results in the Pamlico Sound ranged from 5 to 8 mg/l.

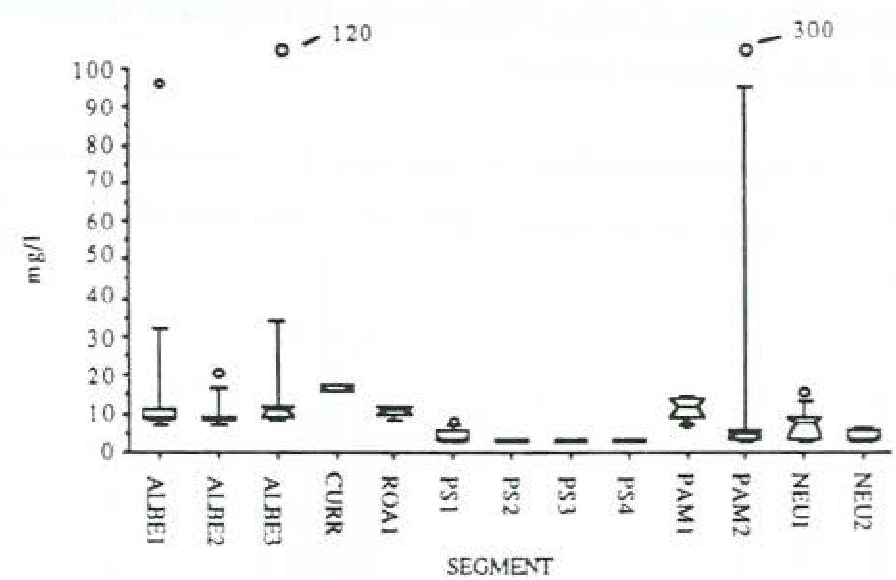

Figure 13. Total organic carbon by segment for the A/P Synoptic Study.

Only three stations had TOC results above 25 mg/l: Albemarle Sound from Sandy Point to Leonards Point near midchannel (96 mg/l), Albemarle Sound between Caroon Pt and Harbor Point (120 mg/l), and South Creek at Mouth (300 mg/l). These high TOC concentrations may be the result of phytoplankton die off. Copeland et al. (1984) reported that sediment composition in the Albemarle Sound grades from sand in the shallow water areas to organic-rich muds in the main channel. There is a possibility that the sediments were disturbed during sampling resulting in a higher total organic carbon concentration in the water column. This explanation does not explain the high value at Caroon Point as Copeland et al. (1984) indicates that the bottom sediments in this area are predominantly very fine sand. Since the actual reason for these high TOC concentrations is unknown, it is recommended that these areas be targeted for further investigation.

Metals. The analysis of metals in estuarine areas has previously been difficult due to interference caused by salinity. The metals for this study were analyzed by a plasma analysis which produced more confident results than have been reported previously. On laboratory spiked samples of estuarine water, 80 percent recovery was obtained. These results indicates that values reported in this study tend to be slightly below actual levels.

The concentrations of cadmium, chromium, nickel, beryllium, cobalt, and arsenic were all below reporting levels (Table 7). Concentrations of lead, zinc and mercury were less than reporting levels at over 98 percent of the stations. The only one lead concentration above the reporting level of 10 ug/l (32 µg/l) was found in the Pamlico Sound near Wysocking Bay (APES 66). This lead concentration is interesting since elevated lead concentrations are often detected around marinas or coastal towns. Wysocking Bay has neither, so the sources of lead are not known. The two positive (above reporting level) zinc concentrations (14 and 32 µg/l) were found at Albemarle Sound at midchannel between Edenton and Albemarle Beach, and in the Pamlico River at mid channel between Pungo River and Goose Creek, respectively. The two positive mercury concentrations (0.64 µg/l and 0.47 µg/l) were found in the Neuse River between Cockle Point and South River, and in Rose Bay, respectively.

Table 7. DEM Laboratory reporting levels and percent of samples below the reporting level for metals sampled during the A/P Synoptic Study. (All reporting levels are in ug/l.)

Metal	Reporting Level (RL)	% Samples Below RL	Metal	Reporting Level (RL)	% Samples Below RL
Cadmium	2.0	100	Chromium	25	100
Copper	2.0	58	Nickel	10	100
Lead	10	99	Zinc	10	98
Aluminum	50	23	Beryllium	25	100
Cobalt	50	100	Iron	50	17
Manganese	25	56	Arsenic	10	100
Mercury	0.2	98			

Copper, aluminum, iron, and manganese concentrations by segment are presented in Figure 14 and in Appendix I, Figures AI.11-14. Copper concentrations ranged from less than 0.2 µg/l to 20 µg/l. The highest concentration was found in the Pungo River across

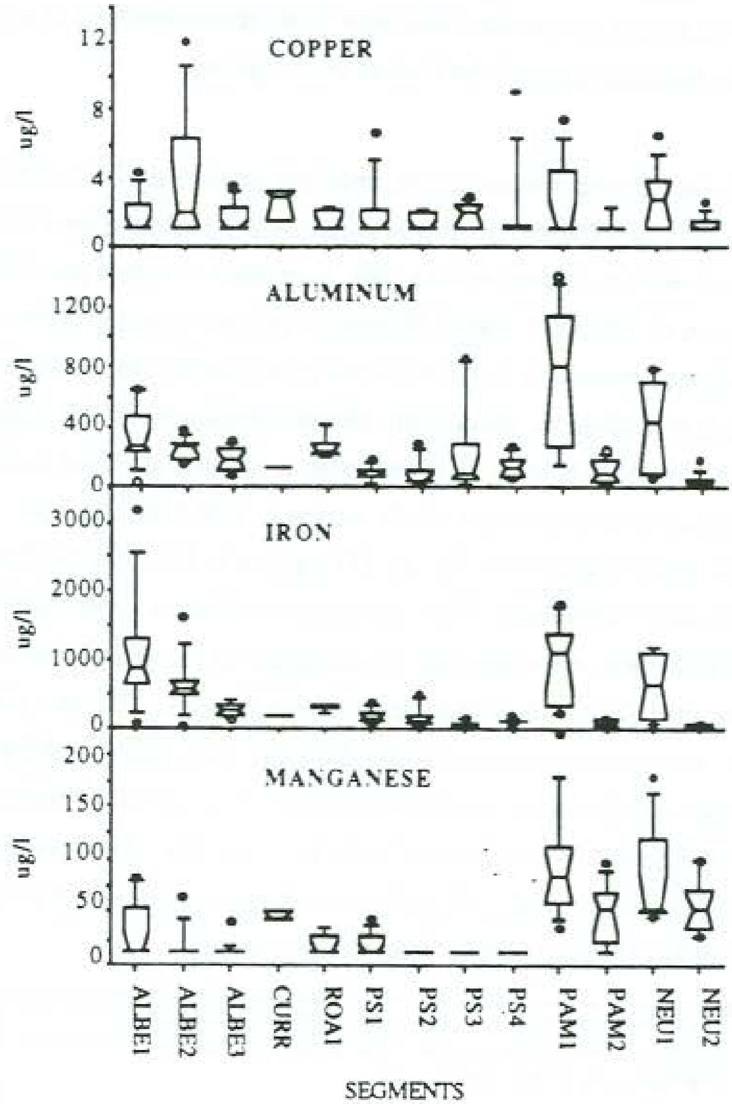

Figure 14. Copper, aluminum, iron, and manganese by segment for the A/P Synoptic Study.

from Belhaven, which is not depicted in Figure 14. Aluminum concentrations ranged from less than 50 µg/l to 1400 µg/l. The highest concentrations were found in the Pamlico River near Washington. This station is at the upper end of the estuary and thus the waters at this station are more riverine and carry a greater sediment load than the other estuarine stations. Therefore, high aluminum concentrations at this site would be expected because of the higher levels of aluminum which occur in the piedmont sediments. Iron concentrations ranged from less than 50 µg/l to 3200 ug/l. The highest concentrations were found in the Chowan River at its mouth. Manganese concentrations ranged from less than 25 µg/l to 220 µg/l. The higher concentrations of manganese were found in the upstream stations in the Neuse and Pamlico Rivers. Like aluminum, the high levels of manganese in the upper estuarine stations of the Pamlico and Neuse River are indicative of the freshwater inputs into the estuary.

Nutrients

Nitrogen. Three forms of nitrogen were sampled: ammonia/ammonium (NH_3/NH_4), nitrate/nitrite (NO_2/NO_3), and total kjeldahl nitrogen (TKN). Total nitrogen (TN) estimates were obtained by adding TKN and NO_2/NO_3. Nitrogen is important for phytoplankton growth and as an indicator of cultural enrichment. Researchers in the Neuse and Pamlico systems have shown that nitrogen's abundance is a major factor controlling nuisance phytoplankton populations (Paerl 1987, Kuenzler et al. 1979, Hobbie 1971).

NH_3/NH_4 is a readily available form of nitrogen for phytoplankton and is usually high in domestic discharges. Concentrations of NH_3/NH_4 ranged from below the detection limit of 0.01 mg/l (indicated as 0.005 mg/l in Tables, Appendices and Figures) to 0.15 mg/l (Figure 15). There are no in-situ water quality standards for nutrients, but nutrients in point source discharges are regulated, particularly in nutrient sensitive waters.

The highest median concentration for NH_3/NH_4 was 0.05 at the mouth of the Chowan River in the Albemarle Sound (ALBE1). Highest concentrations were seen in the upper Alligator River at Highway 64 (APES25) and marker 22 (APES24). Concentrations were 0.15 and 0.13 mg/l, respectively. Lowest concentrations (below detection) were seen in the Currituck Sound, in the Pamlico Sound at the Pingleton Point and Wysocking Bay transects, and in the lower Pamlico River from South Creek to Pamlico Point.

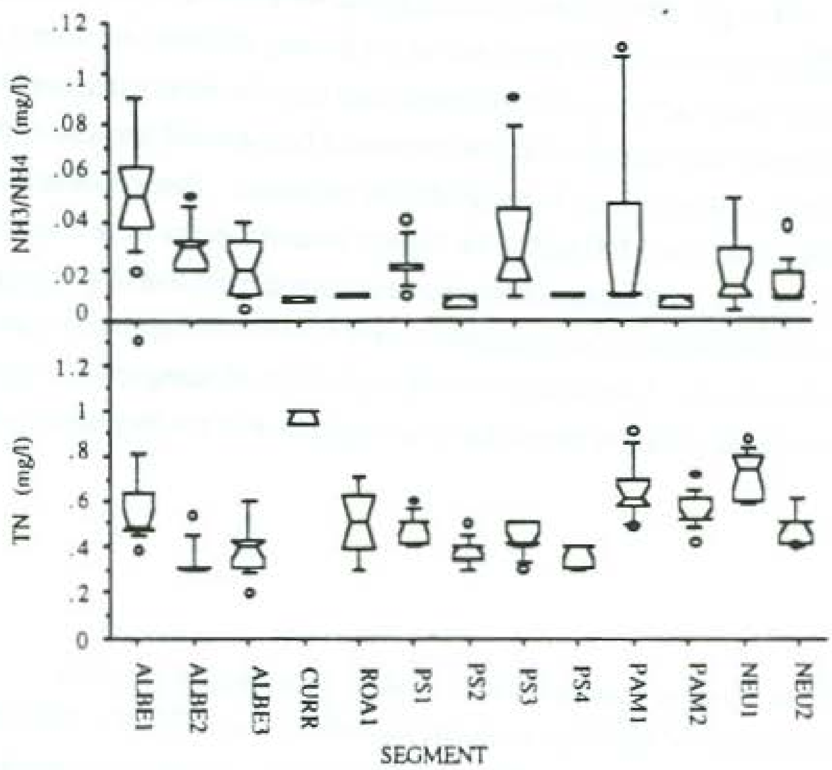

Figure 15. Ammonia/ammonium (NH_3/NH_4) and total nitrogen (TN) by segment for the A/P Synoptic Study.

TN concentrations ranged from 0.20 mg/l in the Albemarle Sound off Wade Point (APES29) to 1.31 mg/l at the Chowan River at Edenhouse (APES3). Figure 15 is somewhat deceptive as it shows TN in the Currituck Sound to be different from all other stations. Statistically this difference is not significant. There are only 3 stations and observations for this segment which limits the power of the statistics. For the most part, TN concentrations were greatest in the upper Pamlico, the upper Neuse, the Currituck Sound, and the Pungo River (Figure 15 & Appendix I, Figure AI.15). Phytoplankton populations in the Pungo River and upper Pamlico and Neuse Rivers were also high due to the availability of nitrogen and phosphorus.

Comparisons made across the transects within the Pamlico Sound indicated no differences in TN or NH_3/NH_4 from west to east.

Phosphorus. Phosphorus is another important nutrient for phytoplankton growth. For this study, two forms of phosphate were sampled: total phosphorus (TP) and orthophosphate (PO_4).

Highest concentrations for TP were found in the Neuse and Pamlico Rivers (Figure 16 & Appendix I, Figure AI.16). Median concentrations for TP ranged from 0.15 to 0.2 mg/l in those two systems, while the medians ranged from 0.03 to 0.075 mg/l for all other groups. A concentration of greater than 0.1 mg/l TP is considered adequate to support nuisance algal growth.

PO4 concentrations exhibited the same spatial patterns as TP with highest concentrations in the Neuse and Pamlico River (Figure 16). Concentrations in the lower Pamlico Sound at the mouths of the Neuse and Pamlico Rivers were also elevated due to the inputs from the Pamlico and Neuse Rivers. Data collected by DEM in special studies and ambient water quality monitoring support this inference as the nutrient sensitive Neuse and Tar-Pamlico basins have historically had high concentrations of phosphorus. These high phosphorus concentrations are not due totally due to natural causes. There is extensive eutrophication in these waters due to anthropogenic sources.

No differences within the Pamlico Sound from west to east were found for TP or PO_4.

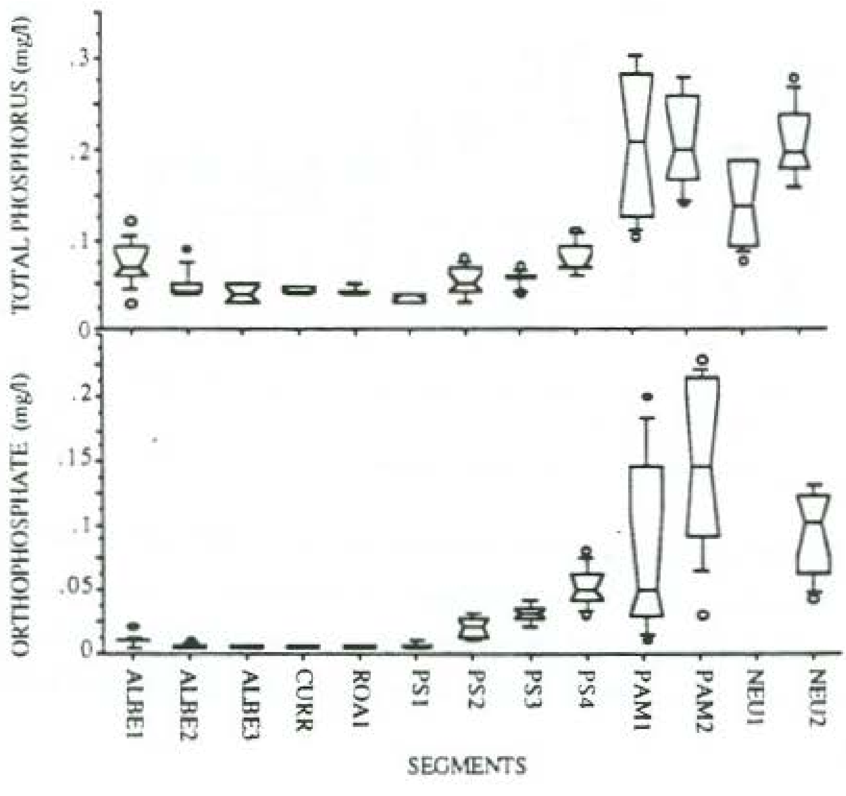

Figure 16. Total phosphorus and orthophosphate by segments for the A/P Synoptic Study.

TN:TP. A comparison of the ratios of TN to TP gives a rough indication of which nutrient may be limiting phytoplankton growth and, as a limiting nutrient, should have stricter controls to insure that phytoplankton growth continues to be low. Phytoplankton species composition is also controlled to a certain extent by which nutrient is in abundance. While nutrients are not the only factors controlling phytoplankton populations, they are relatively easy to measure and control, unlike temperature and sunlight.

TN:TP ratios of 5 to 10 usually indicate co-limitation, values below 5 signify nitrogen limitation and values above 10 signify phosphorus limitation. As would be expected from the high phosphorus concentrations, the Pamlico and Neuse Rivers were essentially nitrogen limited (Figure 17). Stations in the lower Pamlico Sound near the mouths of the Neuse and Pamlico were also nitrogen limited except for APES75, APES76, and APES77. The Currituck Sound was phosphorus limited with an average TN:TP ratio of 23.

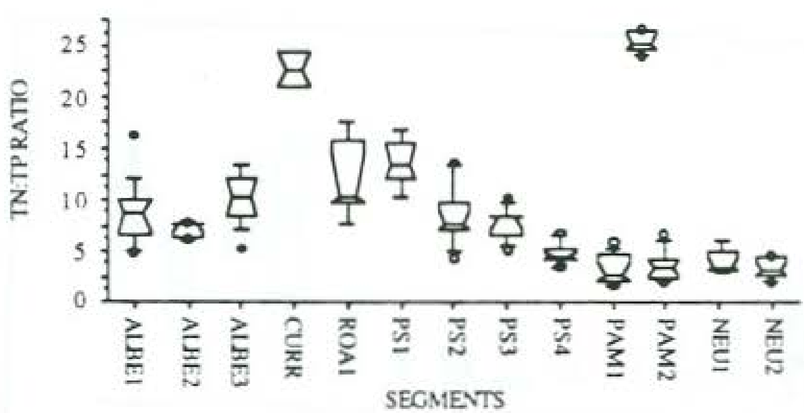

Figure 17. Total nitrogen (TN) to total phosphorus (TP) ratios by segment for the A/P Synoptic Study.

Roanoke Sound was also phosphorus limited at stations APES45 and APES46. Phytoplankton populations were elevated at these two stations with chlorophyll-a concentrations of 38 and 50 ug/l and phytoplankton densities of 149,648 and 337,146 units/ml. Phosphorus concentrations were probably low due to assimilation by the phytoplankton.

Biological Parameters

Chlorophyll-a and Phytoplankton Biovolume and Density. Due to time constraints, phytoplankton analysis was only performed on fifteen stations from the Synoptic Study. Analysis was done on those stations with chlorophyll-a concentrations of 38 ug/l and above (Table 8). Chlorophyll-a concentrations vary according to the algal species present and bloom levels may be present at chlorophyll-a levels less than the state standard of 40 ug/l. Chlorophyll-a data for all stations are presented in Appendix I, Figure AI.17 and Appendix III.

The highest chlorophyll-a concentration (250 ug/l) was taken at the mouth of Upper Broad Creek in the Neuse River. Unfortunately, the phytoplankton sample from that station was not preserved so species composition and population estimates are not available. Elevated DO and pH values at this station were a result of the high phytoplankton activity.

A review of Table 8 and Figure 18 indicates that elevated phytoplankton populations were present in the most urbanized portions of the Synoptic Study area with peak growth where retention times and possibly urban inputs are greater such as Bull Bay (APES14). The upper Albemarle Sound, Neuse River, and Pamlico River all had high chlorophyll-a concentrations and bloom level algal populations. Bloom level algal populations are defined as biovolume estimates greater than 5,000 mm^3/m^3 and/or density estimates greater than 10,000 units/ml. Elevated nutrient levels and slow flushing contribute to the abundance of phytoplankton found in these three areas.

In the Roanoke Sound, chlorophyll-a concentrations were also elevated. APES45 had an chlorophyll-a concentration of 38 ug/l with a phytoplankton biovolume estimate of 13,441 mm^3/m^3 and a density estimate of 149,648 units/ml. APES46 had a chlorophyll-a concentration of 50 ug/l, a biovolume estimate of 26,708 mm^3/m^3, and a density estimate of 337,146 units/ml. The chlorophyll-a values seem low when compared to the biovolume and density estimates; however, this is due to the dominance of Anabaenopsis raciborski and Lyngbya species A, two small filamentous cyanophytes (blue-green algae). These two species have a small amount of chlorophyll-a relative to their size. Both of these species are common summer dominants in some of the more eutrophic waters of the state. Anabaenopsis raciborski has the ability to utilize nitrogen from the atmosphere allowing it to out compete other species.

Table 8. Chlorophyll-a (CHLA), phytoplankton biovolume, phytoplankton density, and dominant classes by biovolume and density for A/P synoptic stations with chlorophyll-a concentrations greater than or equal to 38 ug/l. Abbreviations for classes are: BAC-bacillariophyceae, CHL-chlorophyceae, CRY-cryptophyceae, CHR-chrysophyceae, DIN-dinophyceae, CYA-cyanophyceae, EUG-euglenophyceae.

LOCATION	CHLA ug/l	BIOVOLUME mm^3/m^3	DENSITY units/ml	DOMINANT CLASS BY BIOVOLUME	DOMINANT CLASS BY DENSITY
ALBEMARLE SOUND					
APES1	44	3,928	4,309	BAC,CHL,CRY	BAC,CRY,CHL
APES5	40	3,836	6,848	DIN,CHR,CHL	CRY
APES14	94	4,379	19,914	DIN,CRY,CYA	CYA,CRY
APES34	94	1,231	10,394	CYA	CYA
ROANOKE SOUND					
APES45	38	13,441	149,648	CYA,BAC	CYA
APES46	50	26,708	337,146	CYA	CYA
NEUSE RIVER					
APES96	45	5,120	43,672	DIN,BAC	BAC
APES97	75	6,492	30,920	DIN	BAC,CYA,DIN
APES98	94	9,163	36,335	DIN	BAC,CYA,DIN
APES99	88	14,172	71,971	DIN	BAC,CYA,DIN
PAMLICO RIVER					
APES120	58	22,093	13,043	DIN	BAC,CYA,DIN
APES121	54	7,637	16,071	DIN	BAC,CYA,CRY
APES123	42	1,768	9,188	CRY,BAC,EUG	BAC,CRY,CHL
APES126	48	2;429	16,595	DIN	BAC,CRY,DIN
PUNGO RIVER					
APES114	48	2,429	26,727	DIN,BAC,CRY	BAC

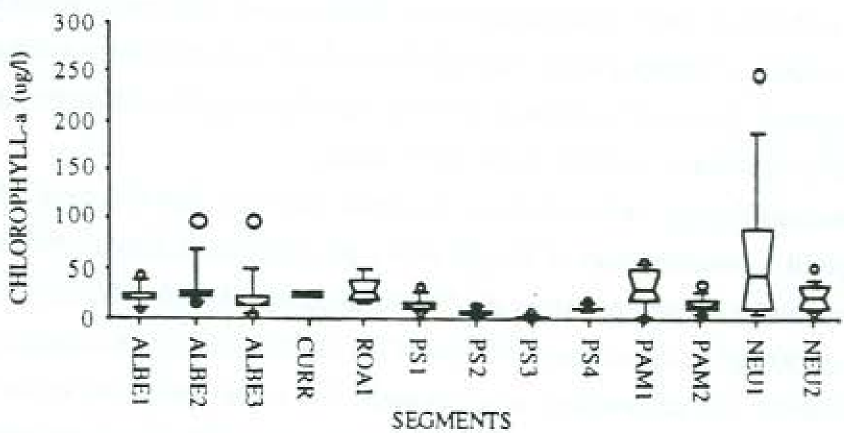

Figure 18. Chlorophyll-a concentrations by segment for the A/P Synoptic Study.

Lowest chlorophyll-a concentrations were seen in the Pamlico Sound (Figure 18), where concentrations ranged from 1 ug/l to 33 ug/l with a mean of 9 ug/l. Means for all other areas ranged from 20 to 66 ug/l. Dilution, sedimentation, and assimilation of nutrients within the rivers and tributaries prior to entering the Pamlico Sound probably account for the lower algal growth found in the Sound.

Blue-green algae (Class Cyanophyceae) dominated the low salinity waters of the Albemarle and Roanoke Sounds, while in the more saline waters of the Neuse and Pamlico Rivers, dinoflagellates (Class Dinophyceae), diatoms (Class Bacillariophyceae), and cryptophytes (Class Cryptophyceae) were the dominant classes.

Overall, dominant species by biovolume included: the dinoflagellates, Gymnodinium aurantium, Gymnodinium species, and Gyrodinium uncatenum; the blue-green algae, Anabaenopsis raciborski; and the diatom, Cyclotella species 2. Cyclotella species 2, a small centric diatom, has been found in the Neuse, Pamlico and New Rivers and is usually associated with eutrophic conditions.

Density estimates at most stations were dominated by Cyclotella species 2, Chroomonas minuta (Cryptophyceae), and the blue-green algae, Oscillatoria geminata, Lyngbya species A and Anabaenopsis raciborski. Oscillatoria geminata, another blue-green, is commonly associated with enriched conditions.

Fecal Coliform Bacteria. Fecal coliform bacteria are used as an indicator of the possible presence of other bacteria which may affect human health. The state standard for fresh and tidal saltwaters is 200 membrane filter fecal coliform colonies (MFFCC)/100ml, where 200 MFFCC/100ml is the geometric mean of 5 consecutive samples taken within a 30 day period. More stringent standards are applied to SA waters, tidal saltwaters whose best usage is shellfishing and which also meet the standards for SB and SC waters. Fecal coliform counts for SA waters may not exceed a geometric mean of 14 MFFCC/100ml. Within the Synoptic Study area, 64 of the sampling stations were within SA waters. Of these stations, no samples were above the state standards for either SA waters or tidal saltwaters.

Table 9. Percent of fecal coliform samples which were below DEM Laboratory reporting level of 10 MFFCC/100ml by segments for the A/P Synoptic Study.

SEGMENT	# OF SAMPLES	% OF SAMPLES BELOW 10 MFFCC/100ml
ALBE1	11	90
ALBE2	9	100
ALBE3	12	75
CURR	3	66
ROA1	5	100
ALLIGATOR	3	100
PS1	9	100
PS2	11	100
PS3	8	100
PS4	9	100
PAM1	9	33
PAM2	11	100
NEU1	10	50
NEU2	12	100
TOTAL	122	86

Eighty-six percent of the samples taken were below the DEM laboratory reporting level of 10 MFFCC/100ml (Table 9). None of the stations sampled had fecal coliform counts above the standards. The upper Pamlico and Neuse Rivers had the highest incidences of detectable fecal coliform levels, but these values were all below state standards.

CONCLUSION

For the most part, contraventions of state water quality standards occurred in the areas experiencing the greatest pressure from anthropogenic sources. Elevated chlorophyll-a concentrations and phytoplankton biovolume and density estimates were found mainly in the western Albemarle Sound (near the mouth of the Chowan and Roanoke Rivers), the Pamlico River, and the Neuse River. Nutrient concentrations in the Pamlico and Neuse Rivers were higher than in other areas. These areas have the greatest number of dischargers and have documented occurrences of algal blooms and fish kills (NRCD 1988) indicating that eutrophication is a major problem in these areas.

The areas where metals were detected also occurred in the western Albemarle Sound, the Pamlico River, and the Neuse River. Sediments from the watersheds of these waters normally contain these metals.

In the Pamlico Sound, most parameters sampled were within state standards or not elevated with the exception of a few stations. These stations were near inputs such as the Pamlico or Neuse River. In the Albemarle Sound below Edenton, elevated chlorophyll-a and phytoplankton populations occurred in Bull Bay (APES14), and in the mouth of North River (APES34).

The Roanoke Sound had some high chlorophyll-a concentrations and phytoplankton populations. Nitrogen and phosphorus concentrations were not elevated; however, this could be a result of phytoplankton uptake. The dominant species were Anabaenopsis raciborski and Lyngbya species. These two small filamentous blue-green algae have been identified in other coastal and freshwaters and are usually associated with eutrophic conditions. DEM has no ambient stations in the Roanoke Sound and little water quality information has been published for that area. Phytoplankton populations and chlorophyll-a concentrations indicate that this area warrants further study.

Overall, the results indicate that present ambient water quality monitoring by DEM is covering the most impacted areas of the A/P Estuarine Study. However, the Roanoke Sound warrants special sampling to determine if apparent enrichment is a normal condition. The only area which is not being sampled by DEM is the Pamlico Sound and negotiations are being initiated with USGS to provide quarterly sampling at several stations in the Pamlico Sound and possibly the upper Currituck Sound.

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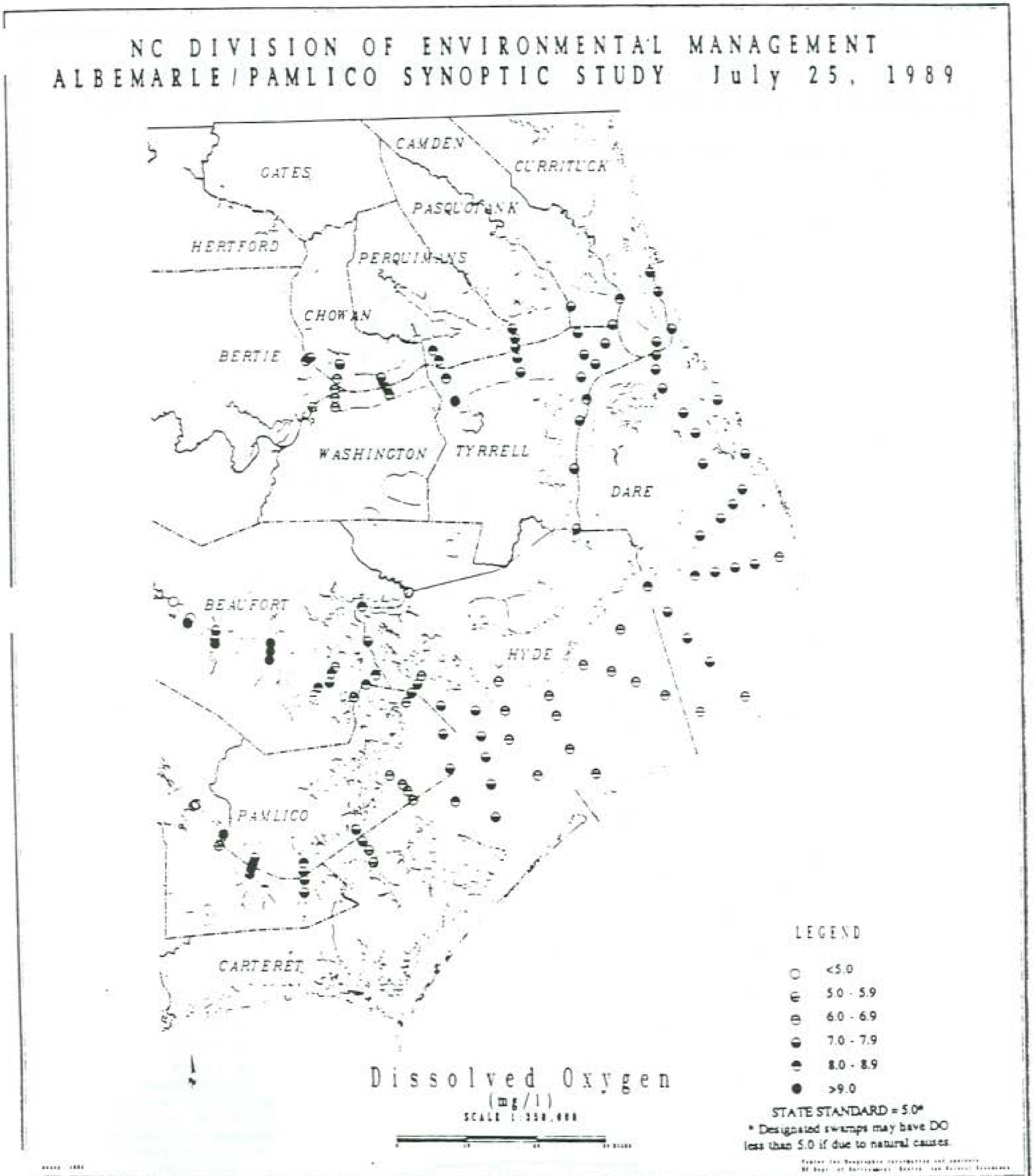
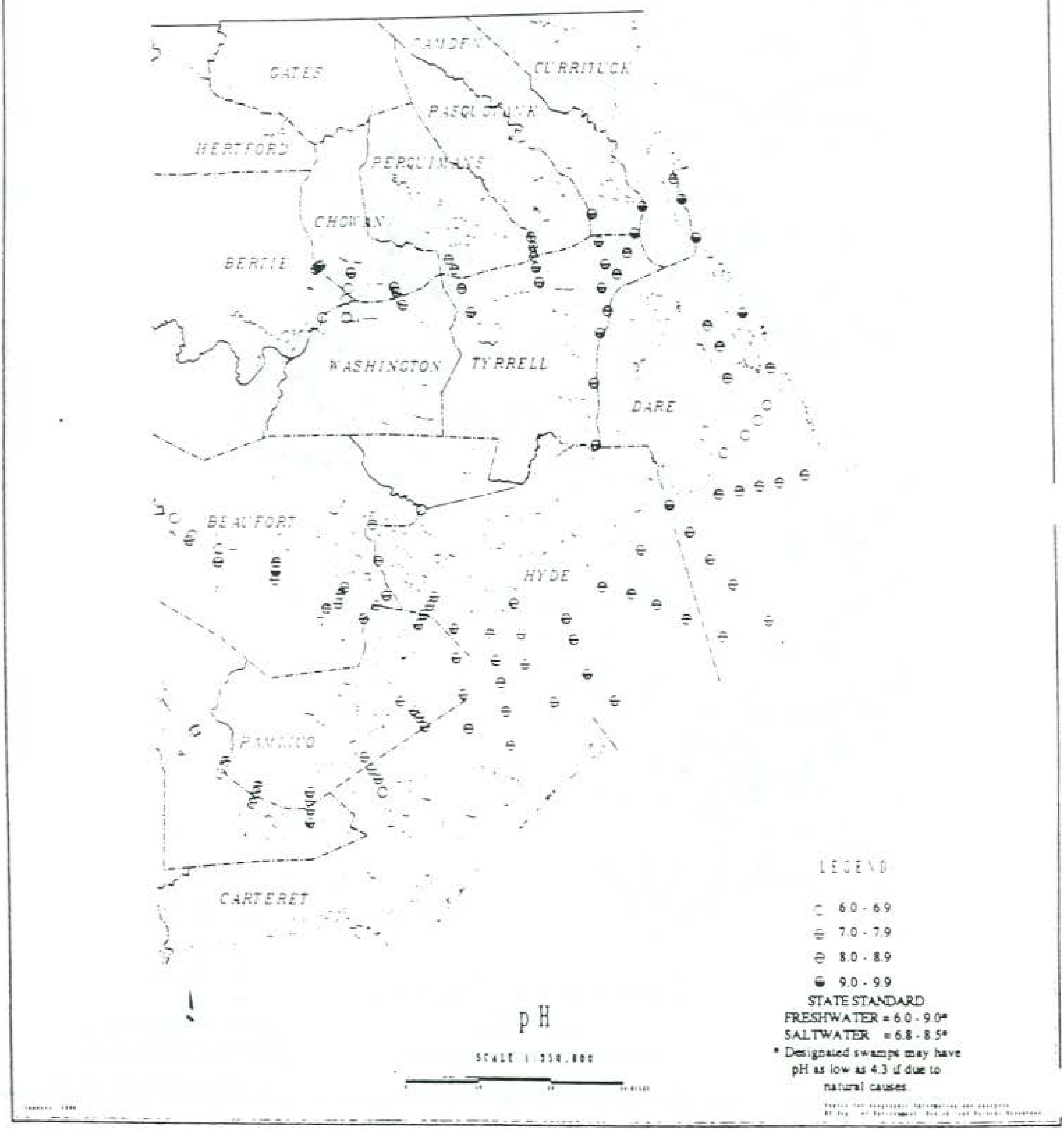
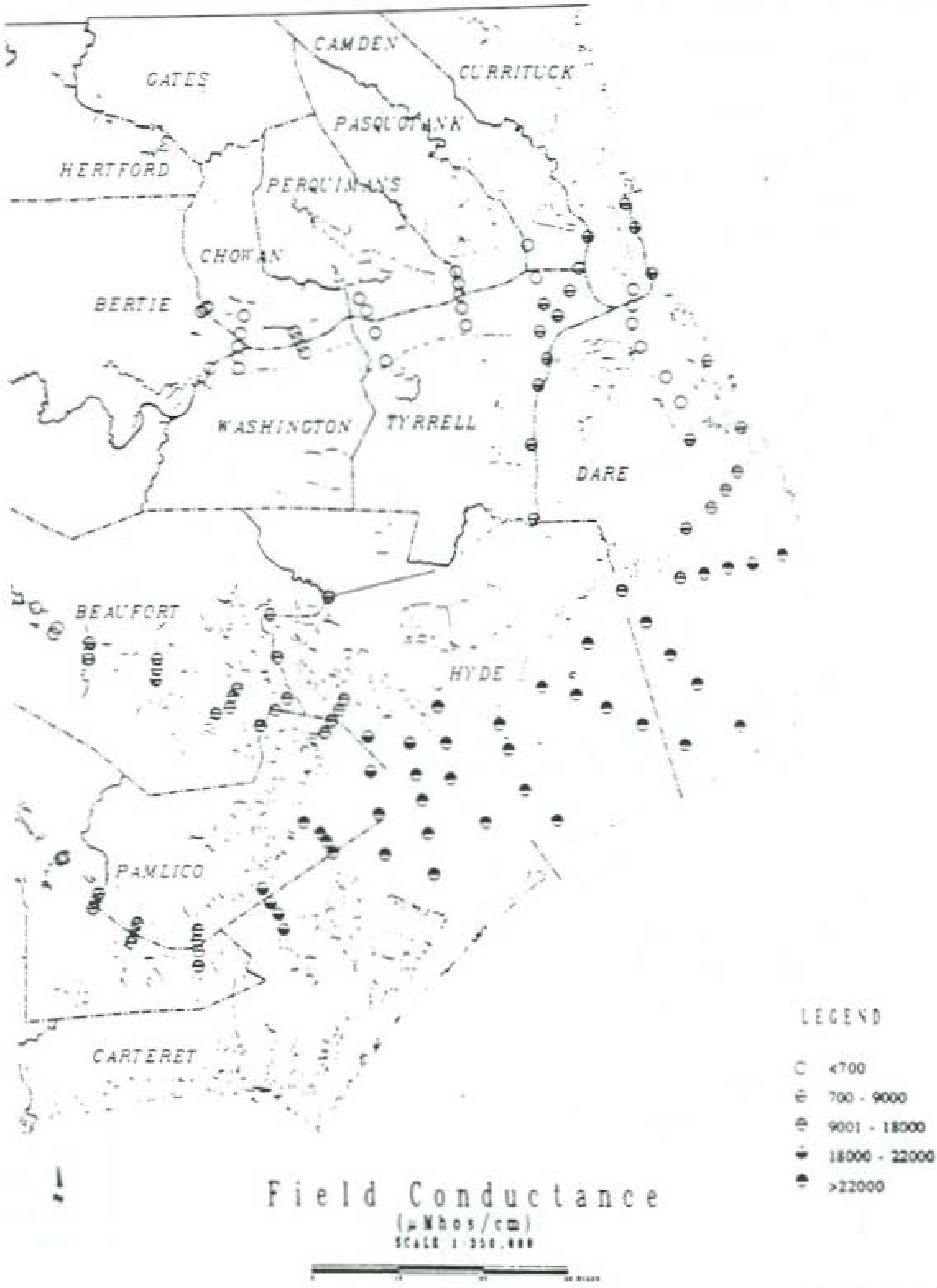
APPENDIX I. MAPS OF SELECTED PARAMETERS
FOR THE A/P SYNOPTIC STUDY.


NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989
CAMDEN
CURRITUCK
GATES
PASQUOTANK
HERTFORD
PERQUIMANS
CHOWAN
BERTIE
WASHINGTON
TYRRELL
DARE
BEAUFORT
HYDE
PAMLICO
CARTERET
LEGEND
<5.0
5.0 - 5.9
6.0 - 6.9
7.0 - 7.9
8.0 - 8.9
>9.0
STATE STANDARD = 5.0*
* Designated swamps may have DO less than 5.0 if due to natural causes.
Dissolved Oxygen
(mg/l)

NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989

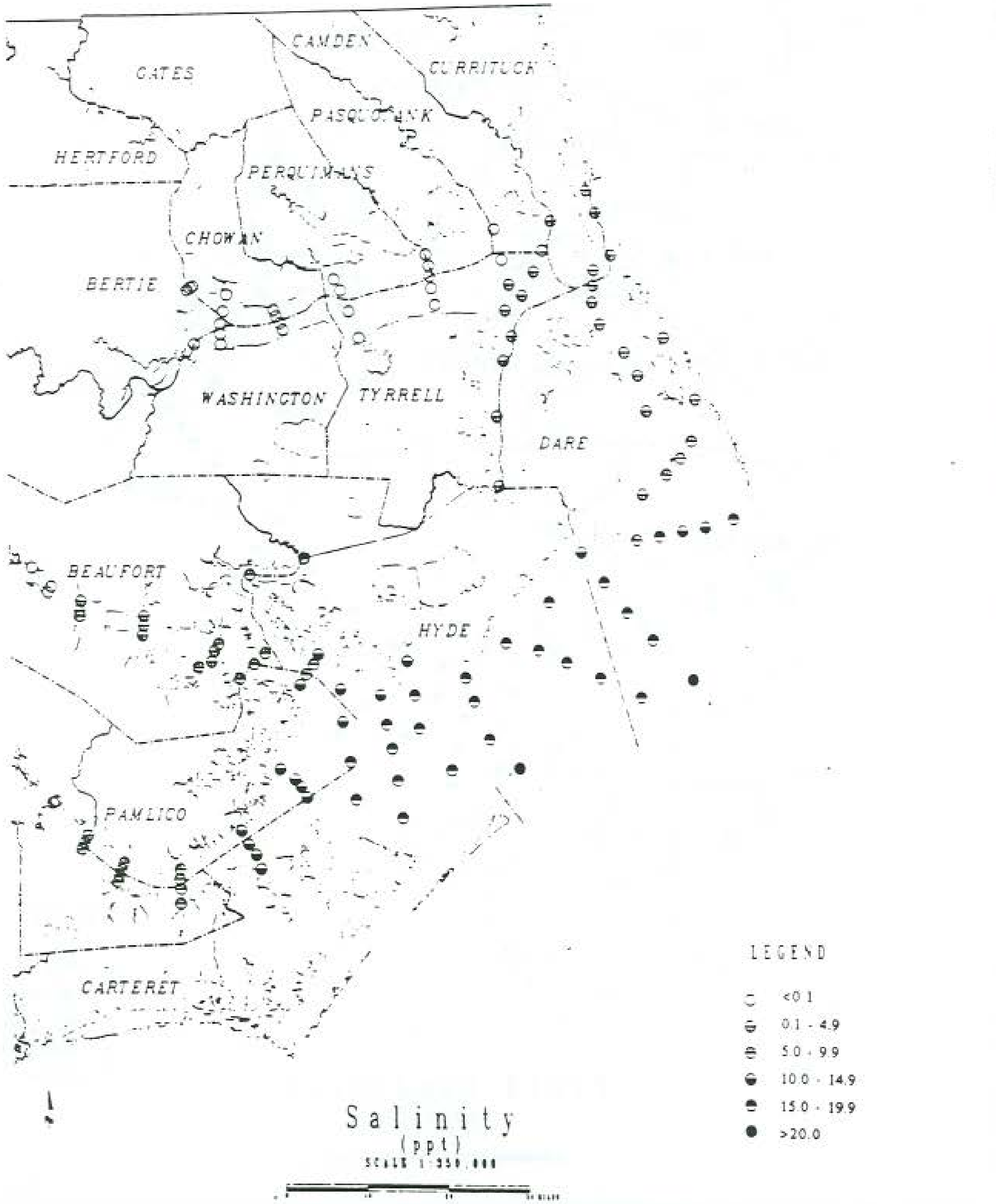


NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989

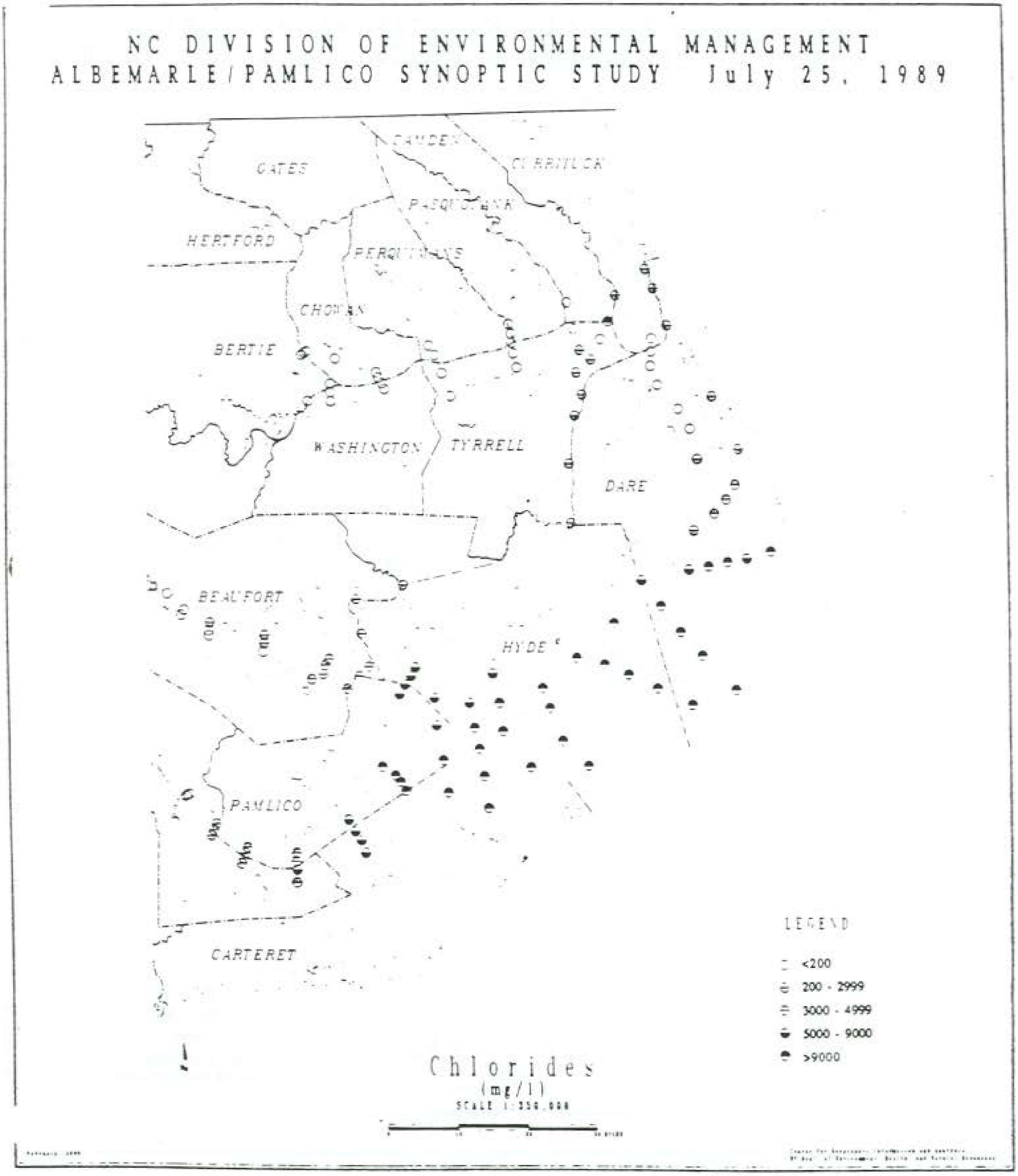


Field Conductance
(μMhos/cm)

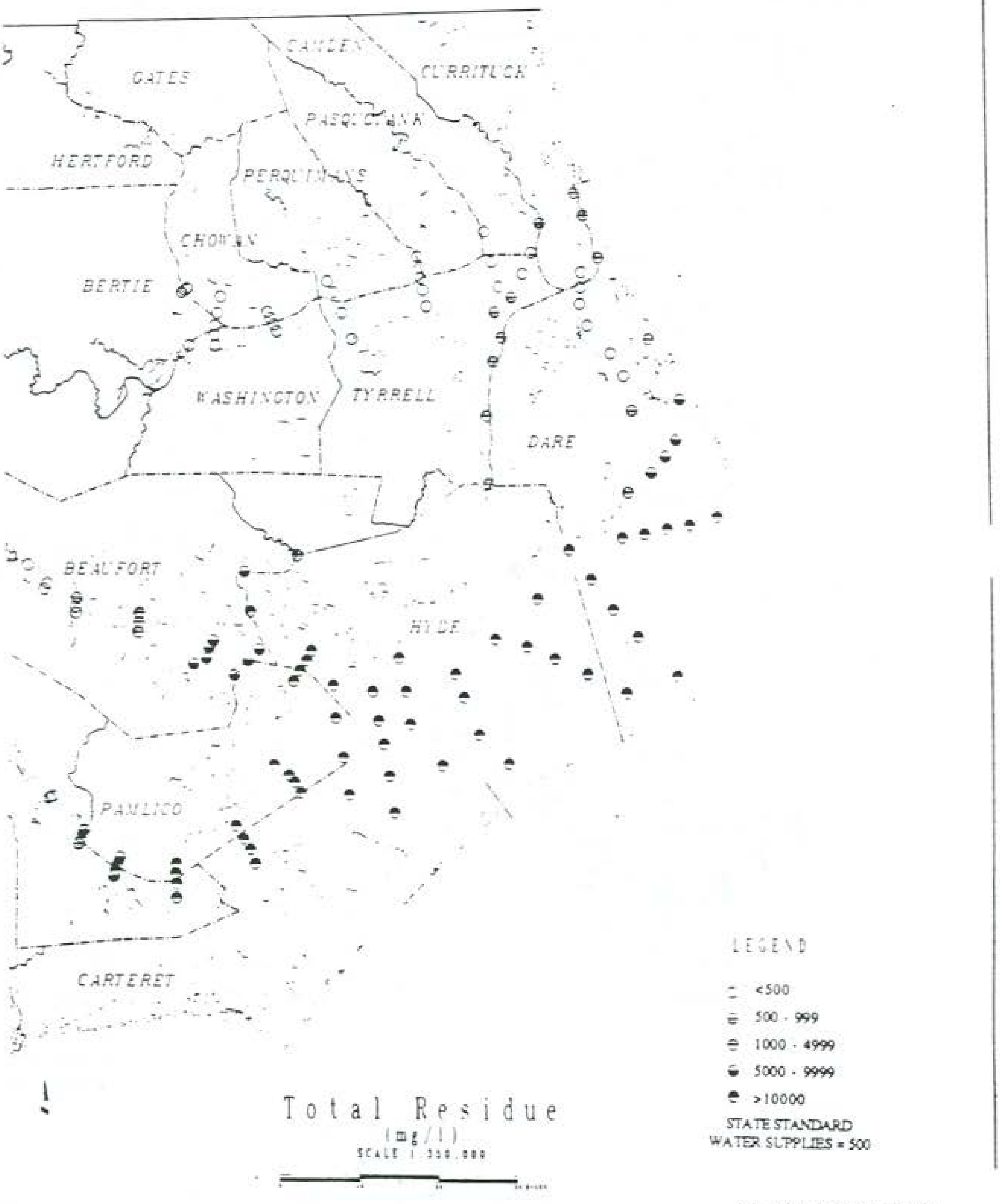
NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989



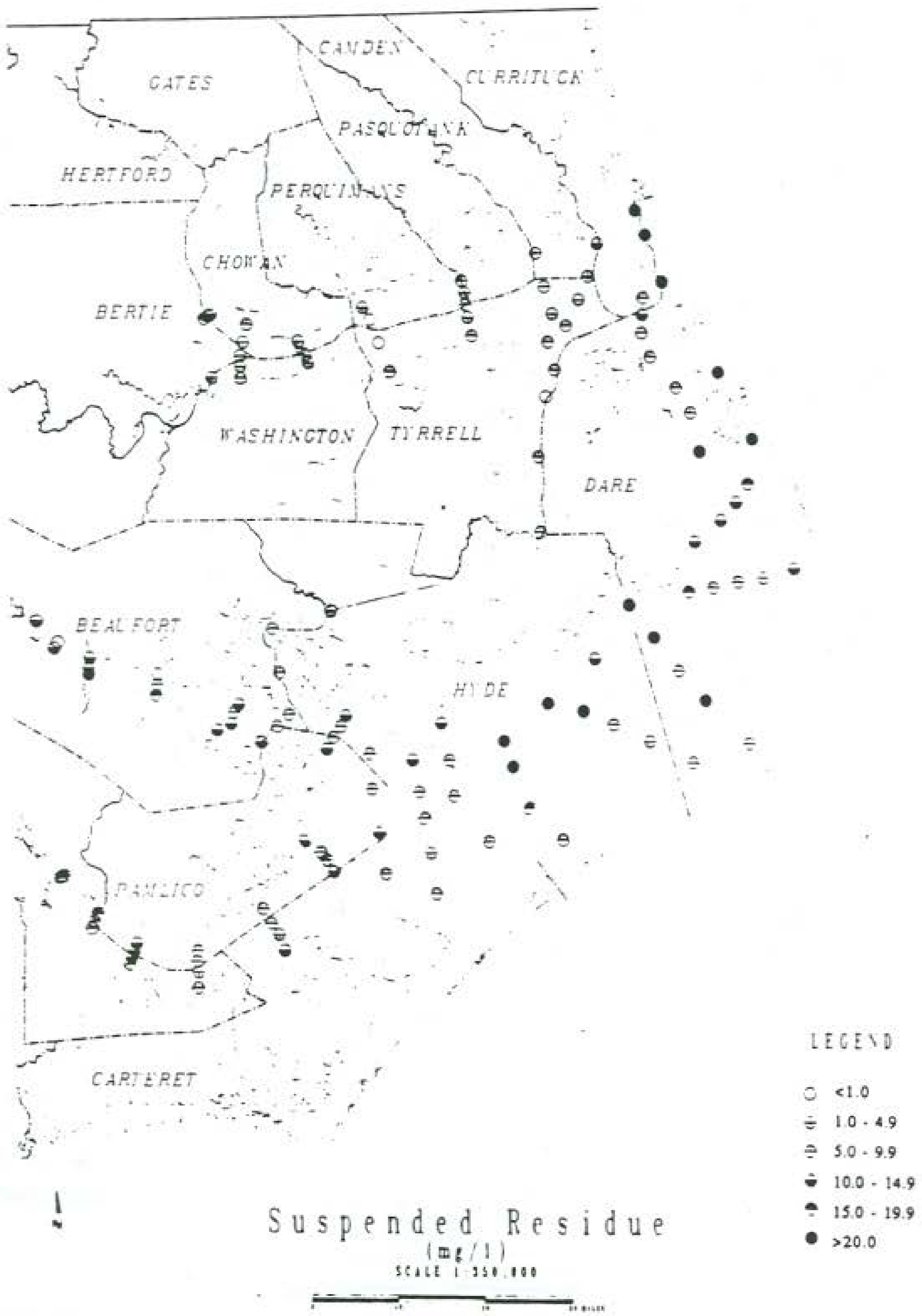
Salinity
(ppt)


NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989
CAMDEN
CURRITUCK
GATES
PASQUOTANK
HERTFORD
PERQUIMANS
CHOWAN
BERTIE
WASHINGTON
TYRRELL
DARE
BEAUFORT
HYDE
PAMLICO
CARTERET
LEGEND
<200
200 - 2999
3000 - 4999
5000 - 9000
>9000
Chlorides
(mg/l)

NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989



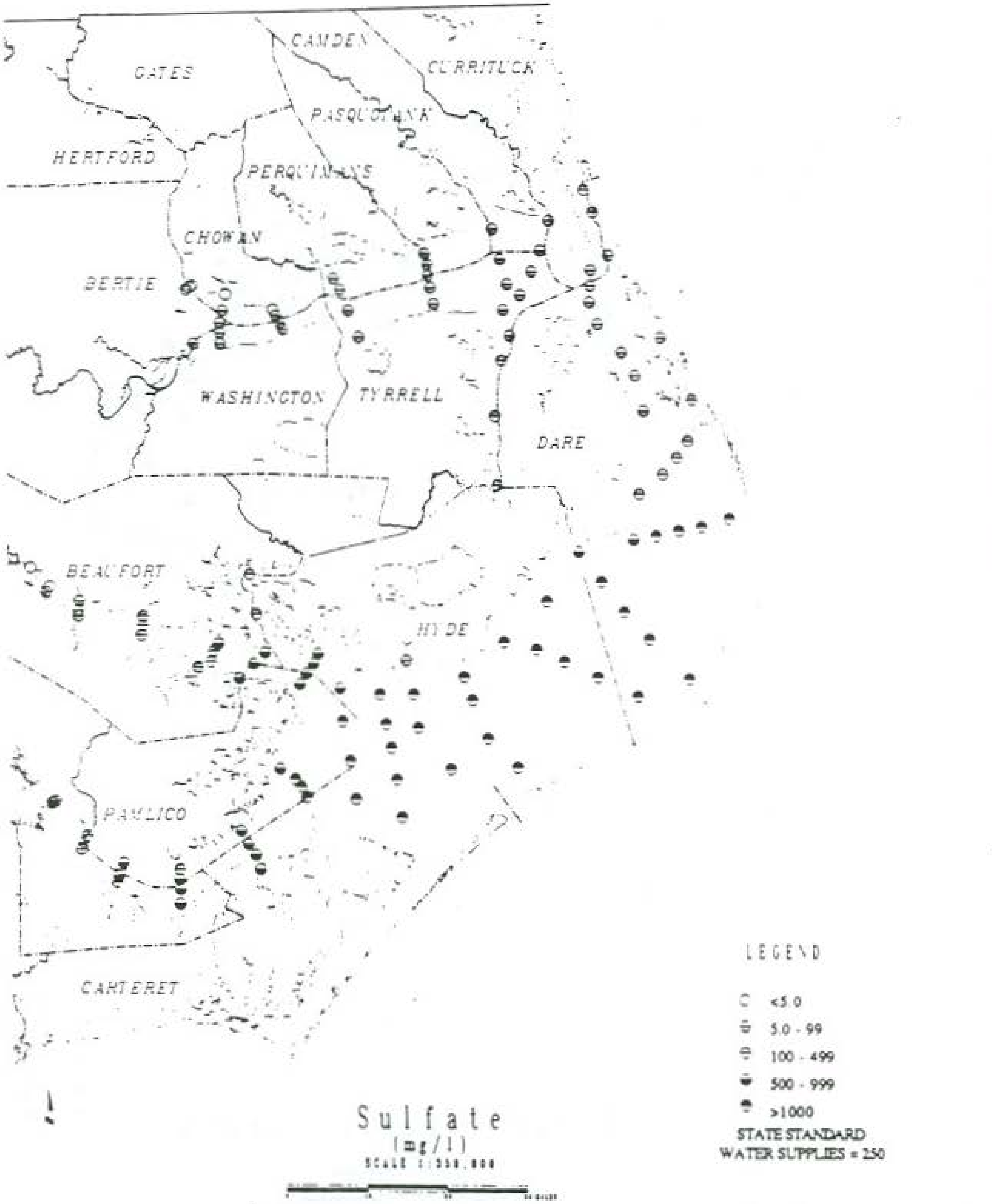
NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989

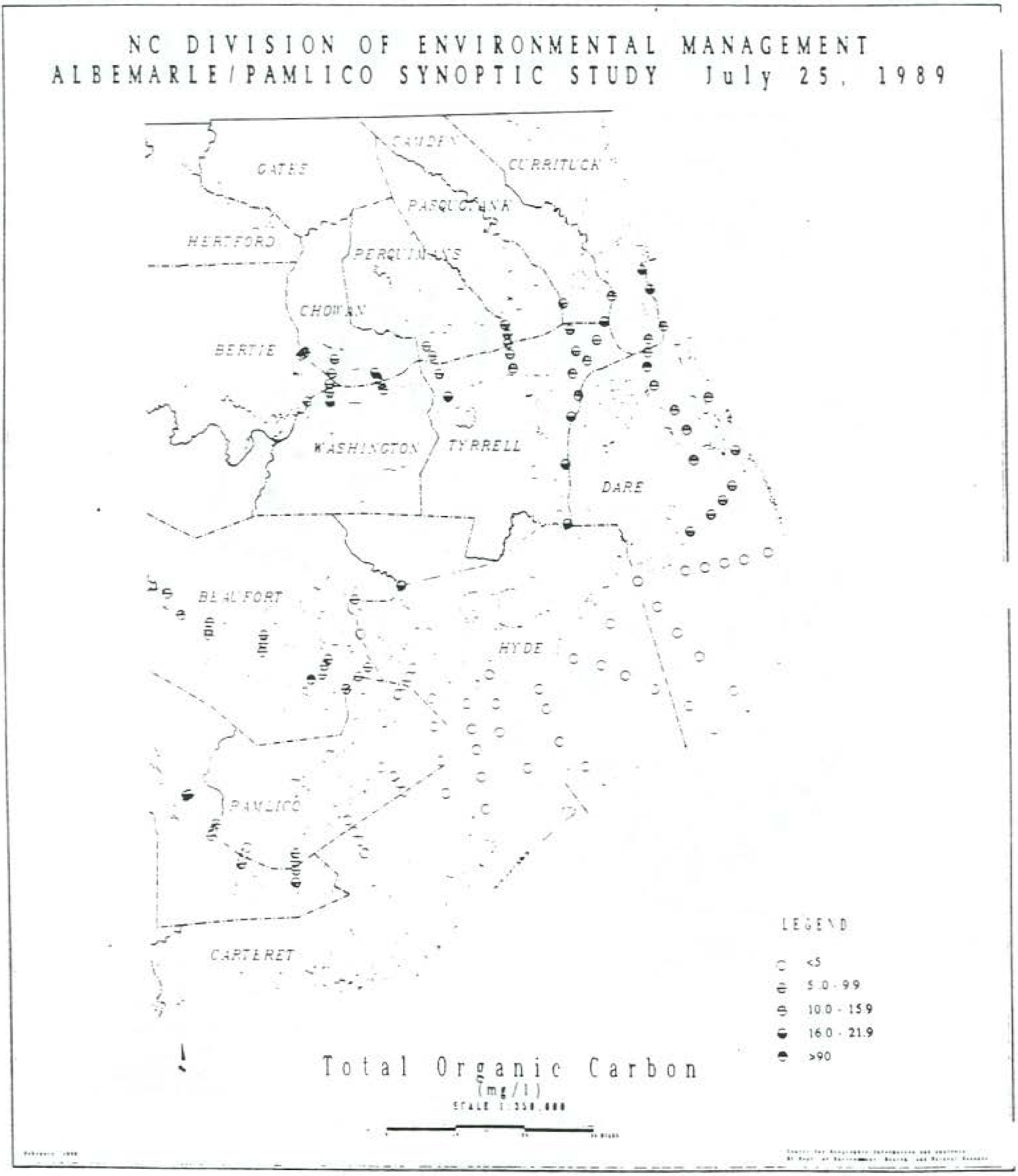


NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989

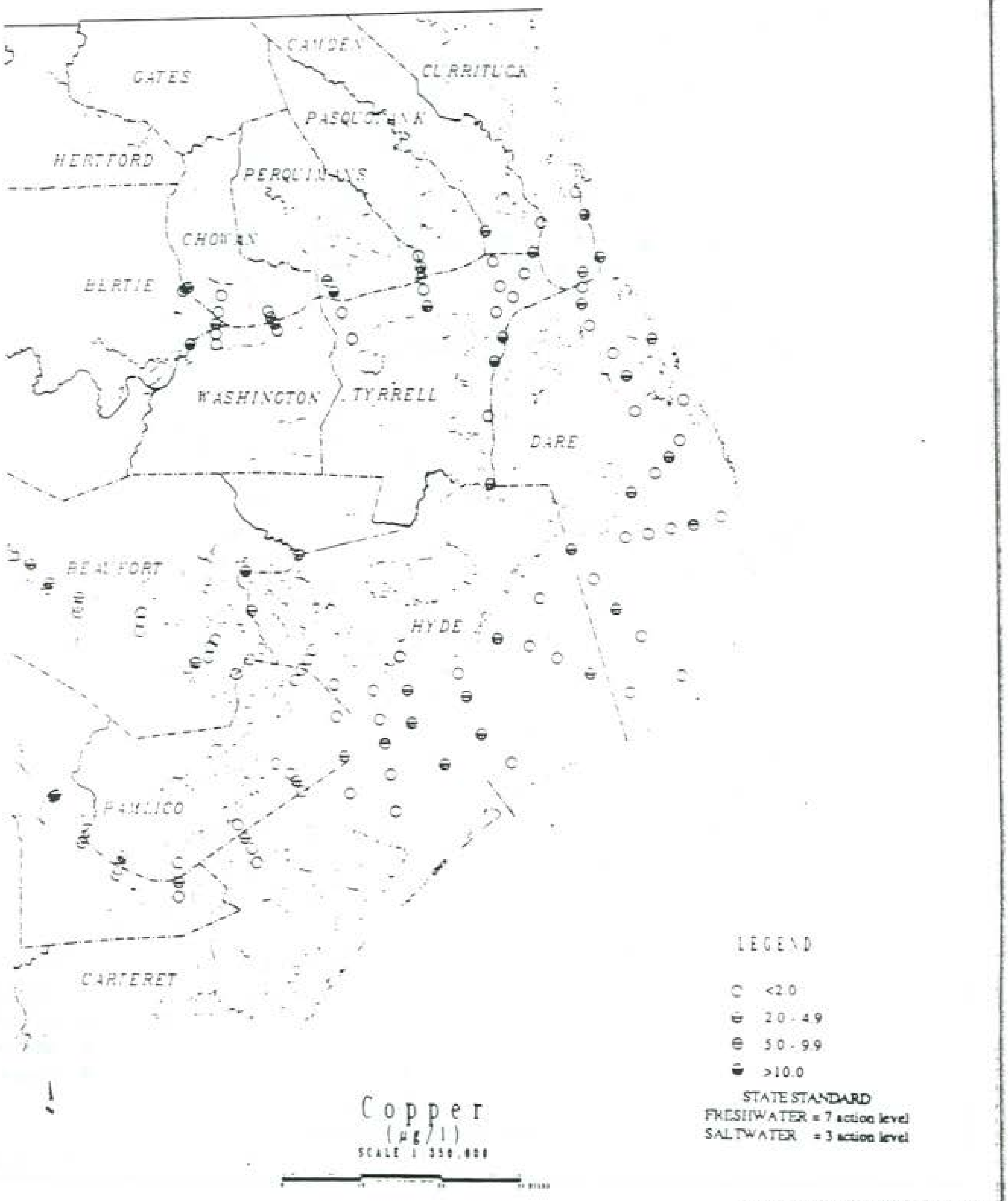
Turbidity
(NTU)

NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989

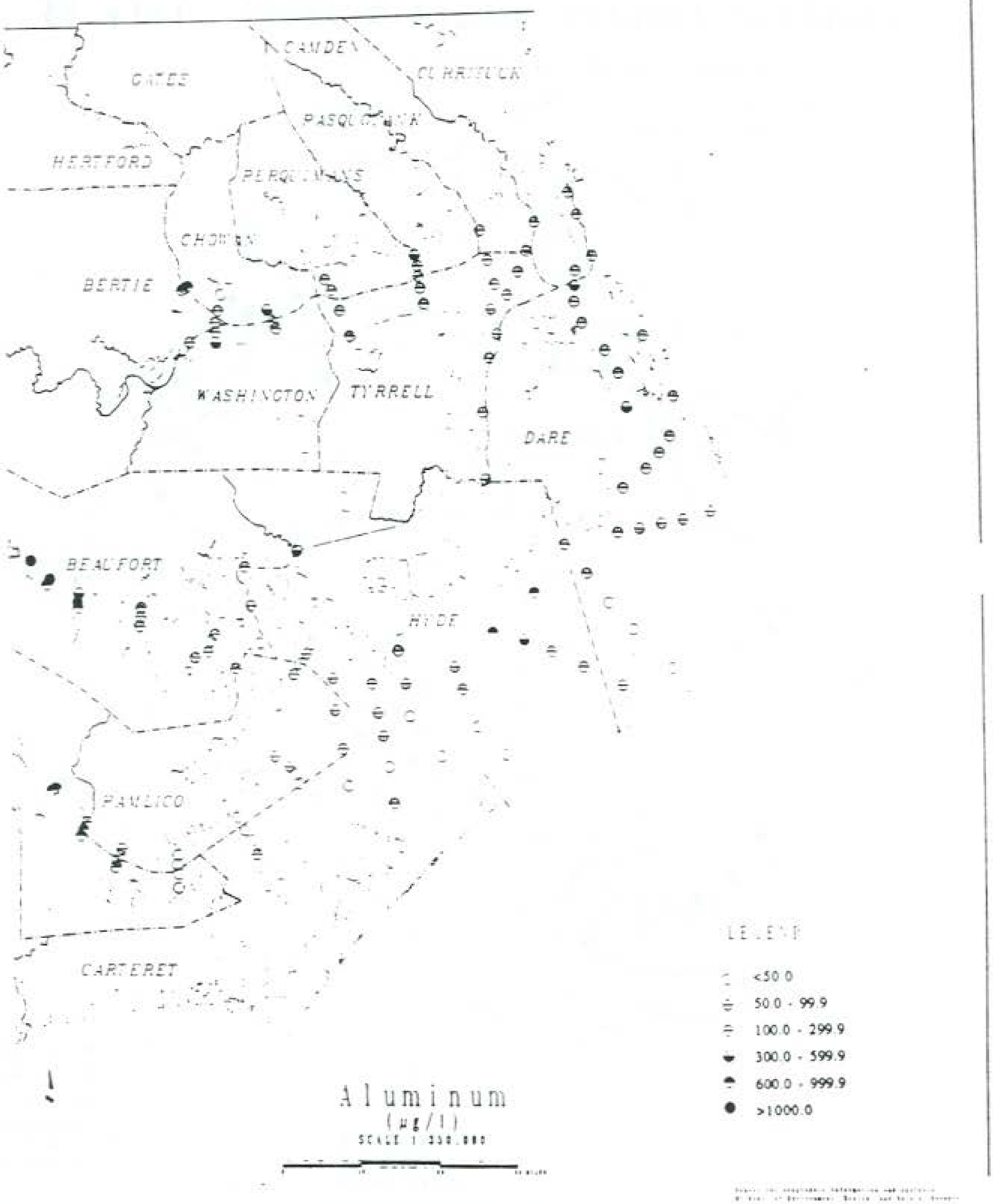



NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989
GATES
CURRITUCK
PASQUOTANK
HERTFORD
PERQUIMANS
CHOWAN
BERTIE
WASHINGTON
TYRRELL
DARE
BEAUFORT
HYDE
PAMLICO
CARTERET
LEGEND
<5
5.0 - 9.9
10.0 - 15.9
16.0 - 21.9
>90
Total Organic Carbon
(mg/l)

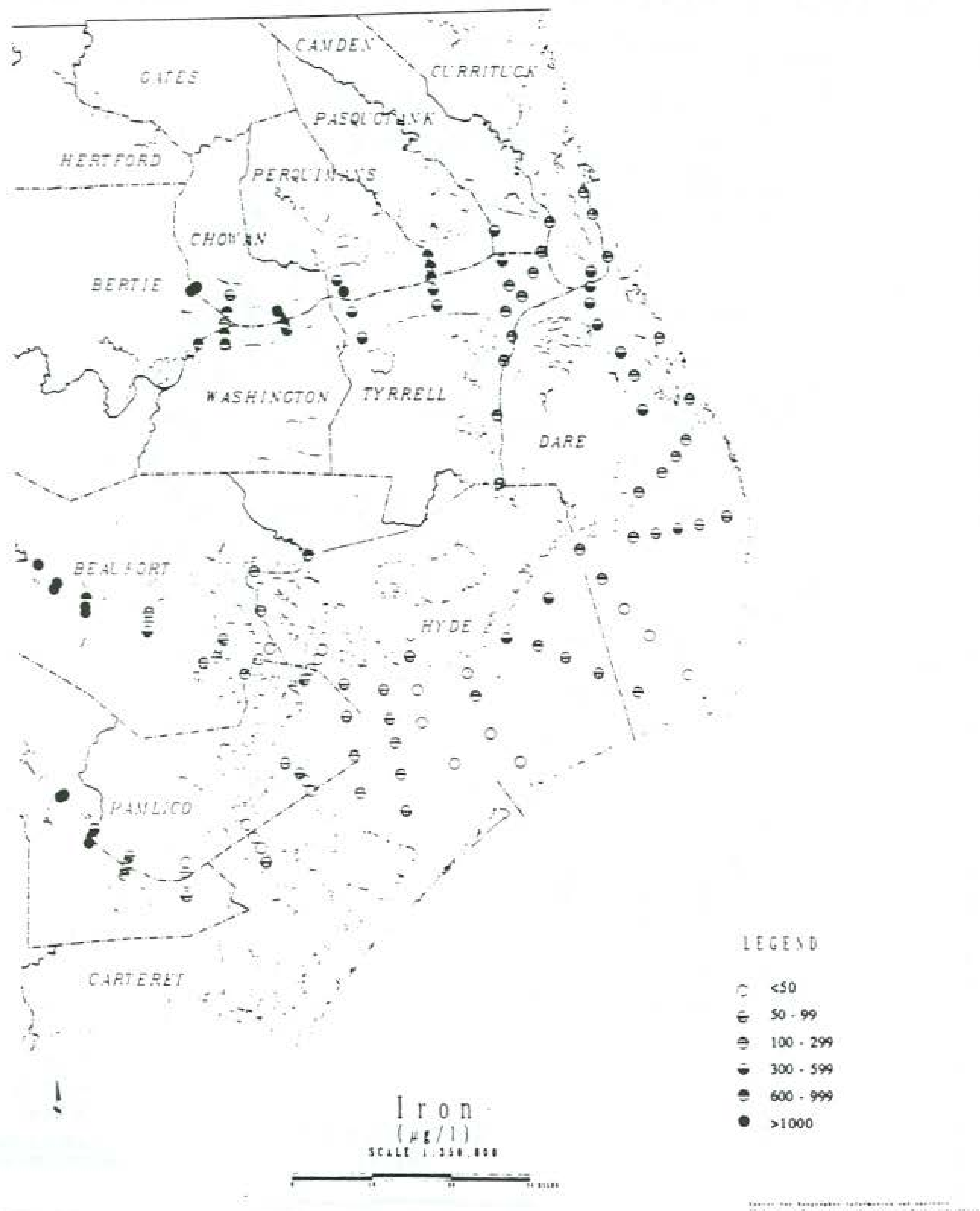
NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989



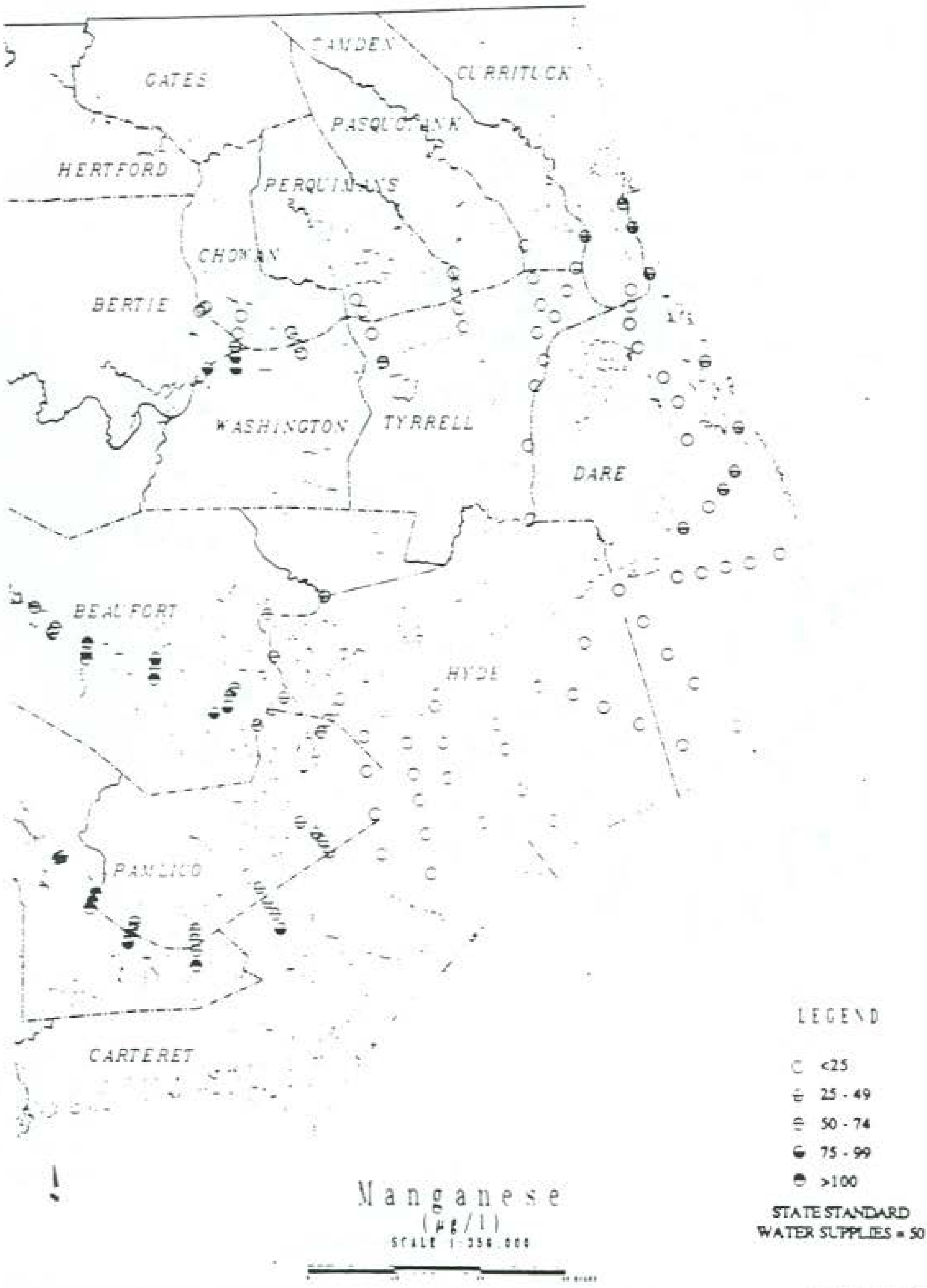
NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989



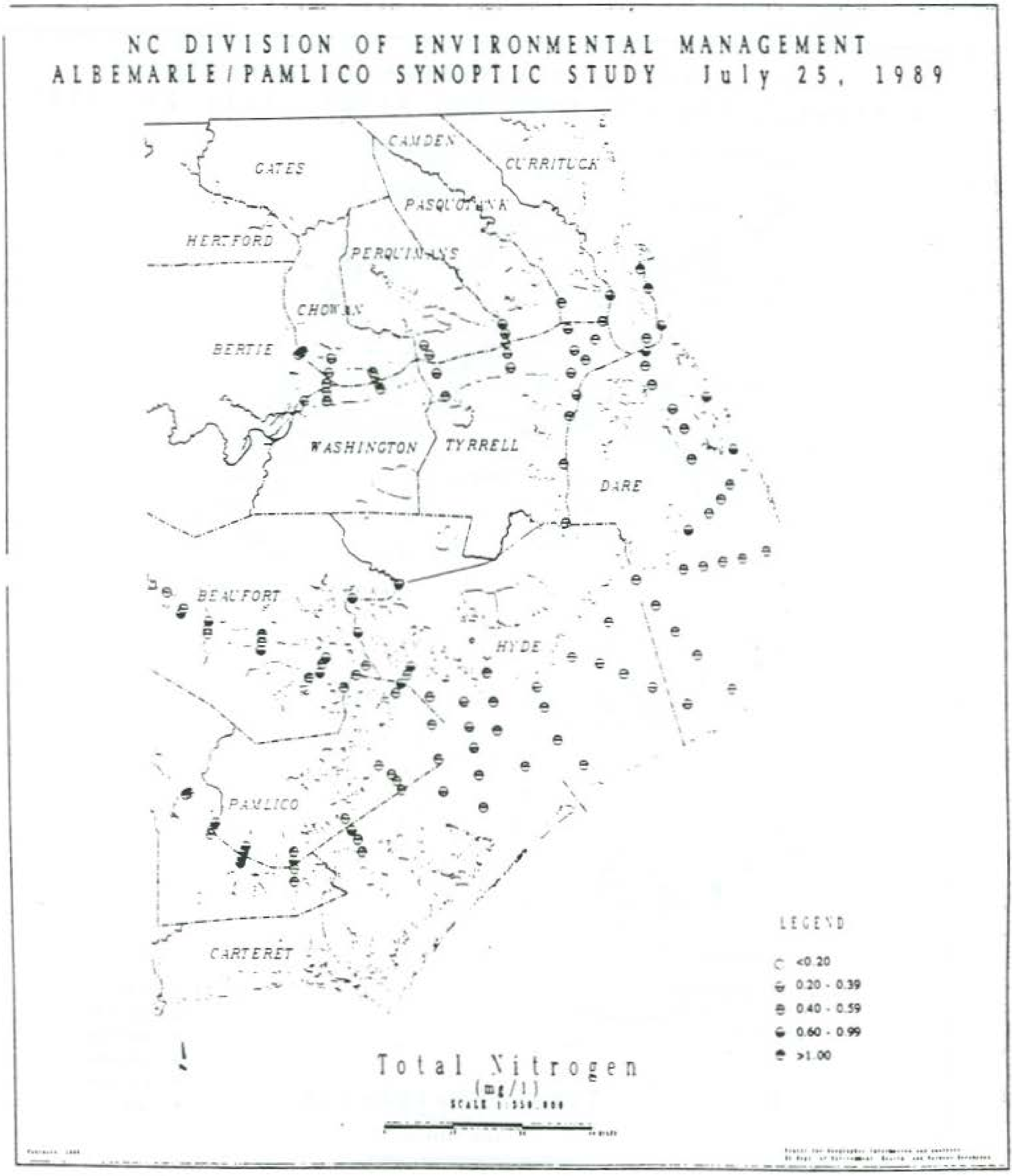
NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989



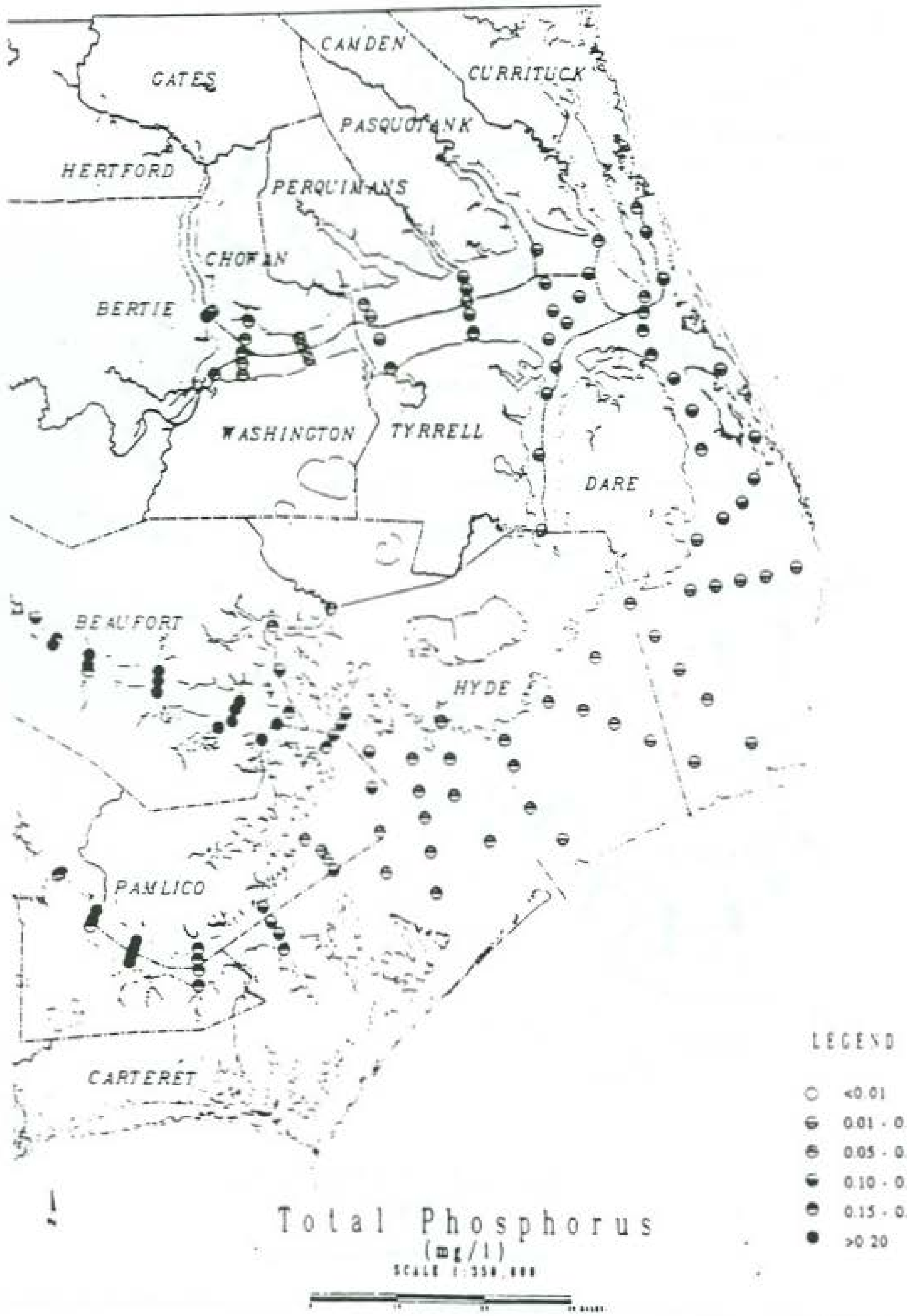
NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989



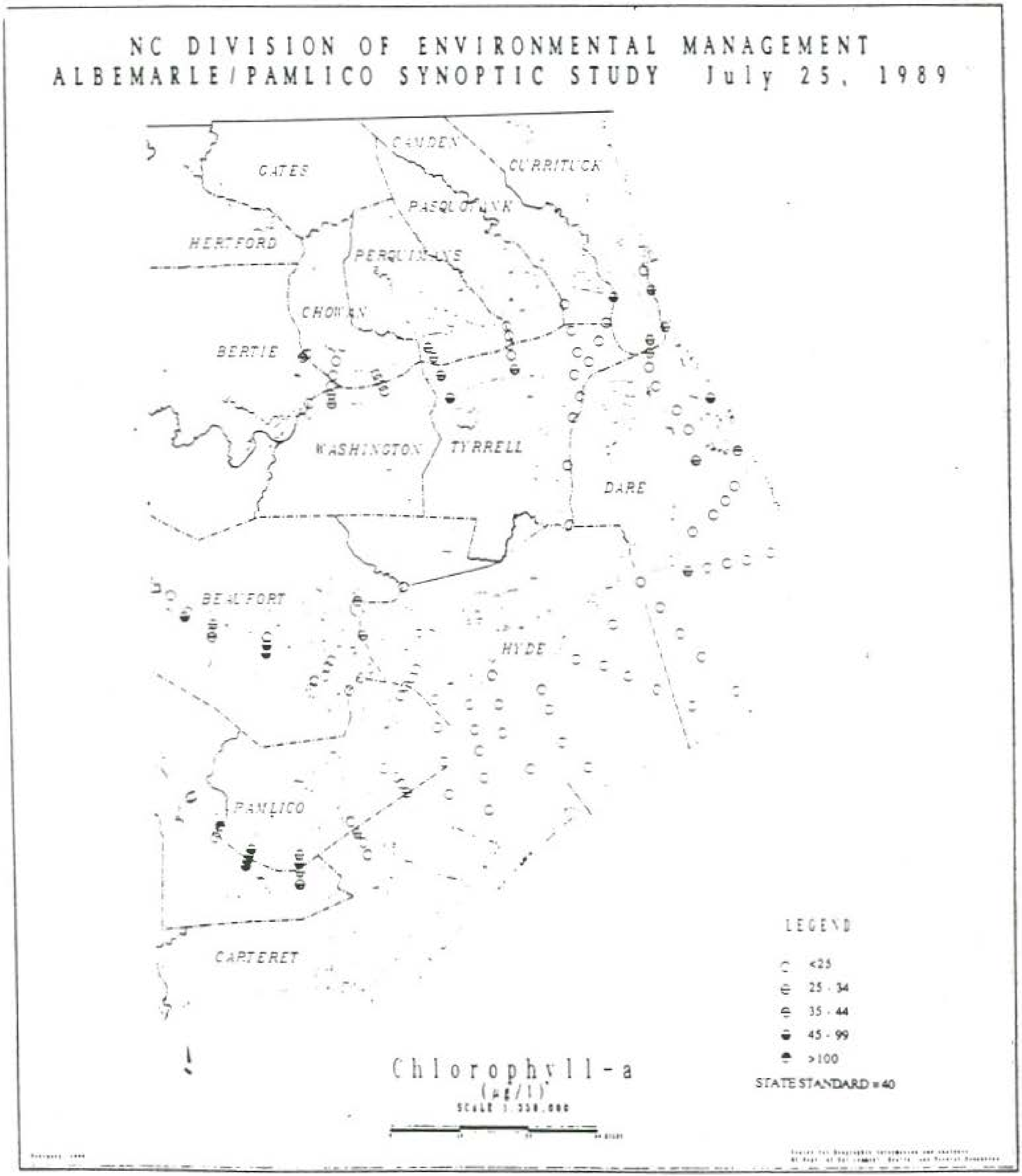
Manganese
(µg/l)
SCALE 1:356,000


NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989
CAMDEN
CURRITUCK
GATES
PASQUOTANK
HERTFORD
PERQUIMANS
CHOWAN
BERTIE
WASHINGTON
TYRRELL
DARE
BEAUFORT
HYDE
PAMLICO
CARTERET
LEGEND
<0.20
0.20 - 0.39
0.40 - 0.59
0.60 - 0.99
>1.00
Total Nitrogen
(mg/l)

NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989



Total Phosphorus
(mg/l)


NC DIVISION OF ENVIRONMENTAL MANAGEMENT
ALBEMARLE/PAMLICO SYNOPTIC STUDY July 25, 1989
CAMDEN
CURRITUCK
GATES
PASQUOTANK
HERTFORD
PERQUIMANS
CHOWAN
BERTIE
WASHINGTON
TYRRELL
DARE
BEAUFORT
HYDE
PAMLICO
CARTERET
LEGEND
<25
25 - 34
35 - 44
45 - 99
>100
STATE STANDARD = 40
Chlorophyll-a
(µg/l)

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989.

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O. (mg/l)	Temp. (C)	pH	Conductance (uMhos/cm)	Salinity (‰)
APES 1	Chowan River at Edenhouse	75%	360235	764215	1315	0.15	8.2	29.8	7.9	69	0
						1	8.0	29.8	8.0	69	0
						2	7.2	28.8	7.7	68	0
APES 2	Chowan River at Edenhouse	50%	360250	764150	1335	0.15	7.9	29.4	7.5	65	0
						1	7.2	28.2	7.6	68	0
						2	6.3	27.6	7.3	65	0
						3	6.1	27.5	7.2	69	0
						4	6.1	27.4	7.1	69	0
						5	5.5	27.2	7.0	69	0
						6	5.0	27.0	6.9	69	0
						7	4.8	26.9	6.8	70	0
APES 3	Chowan River at Edenhouse	25%	360300	764130	1345	0.15	7.7	29.2	7.1	69	0
						1	7.0	28.2	7.3	68	0
						2	6.1	27.6	7.3	69	0
						3	5.3	27.1	7.1	69	0
						4	5.1	27.0	7.0	69	0
						5	4.7	27.0	6.9	69	0
APES 4	Roanoke River at Mouth Marker G "5"	50%	355640	764130	1245	0.15	5.4	28.4	6.8	98	0
						1	4.9	27.9	6.8	97	0
						2	2.9	26.3	6.8	99	0
						2.5	2.8	26.1	6.5	68	0
APES 5	Albemarle Sound from Edenton to Albemarle Beach	90%	355635	763800	1115	0.15	6.4	28.0	6.8	93	0
						1	5.8	27.9	6.7	93	0
						2	5.2	27.6	6.5	95	0
APES 6	Albemarle Sound from Edenton to Albemarle Beach	75%	355745	763800	1130	0.15	6.6	28.3	6.6	93	0
						1	6.0	27.9	6.8	94	0
						2	5.4	27.4	6.7	94	0
						3	5.0	27.1	6.7	94	0
						4	2.5	26.4	6.6	98	0
						5	2.4	26.3	6.6	98	0
APES 7	Albemarle Sound from Edenton to Albemarle Beach	50%	355850	763800	1145	0.15	6.5	27.5	6.9	91	0
						1	5.7	27.0	7.0	91	0
						2	5.3	26.8	6.5	93	0
						3	5.2	26.7	6.8	92	0
						4	5.1	26.6	6.8	92	0
						5	3.4	26.3	6.8	96	0
APES 8	Albemarle Sound frm Edenton to Albemarle Beach Mark "AS"	25%	360010	763735	1200	0.15	6.8	27.4	6.9	84	0
						1	6.3	27.2	7.0	85	0
						2	6.0	27.0	7.0	86	0
						3	5.9	26.9	7.0	86	0
						4	5.8	26.7	6.9	86	0
						5	4.5	26.6	6.8	86	0
						5.2	4.3	26.4	6.8	86	0
APES 9	Edenton Bay at Marker Fl "2"		360200	763705	1215	0.15	7.0	28.8	7.2	78	0
						1	6.9	28.0	7.3	79	0
						2	6.5	27.4	7.3	80	0
						3	6.3	27.3	7.1	79	0
						4	6.3	27.1	7.1	80	0
						5	6.2	27.1	7.1	80	0
APES 10	Albemarle Sound from Sandy Pt to Leonards Pt	80%	355800	762940	1000	0.15	6.6	28.2	7.1	90	0
						1	6.5	28.3	7.1	90	0
						2	6.5	28.3	7.1	90	0
APES 11	Albemarle Sound from Sandy Pt to Leonards Pt	60%	355845	763000	1020	0.15	7.1	28.1	6.9	90	0
						1	7.0	27.9	7.1	90	0
						2	6.8	27.8	7.1	90	0
						3	6.5	27.8	7.1	90	0
						4	6.3	27.7	7.1	90	0
						5	6.5	27.6	7.1	90	0
						6	6.3	27.5	7.1	90	0

	Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989										
Station Number	Location	%	Latitude	Longitude	Time *	Depth (meters)	D.O. (mg/l)	Temp (°C)	pH	Conductance (uMhos/cm)	Salinity (‰)
APES 12	Albemarle Sound from Sandy Pt to Leonards Pt	40%	355930	763030	1035	0.15	7.4	27.7	7.1	88	0
						1	7.3	27.5	7.4	87	0
						2	6.9	27.2	7.3	87	0
						3	6.8	27.1	7.3	87	0
						4	6.8	27.1	7.3	87	0
						5	6.7	27.1	7.3	87	0
						6	6.7	27.1	7.3	86	0
						7	6.6	27.1	7.2	87	0
APES 13	Albemarle Sound from Sandy Pt to Leonards Pt	20%	360010	763050	1050	0.15	7.0	27.9	7.1	86	0
						1	6.9	27.3	7.2	86	0
						2	6.8	27.2	7.2	85	0
						3	6.8	27.1	7.2	85	0
						4	6.7	27.0	7.2	85	0
						5	6.7	27.0	7.3	85	0
						6	6.6	27.0	7.3	85	0
						6.5	6.6	27.0	7.2	85	0
APES 14	Albemarle Sound in Bull Bay at Marker "1"		355655	761935	1256	0.15	9.0	29.0	7.6	230	0
						1	8.0	28.1		211	0
						2	5.4	28.8		175	0
						3	5.3	28.2	7.5	201	0
APES 15	Albemarle Sound from Snug Harbor to Bull Bay	75%	355950	762050	1327	0.15	8.3	29.8	8.0	165	0
						1	8.2	29.0		167	0
						2	7.2	28.3		187	0
						3	7.0	28.1		197	0
						4	7.0	28.1		197	0
						5	7.0	28.0		197	0
						6	7.0	28.0		207	0
						7	4.4	28.0	7.4	207	0
APES 16	Albemarle Sound from Snug Harbor to Bull Bay	50%	360210	762150	1358	0.15	8.8	29.5	8.6	120	0
						1	9.0	29.0		120	0
						2	8.6	28.0		104	0
						3	7.8	28.0		104	0
						4	7.4	28.0		102	0
						5	7.3	27.8		102	0
						6	7.0	27.8		104	0
						7	7.0	27.8	7.6	104	0
APES 17	Albemarle Sound from Snug Harbor to Bull Bay	25%	360325	762240	1449	0.15	8.8	29.0	8.6	143	0
						1	8.8	29.0		147	0
						2	8.8	29.0		147	0
						3	8.8	29.0		138	0
						4	7.8	28.0	8.0	120	0
APES 18	Albemarle Sound from Stevenson Pt to Ship Pt	90%	360020	760920	1213	0.15	7.7	29.5	7.6	437	
						1	7.7	29.4		445	
						1.5	7.6	29.2		447	
APES 19	Albemarle Sound from Stevenson Pt to Ship Pt	75%	360210	760945	1143	0.15	7.6	28.7	7.9	336	0
						1	7.6	28.4		344	0
						2	7.4	28.0		357	0
						3	7.0	28.0		359	0
						4	6.9	28.0		367	0
						5	6.8	28.0		381	0
						6	6.8	28.0	7.5	385	0
APES 20	Albemarle Sound from Stevenson Pt to Ship Pt	50%	360330	761000	1114	0.15	7.6	28.3	8.0	262	0
						1	7.6	28.3		262	0
						2	7.4	28.1		263	0
						3	7.2	28.0		271	0
						4	7.2	28.0		271	0
						5	7.0	28.0		271	0
						6	6.8	27.9		276	0
						6.5	2.4	27.1	7.5	479	0

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O. (mg/l)	Temp (°C)	pH	Conductance (uMhos/cm)	Salinity (‰)
APES 21	Albemarle Sound from Stevenson Pt to Ship Pt	25%	360440	761000	1045	0.15	7.4	28.0	7.7	216	0
						1	7.4	28.0		224	0
						2	7.2	28.0		223	0
						3	7.0	27.9		220	0
						4	6.9	27.9		224	0
						5	6.8	27.9		225	0
						6	6.6	27.9	7.6	228	0
APES 22	Albemarle Sound from Stevenson Pt to Ship Pt at "1" PA	10%	360555	761020	1004	0.15	7.5	28.2	8.1	232	0
						1	7.5	28.2		232	0
						2	7.5	28.1		233	0
						3	7.3	28.0		233	0
						4	7.2	28.0	8.0	233	0
APES 23	Alligator River at Marker "37"		354022	760150	1100	0.15	7.0	27.8	7.2	4720	3
						1	7.0	27.8		4720	3
						2	6.9	27.8		4720	3
						3	6.6	27.8		4106	2.5
APES 24	Alligator River at Marker "22"		354805	760330	1030	0.15	7.0	27.8	7.3	3960	2.5
						1	7.0	27.8		4010	2.5
						2	7.0	27.8		3961	2.5
						3	7.0	27.8		3980	2.5
						4	6.5	27.5		3940	2.5
APES 25	Alligator River at US - 64	50%	355400	760035	1000	0.15	7.5	28.0	7.4	3760	2.2
						1	7.3	28.0		3810	2.2
						2	6.4	27.8		3780	2.2
						3	6.3	27.5		3990	2.2
APES 26	Alligator River at Marker G "7" PA		355640	755920	1440	0.15	8.2	28.0	8.2	1740	1
						1	8.2	28.0		1740	1
						2	8.1	27.5		1900	1
						3	7.4	27.0		2540	1.5
						4	7.0	27.0		2690	2
APES 27	Albemarle Sound from Wade Pt to Alligator River	90%	355806	755828	1000	0.15	7.8	27.5	7.8	1090	1.5
						1	7.8	27.5		1090	1.5
						2	7.7	27.5		1090	1
						3	7.6	27.0		1150	1
						4	6.4	27.0		1820	1
						4.5	6.1	27.0		2590	2
APES 28	Albemarle Sound from Wade Pt to Alligator River	75%	360220	755925	1045	0.15	7.5	27.0	7.6	864	0.5
						1	7.5	27.0		864	0.5
						2	7.5	27.0		864	0.5
						3	7.4	27.0		864	0.5
						4	7.2	27.0		864	0.5
						5	7.2	27.0		864	0.5
						5.5	6.7	27.0		912	0.5
APES 29	Albemarle Sound from Wade Pt to Alligator River	50%	3600506	760015	1110	0.15	7.0	27.0	7.4	576	0
						1	7.1	27.0		576	0.25
						2	7.0	27.0		576	0.25
						3	7.0	27.0		576	0.25
						4	6.8	27.0		576	0.25
						5	6.5	27.0		576	0.5
						6	5.9	26.5		631	0.5
APES 30	Albemarle Sound from Wade Pt to Alligator River	25%	360830	760108	1145	0.15	7.6	27.0	7.4	312	0
						1	7.6	27.0		307	0
						2	7.4	27.0		307	0
						3	7.2	27.0		302	0
						4	7.0	27.0		302	0
APES 31	Albemarle Sound from Alligator R to North R "S"		360105	755745	1405	0.15	7.8	27.5	8.6	1240	0.5
						1	8.0	27.5		1240	1
						2	7.9	27.5		1240	1

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989.											
Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O. (mg/l)	Temp (°C)	pH	Conductance (uMhos/cm)	Salinity (‰)
						3	7.7	27.5		1240	1
						4	7.2	27.0		1300	1
						5	7.0	26.5		1310	1
						6	6.2	26.5		1310	1
APES 32	Albemarle Sound from Alligator R to North R "AS"		360340	755605	1340	0.15	7.9	27.5	8.3	807	0.5
						1	8.0	27.5		807	0.5
						2	7.8	27.0		816	0.5
						3	7.7	27.0		864	0.5
						4	7.5	27.0		960	0.5
						5	6.5	27.0		1010	0.5
						6	6.2	26.5		1020	0.5
APES 33	Albemarle Sound from Alligator R to North R "N"		360600	755450	1315	0.15	7.6	27.5	7.8	456	0
						1	7.6	27.5		456	0.25
						2	7.5	27.0		461	0.25
						3	7.4	27.0		466	0.25
						4	7.0	27.0		466	0
						5	6.0	27.0		480	0.25
APES 34	Albemarle Sound from Alligator R to North R GR "171" PA		360915	755330	1245	0.15	8.4	27.5	9.4	1140	0.5
						1	8.5	27.5		1140	0.5
						2	8.3	27.5		1090	0.5
APES 35	Currituck Sound at NC-158		360515	754545	1120	0.15	7.8	28.0	9.2	2770	2
						1	7.7	28.0		2770	2
						2	7.8	28.0		2770	2
APES 36	Currituck Sound off Thorofare Island		361000	754735	1050	0.15	7.7	28.0	9.3	2870	2
						1	7.7	28.0		2870	2
APES 37	Currituck Sound off Dew Island		361230	754840	1020	0.15	7.4	28.5	8.5	3910	3
						1	7.4	28.5		3950	3
APES 38	Albemarle Sound from Point Harbor to Caroon Pt R"2" PA		355745	754735	1000	0.15	7.2	27.8		660	0.8
						1	7.2	27.8		708	0.8
						2	7.2	27.8		708	0.8
						3	7.2	27.5		712	0.8
APES 39	Albemarle Sound from Point Harbor to Caroon Pt "MG"		360010	754830	1025	0.15	7.2	27.9		518	0.4
						1	7.2	27.6		521	0.4
						2	7.2	27.5		522	0.4
						3	7.0	27.5		522	0.4
						4	6.7	27.5		522	0.4
						4.5	6.7	27.5		522	0.4
APES 40	Albemarle Sound from Point Harbor to Caroon Pt	50%	360200	754820	1055	0.15	7.1	27.8		585	0.7
						1	7.2	27.8		585	0.7
						2	7.1	27.5		589	0.7
						3	7.0	27.5		589	0.7
						4	6.8	27.5		589	0.7
APES 41	Albemarle Sound from Point Harbor to Caroon Pt	25%	360340	754810	1120	0.15	7.3	27.5		570	0.6
						1	7.3	27.5		570	0.6
						2	7.2	27.5		570	0.6
APES 42	Croatan Sound at Marker RM		354805	754200	1135	0.15	7.6	28.6	8.6	1110	0.5
						1	7.5	28.5		1120	0.5
						2	7.3	28.5		1140	0.5
						3	7.2	28.5		1210	0.6
						4	0.9	27.2		10040	5.8
APES 43	Croatan Sound at Marker 4M "8" PA		355200	754255	1100	0.15	7.6	28.0	8.4	451	0.1
						1	7.6	28.0		470	0.2
						2	7.4	28.0		564	0.2
						3	7.2	28.0		677	0.2
APES 44	Croatan Sound at Marker 3M "4" PA		355435	754435	1035	0.15	7.5	31.0	8.3	528	0.1
						1	7.5	28.1		563	0.2

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O. (mg/l)	Temp. (°C)	pH	Conductance (uMhos/cm)	Salinity (%)
						2	7.5	28.0		564	0.2
						3	7.4	28.0		564	0.2
						4	7.2	28.0		564	0.2
						5	7.2	28.0		564	0.2
APES 45	Roanoke Sound at Marker G "9"		354910	753535	1205	0.15	7.1	28.8	8.6	6650	4
						1	7.0	28.7		7220	4.2
						2	4.6	28.2		7680	4.8
APES 46	Roanoke Sound at Marker G "33" PA		355600	753920	1000	0.15	7.5	28.2	9.2	2900	1.5
						1	7.4	28.1		2910	1.5
						2	6.8	28.0		3480	2
APES 47	Pamlico Sound from Sandy Pt to Oregon Inlet		353900	754300	1005	0.15	7.4	28.0	5.4	5640	3
	-Marker FIR 5M "2"					1	7.4	28.0		5640	3
						2	7.5	28.5		10230	6
						3	7.6	28.5		10230	6
						3.5	7.6	28.5		10230	6
APES 48	Pamlico Sound from Sandy Pt to Oregon Inlet	25%	354105	753945	1103	0.15	7.2	28.0	6.2	12220	7
						1	7.3	28.0		12220	7
						2	7.2	28.0		12220	7
						3	7.0	27.0		17280	9
APES 49	Pamlico Sound from Sandy Pt to Oregon Inlet		354250	753750	1130	0.15	7.2	28.0	6.1	12220	7
	- FIR 3M "24OH"					1	7.2	28.0		12220	7
						2	7.2	27.5		13300	8
						3	7.0	27.0		18240	14
APES 50	Pamlico Sound from Sandy Pt to Oregon Inlet		354440	753620	1200	0.15	7.2	28.0	6.0	11280	7
	- R 4M14 "PA"					1	7.2	28.0		11280	7
						2	7.2	28.0		11750	7
						3	7.0	27.0		12480	7.5
						4	6.8	27.0		17280	12
APES 51	Pamlico Sound from Long Shoal Pt to Rodanthe	90%	353400	754400	1247	0.15	8.0	27.0	8.8	10560	6
	7 MLS					1	8.0	28.0		7520	4
APES 52	Pamlico Sound from Long Shoal Pt to Rodanthe	75%	353420	754100	1211	0.15	7.0	27.0	8.4	24000	15
						1	7.0	27.0		24000	15
						2	6.5	27.0		24000	15
						3	6.1	27.0		24960	15
APES 53	Pamlico Sound from Long Shoal Pt to Rodanthe	50%	353450	753800	1140	0.15	7.0	27.0	8.4	22080	14
						1	7.0	27.0		23040	14
						2	6.5	27.0		27840	17
						3	4.6	27.0		27840	17
APES 54	Pamlico Sound from Long Shoal Pt to Rodanthe	25%	353510	753500	1111	0.15	7.0	27.0	8.4	21120	13
						1	6.8	27.0		23040	17
						2	5.5	27.0		27840	17
						3	4.4	26.0		28420	17
APES 55	Pamlico Sound from Long Shoal Pt to Rodanthe	10%	353600	753115	1021	0.15	6.5	27.0	8.5	27840	17
	- 4MICC					0.75	6.2	27.0		27840	17
						1.5	5.5	27.0		29760	19
APES 56	Pamlico Sound from Pingleton Pt to Hatteras	90%	351830	753730	1200	0.15	6.9	28.5	7.0	30690	20
	- 5M "1"					1	6.9	28.5		30690	20
						2	6.9	28.5		30690	20
						3	6.9	28.5		27900	19.5
APES 57	Pamlico Sound from Pingleton Pt to Hatteras	75%	352300	754230	1130	0.15	7.0	28.4	7.6	28010	18
						1	7.0	28.5		27950	18
						2	7.0	28.5		28830	18
						3	7.0	28.0		29140	18
						4	7.0	28.5		28830	18
						5	6.5	28.5		28830	18.5
						6	6.2	28.5		22370	16.5

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O. (mg/l)	Temp (°C)	pH	Conductance (uMhos/cm)	Salinity (‰)
APES 58	Pamlico Sound from Pingleton Pt to Hatteras	50%	352605	754540	1100	0.15	7.0	28.0	7.6	27310	17
						1	7.0	28.0		27310	18
						2	7.0	28.0		27310	18
						3	6.6	28.0		27310	18
						4	7.0	28.0		28200	18
						5	5.4	28.0		28200	18.5
						6	3.8	28.0		28200	18.5
						7	3.9	28.0		28200	18
APES 59	Pamlico Sound from Pingleton Pt to Hatteras	25%	352930	754830	1030	0.15	7.5	28.0	7.2	25380	17
						1	7.0	28.0		25390	17
						2	7.0	28.0		25380	17
						3	7.0	28.0		25380	17
						4	7.0	28.0		25400	17
						5	6.3	28.0		26320	17
						6	5.7	28.0		24490	16
APES 60	Pamlico Sound from Pingleton Pt to Hatteras	10%	353250	755120	1000	0.15	8.0	26.0	7.4	17640	11
	- FL 4M					1	7.5	28.0		19740	13
						2	7.4	28.0		22560	14
						3	5.6	28.0		21620	15
						4	5.0	28.0		24440	16
						5	5.0	28.0		24440	16
APES 61	Pamlico Sound off Englehard at Marker Fl. 4M		352730	755550	1000	0.15	6.1	28.0	7.9	26900	16.3
						1	6.2	28.0	7.9	26900	16.3
						2	6.2	28.0	7.9	26900	16.3
						3	6.0	28.0	7.9	26900	16.4
						4	6.1	28.0	7.9	26800	16.3
						5	6.0	27.9	7.9	26900	16.3
APES 62	Pamlico Sound from Wysocking Bay to Hatteras	90%	351645	754420	1112	0.15	6.2	28.1	8.1	31400	19.3
	- FL 7M "1"					1	6.2	28.1	8.1	31200	19.3
						2	6.2	28.1	8.1	31300	19.4
						3	6.2	28.1	8.1	31300	19.4
						4	6.3	28.1	8.1	31300	19.4
APES 63	Pamlico Sound from Wysocking Bay to Hatteras	75%	351900	754930	1157	0.15	6.6	28.0	8.2	29100	17.9
						1	6.6	28.1	8.2	29100	17.8
						2	6.7	28.0	8.2	29100	17.9
						3	6.5	28.0	8.2	29100	17.9
						4	6.5	28.0	8.2	29200	17.9
						5	6.3	27.9	8.2	29400	18.2
						6	5.2	27.9	8.1	30000	18.8
						7	2.4	27.8	8.0	34300	22.4
APES 64	Pamlico Sound from Wysocking Bay to Hatteras	50%	352050	755350	1226	0.15	6.7	28.2	8.2	29200	17.9
						1	6.7	28.2	8.2	29200	17.9
						2	6.6	28.2	8.2	29200	18
						3	6.7	28.1	8.2	29200	18
						4	6.6	28.1	8.2	29200	18
						5	6.5	28.1	8.1	29200	18
						6	1.1	27.3	7.4	29200	18
APES 65	Pamlico Sound from Wysocking Bay to Hatteras	25%	352215	755730	1253	0.15	6.6	28.2	8.2	27600	16.9
	- FL 7M					1	6.6	28.2	8.1	27600	16.9
						2	6.6	28.1	8.1	27700	16.8
						3	6.6	28.1	8.1	27600	16.9
APES 66	Pamlico Sound from Wysocking Bay to Hatteras	10%	352310	760145	1320	0.15	6.5	28.3	8.1	26800	16.3
	- G "5"					1	6.5	28.3	8.1	26800	16.2
						2	6.4	28.3	8.1	26800	16.3
						3	6.3	28.3	8.1	26800	16.2
APES 67	Pamlico Sound from Bluff Pt to Ocracoke	90%	350920	760035	1145	0.15	6.3	27.7	7.8	32900	20.5
	- FLR "14"					1	6.6	27.7	7.8	33000	20.5
						2	6.0	27.7	7.9	33100	20.6
						3	6.0	27.7	7.9	30000	20.6

	Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989										
Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O. (mg/l)	Temp (°C)	pH	Conductance (uMhos/cm)	Salinity (‰)
						4	6.0	27.7	7.9	33000	20.6
APES 68	Pamlico Sound from Bluff Pt to Ocracoke-Marker BL	70%	351235	760425	1210	0.15	6.4	27.7	7.8	32000	19.8
						1	6.1	27.7	7.8	32100	19.8
						2	6.0	27.7	7.9	32100	20
						3	6.0	27.7	7.9	32200	20
APES 69	Pamlico Sound from Bluff Pt to Ocracoke- FL 4M	30%	351650	760615	1240	0.15	6.4	27.9	7.7	29800	18.4
						1	6.2	27.9	7.8	29800	18.4
						2	5.8	27.8	7.8	30000	18.5
						3	5.4	27.7	7.8	30600	19
APES 70	Pamlico Sound from Bluff Pt to Ocracoke- FL 4M	10%	351925	760715	1255	0.15	6.9	28.1	7.8	27400	16.7
						1	6.7	28.1	7.9	27400	16.7
						2	6.5	28.1	7.9	27400	16.7
						3	6.5	28.1	7.9	27400	16.7
						3.5	6.5	28.1	7.9	27500	16.8
APES 71	Pamlico Sound frm Juniper Bay to Portsmouth I.		350920	760930	1105	0.15	6.4	27.7	7.8	31900	19.9
	- FL G 5M "5"					1	6.1	27.6	7.8	32200	19.9
						2	6.0	27.7	7.9	32100	19.9
						3	5.7	27.5	7.9	32200	20
						4	5.6	27.5	7.9	32300	20
						5	5.5	27.4	7.9	32300	20.1
						5.5	5.0	27.4	7.8	32400	20
APES 72	Pamlico Sound frm Juniper Bay to Portsmouth I.		351400	761335	1035	0.15	6.5	27.6	7.8	29100	17.9
	- FL 2 6M "LM"					1	6.2	27.6	7.8	29200	18
						2	6.2	27.6	7.8	29300	17.9
						3	5.9	27.6	7.8	29300	18
						3.5	5.6	27.5	7.8	29400	18
APES 73	Pamlico Sound frm Juniper Bay to Portsmouth I.		351740	761400	1010	0.15	6.3	27.4	7.7	27400	16.7
	- FL G 5M "1"					1	6.3	27.5	7.7	27400	16.7
						2	6.2	27.5	7.7	27500	16.7
APES 74	Pamlico Sound frm Juniper Bay to Portsmouth I.		352125	761450	1000	0.15	6.0	28.1	7.2	22900	13.6
	-G "3" PA					1	5.9	28.2	7.5	22900	13.7
						2	5.8	28.2	7.5	23000	13.8
						3	1.3	27.7	7.0	27500	17
APES 75	Swanquarter to Core Sound	90%	350412	761610	1200	0.15	7.0	27.8	8.0	30300	19.5
						1	7.0	27.8		30400	19.5
						2	7.0	27.8		30400	19.6
						3	7.0	27.8		30400	19.6
						4	6.9	27.8		30400	19.6
						5	6.8	27.7		30460	19.6
						6	6.0	27.6		31380	20
APES 76	Swanquarter to Core Sound - Marker QK FI 5M	75%	350820	761640	1125	0.15	7.5	27.9	8.9	28730	18.5
						1	7.6	27.9		28730	18.5
						2	7.5	27.9		28730	18.5
						3	7.5	27.8		28790	18.5
						4	7.3	27.8		28790	18.5
						5	7.0	27.8		29080	18.6
						6	1.0	27.3		31480	20
APES 77	Swanquarter to Core Sound	50%	351150	761715	1050	0.15	7.2	27.8	8.0	27570	17.7
						1	7.2	27.9		27510	17.8
						2	7.1	27.9		27600	17.8
						3	7.0	27.5		28030	17.9
						4	6.9	27.8		28130	18
						5	6.8	27.6		28440	18.2
APES 78	Swanquarter to Core Sound - Marker 4M "M"	25%	351430	761750	1020	0.15	7.1	27.5	7.9	24700	15.5
						1	7.1	27.7		24600	15.5
						2	7.2	27.6		24840	15.7
						3	6.9	27.7		26020	16.5
						4	3.0	27.5		28410	18

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D O (mg/l)	Temp. (°C)	pH	Conductance (uMhos/cm)	Salinity (%)
APES 79	Swanquarter to Core Sound - Marker FL G "ISQ" PA	10%	351745	761830	1000	0.15	7.0	28.0	8.0	21900	13.9
						1	7.0	28.0		21810	14
						2	7.0	28.0		21900	13.9
						3	6.9	28.0		22090	14
						4	3.8	27.5		23750	14.9
APES 80	Pamlico Sound from Great Island to West Bay	80%	350620	762210	1235	0.15	8.1	28.1	8.1	26450	17
						1	8.1	28.0		26510	17
						2	8.0	28.0		26510	17
						3	7.9	28.0		26790	17.2
						4	7.6	27.9		27320	17.5
						5	7.2	27.9		28080	18
						6	1.2	27.2		31540	21
APES 81	Pamlico Sound frm Great Island to West Bay	50%	351030	762245	1310	0.15	7.3	28.0	7.9	23970	15.2
	- 5M "1"5PA					1	7.2	28.0		24060	15.2
						2	7.1	28.0		24060	15.2
						3	5.3	27.7		25640	16.2
						4	2.6	27.3		27860	17.8
APES 82	Pamlico Sound from Great Island to West Bay	30%	351455	762335	1347	0.15	7.5	28.0	7.9	21430	13.3
						1	7.5	28.0		21530	13.5
						2	7.4	27.9		21570	13.5
						3	7.2	27.5		21950	14
						4	6.3	27.4		23040	14.5
						5	2.1	27.1		27110	17.1
APES 83	Pamlico Sound frm Great Island to West Bay	10%	351830	762345	1440	0.15	7.3	27.9	7.9	19780	12.3
	- FL 4M PA					1	7.3	27.9		19780	12.3
						2	7.2	27.9		19780	12.3
						3	5.3	27.7		21950	14
						4	2.7	27.2		26670	16.1
APES 84	Neuse River frm Maw Pt to Point of Marsh- 7M "NR"	80%	350640	762835	1000	0.15	6.6	27.7	7.1	24800	14.3
						1	6.5	27.7	7.1	23900	14.4
						2	6.5	27.7	7.1	24100	14.5
						3	6.3	27.8	7.1	24200	14.5
						4	4.6	27.9	7.0	24900	14.9
APES 85	Neuse River from Maw Pt to Point of Marsh	60%	350750	762920	1030	0.15	6.3	27.5	7.0	24300	14.8
						1	6.3	27.6	7.0	24300	14.6
						2	6.2	27.6	7.0	24300	14.8
						3	6.1	27.8	7.0	24300	14.9
						4	6.0	27.9	7.1	24500	14.9
APES 86	Neuse River from Maw Pt to Point of Marsh	40%	350840	763005	1050	0.15	6.3	27.5	7.2	24300	14.8
	-Marker 5M					1	6.3	27.6	7.2	24400	14.5
						2	6.2	27.5	7.1	24400	14.9
						3	6.1	27.5	7.2	24300	14.9
						4	6.0	27.7	7.1	24500	14.9
APES 87	Neuse River from Maw Pt to Point of Marsh	20%	350950	763200	1110	0.15	6.0	27.8	7.0	24000	14.4
	- FL G "1"					1	6.0	27.6	7.2	24300	14.4
						2	5.9	27.5	7.1	24300	14.4
APES 88	South River at Mouth - Marker "WR3"		345850	763500	1145	0.15	5.0	28.5	6.9	20100	11.6
						1	5.0	28.5	6.9	20100	11.6
						2	4.9	28.5	6.9	20200	11.7
						3	4.9	28.6	6.9	20300	11.8
						4	4.8	28.6	6.9	20400	11.9
APES 89	Neuse River from Cockle Pt to South River	75%	350025	763535	1230	0.15	5.4	28.0	7.0	19400	11.1
						1	5.3	28.1	7.0	20400	12
						2	5.0	28.2	6.9	20400	12
						3	5.1	28.3	6.9	20400	12
						4	5.0	28.2	7.0	20400	12
APES 90	Neuse River from Cockle Pt to South River	50%	350135	763630	1240	0.15	7.2	28.1	7.2	20400	12

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989.

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O. (mg/l)	Temp (°C)	pH	Conductance (uMhos/cm)	Salinity (%)
						1	7.2	28.1	7.2	20400	12
						2	7.3	28.0	7.2	20400	12
						3	7.1	28.1	7.0	20400	11.9
						4	7.1	28.1	7.0	20400	12
APES 91	Neuse River from Cockle Pt to South River	25%	350305	763725	1300	0.15	7.2	28.2	7.1	20900	12.3
						1	7.2	28.3	7.2	20900	12.3
						2	7.2	28.7	7.1	21000	12.4
						3	7.1	28.7	7.2	21000	12.7
						4	7.1	28.8	7.1	21200	12.8
APES 92	Neuse River from Janeiro to Temple	80%	345515	764535	1330	0.15	7.2	28.6	7.2	13990	7.8
	- Marker FL G "3"					1	7.0	28.5	7.2	14200	7.9
						2	6.7	28.5	7.2	14300	7.9
						3	6.5	28.4	7.2	14400	8
						4	5.1	28.3	7.2	14500	8.1
APES 93	Neuse River from Janeiro to Temple	60%	345650	764530	1345	0.15	7.4	28.5	7.2	14190	7.9
						1	7.4	28.4	7.1	14190	7.9
						2	7.4	28.4	7.2	14190	7.9
						3	7.5	28.5	7.2	14210	8
APES 94	Neuse River from Janeiro to Temple	40%	345755	764537	1355	0.15	7.7	28.8	7.3	13780	7.7
						1	7.6	28.1	7.3	13800	7.7
						2	7.5	28.5	7.4	13790	7.5
						3	7.6	28.5	7.4	13790	7.6
						4	7.6	28.8	7.4	13800	7.6
APES 95	Neuse River from Janeiro to Temple	10%	345900	764530	1415	0.15	8.0	28.4	7.3	14430	8.2
						1	8.0	28.2	7.4	14400	8.1
						2	7.3	28.3	7.3	14300	8
						3	6.5	28.0	7.0	15000	9.1
APES 96	Neuse River from Beard Cr to Slocum Cr.	90%	345745	765342	1200	0.1	7.9	28.4	8.5	10250	6
						1	7.9	28.4		10250	6.2
						2	7.8	28.3		10270	6
						3	6.2	28.1		10790	7
APES 97	Neuse River from Beard Cr to Slocum Cr.	60%	345825	765330	1120	0.15	9.0	28.8	8.6	11180	7
						1	9.1	28.8		11180	7
						2	9.2	28.8		11180	7
						3	6.7	28.6		12530	7.1
						4	1.8	28.1		15480	10
						5	0.1	27.7		18920	12
						6	0.0	27.5		21760	13
						7	0.0	27.5		21760	13
APES 98	Neuse River from Beard Cr to Slocum Cr.	40%	345905	765310	1100	0.15	9.3	28.8	8.7	11090	7.5
						1	8.5	28.6		11600	8
						2	8.7	28.4		13230	9
						3	4.1	28.2		14510	9
						4	1.5	28.2		15910	10
						5	0.0	27.2		21330	13
						6	0.0	27.5		21760	13.2
APES 99	Neuse River from Beard Cr to Slocum Cr.	10%	345950	765250	1015	0.15	7.3	28.6	8.2	12900	8
						1	7.0	28.4		13050	8.5
						2	6.7	28.1		13630	9
						3	4.5	28.2		14040	9.1
						4	1.4	28.2		15910	10
						5	0.0	27.7		19870	13.5
APES 100	Neuse R. frm Rowland Pt to Fisher Ldg Pt	75%	350125	765812	1235	0.15	5.2	27.5	6.5	1140	0.5
	- FL G 4M "17"					1	5.1	27.4		1140	0.7
						2	4.5	26.9		1440	1
						3	3.9	26.9		2120	1.5
						4	0.1	26.6		17420	10
						5	0.0	26.5		16980	10

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O. (mg/l)	Temp. (°C)	pH	Conductance (uMhos/cm)	Salinity (‰)
APES 101	Neuse River from Rowland Pt to Fisher Ldg Pt	50%	350207	765750	1255	0.15	5.3	27.8	6.6	1510	1
						1	5.3	27.7		1510	1
						2	3.9	27.1		3350	2
						3	0.3	26.9			6
APES 102	Neuse R. frm Rowland Pt to Fisher Ldg Pt - FL R 3M "2"	25%	350255	765725	1310	0.15	10.6	28.7	8.8	6020	4
						1	10.2	28.7		6200	4
						2	2.0	28.0		9400	5
						3	1.6	27.7		10400	6.5
APES 103	Neuse River at US-17 at New Bern	75%	350635	770150	1410	0.15	4.9	27.2	6.5	190	0
						1	4.9	26.8		183	0
						2	4.7	26.6		189	0
						3	4.5	26.4		486	0.5
						4	0.1	26.5		11740	6.5
						5	0.1	26.5		12610	7.5
APES 104	Neuse River at US-17 at New Bern	50%	350645	770135	1430	0.15	4.8	26.5	6.4	97	0
						1	4.7	26.2		105	0
						2	4.7	26.1		137	0
						3	4.0	25.7		1130	1
						4	0.2	26.2		11810	7
APES 105	Neuse River at US-17 at New Bern	25%	350650	770117	1445	0.15	4.7	26.6	6.3	135	0
						1	4.6	25.8		118	0
						2	4.4	25.3		234	0
						2.5	4.4	25.1		245	0
APES 106	Pamlico River frm Rose Bay to Pamlico Pt - G "1" PA	75%	351905	762900	1055	0.15	6.5	27.6	7.5	17100	10
						1	6.4	27.5	7.4	17000	9.8
						2	6.5	27.4	7.4	17000	9.9
						3	6.5	27.5	7.4	17300	10
APES 107	Pamlico River from Rose Bay to Pamlico Pt	50%	352015	762810	1040	0.15	7.3	27.8	7.6	15900	9
						1	7.3	27.9	7.6	15900	9
						2	7.2	27.8	7.6	15900	9
						3	6.9	27.8	7.6	15800	9
						4	6.7	27.7	7.5	16000	9.1
						5	6.6	27.7	7.5	16200	9.2
						6	6.3	27.6	7.5	16800	9.6
APES 108	Pamlico River from Rose Bay to Pamlico Pt	25%	352120	762710	1020	0.15	7.3	27.7	7.5	16500	9.5
						1	6.9	27.7	7.5	16900	9.7
						2	6.8	27.7	7.5	17000	9.6
						3	4.9	27.7	7.3	17400	10
						4	2.3	27.5	6.9	19300	12
						5	1.6	27.2	6.7	21400	12.9
APES 109	Rose Bay at Mouth - Marker FL R 3M "2"		352225	762630	1000	0.15	6.9	27.4	7.5	17300	10
						1	6.9	27.4	7.5	17300	10
						2	6.8	27.4	7.5	17400	10
						2.5	3.6	27.3	6.9	20000	11.3
APES 110	Pamlico River frm.Pungo River to Goose Cr - G "5" PA	90%	351955	763655	1200	0.15	6.7	29.0	7.5	12500	6.8
						1	6.6	29.0	7.5	12600	6.9
						2	5.6	28.6	7.3	12700	7
						2.5	5.4	28.5	7.2	12700	7
APES 111	Pamlico River from Pungo River to Goose Cr	50%	352130	763500	1135	0.15	8.0	28.4	7.9	12600	6.9
						1	7.9	28.4	7.9	12500	6.8
						2	7.1	28.2	7.7	12700	7
						3	6.3	28.1	7.6	13200	7.3
						4	6.1	28.0	7.5	13700	7.7
						5	6.3	27.9	7.6	14000	7.9
APES 112	Pamlico River frm Pungo R. to Goose Cr - QR 5 M "PR"	10%	352240	763330	1120	0.15	8.0	28.3	7.8	12600	7
						1	7.3	28.1	7.7	13400	7.4
						2	6.6	27.9	7.6	13500	7.5
						3	6.6	27.8	7.6	13600	7.6

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D.O (mg/l)	Temp. (°C)	pH	Conductance (uMhos/cm)	Salinity (%)
						3.5	6.5	27.8	7.6	13600	7.6
APES 116	South Creek at Mouth - Marker G "7" PA		352115	764217	1235	0.15	8.5	29.4	8.1	9500	5
						1	8.0	29.2	7.7	9300	4.8
						2	7.0	29.0	7.9	9600	5.1
						3	3.6	28.2	7.1	10800	5.8
APES 117	Pamlico River from Mare Pt to Hickory Pt	75%	352150	764035	1250	0.15	7.1	29.1	7.8	9100	4.7
	-Marker G "1"					1	6.9	29.0	7.7	9400	4.9
APES 118	Pamlico River from Mare Pt to Hickory Pt	50%	352300	764010	1305	0.15	8.3	28.8	8.1	9100	4
	-Marker G "1"					1	8.3	28.8	8.1	9200	4.7
						2	8.3	28.5	8.1	10000	5.4
						3	8.1	28.2	8.0	10500	5.5
						4	7.8	28.2	8.0	10600	5.7
						5	7.5	28.2	8.0	10700	5.7
APES 119	Pamlico River from Mare Pt to Hickory Pt	25%	352347	763935	1320	0.15	6.7	29.1	7.5	11700	6.4
	-Marker G "1"					1	6.7	29.0	7.5	11100	6.2
						2	1.6	27.5	6.8	13000	7.1
						2.5	3.0	27.7	6.8	12600	7
APES 113	Pungo River at Marker FL R 4M "4"		352655	763430	1243	0.15	7.6	28.9	8.7	10140	
						1	7.7	28.6		10210	
						2	6.5	28.5		11160	
						3	2.5	28.2		15910	
						4	2.2	28.2		18380	
						5	2.4	27.8		17460	
						6	2.2	27.5		15680	
						6.5	1.2	27.4		11420	
APES 114	Pungo River at Marker G "11" PA		353120	763510	1403	0.15	8.1	28.0	8.2	7710	9
						1	8.1	28.0		7710	9
						2	6.8	27.6		7740	9.2
						2.5	6.0	27.4		7810	9.1
APES 115	Pungo River at Marker R "24"		353300	762755	1146	0.15	4.5	29.8	6.2	2890	7.5
						1	4.5	29.5		2910	7.5
						2	3.2	29.1		6430	15.5
						2.5	3.2	28.7		6480	15
APES 120	Pamlico River from Bath Cr to Durham Cr	90%	352453	764930	1305	0.15	9.9	29.6	8.4	4410	2.6
						1	7.1	28.7	7.9	4250	2.6
						2	6.4	28.6	7.5	4950	3.1
APES 121	Pamlico River from Bath Cr to Durham Cr	50%	352558	764920	1320	0.15	11.0	29.4	9.1	5040	2.9
						1	9.3	28.8	9.0	5050	2.9
						2	7.6	28.4	8.4	5300	3.2
						3	0.0	27.6	7.5	9650	6.4
						3.8	0.0	27.1	6.9	11330	6.9
APES 122	Pamlico River frm Bath Cr to Durham Cr- FL G "1"	10%	352700	764915	1340	0.15	9.6	29.6	8.6	6580	3.8
						1	10.0	29.0	8.8	6520	3.8
						2	7.0	28.7	8.4	7190	4.3
						3	0.3	28.0	7.5	9010	4.5
						4	0.0	27.3	7.0	11380	6.9
APES 123	Pamlico River from Broad Cr to Blounts Bay	75%	352707	765735	1220	0.15	10.0	28.9	7.2	765	0.4
						1	9.4	28.4	7.3	870	0.7
						2	7.3	27.8	7.0	1430	0.9
						2.7	0.2	27.0	6.4	4650	4.9
APES 124	Pamlico River from Broad Cr to Blounts Bay- 4M "9"	50%	352745	765737	1200	0.15	7.2	28.2	6.8	424	0.4
						1	6.1	27.7	6.6	827	1
						2	6.4	27.3	6.6	1000	1.3
						2.8	0.0	27.0	6.4	8050	11
APES 125	Pamlico River frm Broad Cr to Blounts Bay- FL G "1"	25%	352845	765725	1140	0.15	7.7	28.3	6.8	1660	2.1
						1	6.4	27.8	6.7	1640	2

Appendix II. Albemarle/Pamlico Estuarine Study Synoptic Station Locations and Physical Data, July 25, 1989

Station Number	Location	%	Latitude	Longitude	Time	Depth (meters)	D O (mg/l)	Temp (°C)	pH	Conductance (uMhos/cm)	Salinity (‰)
						1.8	2.8	27.1	6.4	2720	4.1
APES 126	Chocowinity Bay at Mouth		352947	770140	1055	0.15	9.8	28.6	7.3	321	0
						1	7.3	27.8	7.0	245	0
						1.8	5.1	27.2	6.6	151	0
APES 127	Pamlico River near Hills Pt - Marker FL R "16"		353025	770115	1040	0.15	4.9	27.0	5.9	82	0
						1	4.4	26.6	5.8	82	0
						2	4.2	26.2	5.8	84	0
						3	4.1	26.1	5.8	85	0
APES 128	Pamlico River at US-17 at Washington	50%	353233	770342	1010	0.15	4.0	25.7	5.8	82	0
						1	4.0	25.6	5.8	83	0
						2	4.0	25.5	5.8	83	0
						3	4.0	25.5	5.8	83	0
						4	3.9	25.4	5.7	83	0
						5	3.9	25.4	5.5	81	0
CHOC 1	Chocowinity Bay				1115	0.15	9.2	29.4	7.3	391	0.5
						0.5	6.8	28.6	7.2	370	0.4
						1	6.2	28.2	6.9	380	0.4
						1.5	4.2	28.0	6.7	355	0.3

Station Number	Time	Secchi (meters)	Fecal coliform (#/100ml)	Chlorides (mg/l)	Conductance-1 (uMhos/cm)	Sulfate (mg/l)	Residue, T (mg/l)	Residue, susp (mg/l)	Turbidity (NTU)	Chl a tri (µg/l)	Chl a corr (µg/l)	Pheo (µg/l)	NH3 as N (mg/l)	TKN as N (mg/l)	NO2 + NO3 (mg/l)	P, total (mg/l)	PO4 (mg/l)	TOC (mg/l)	Sulfide mg/l
APES 1	1315	0.50	<10	7	84	<5	96	7	6.6	46	44	4	0.04	0.4	0.09	0.1	0.01	11	<0.1
APES 2	1335	0.50	<10	7	84	<5	95	2	11	25	23	4	0.03	0.4	0.1	0.1	0.01	10	<0.1
APES 3	1345	0.40	<10	7	84	<5	94	3	11	26	23	6	0.05	1.2	0.11	0.12	0.01	11	<0.1
APES 4	1245	0.50	<10	7	120	5	96	2	7.9	25	24	3	0.05	0.3	0.19	0.07	0.01	7	<0.1
APES 5	1115	0.50	10	8	110	6	110	5	6.9	42	40	5	0.09	0.4	0.23	0.09	0.01	16	<0.1
APES 6	1130	0.60	<10	8	110	6	96	4	NS	32	29	5	0.06	0.4	0.29	0.08	0.01	8	<0.1
APES 7	1145	0.60	NS	.7	110	5	90	1	5.6	10	9	1	0.09	0.4	0.25	0.06	0.01	8	<0.1
APES 8	1200	0.70	<10	NS	NS	5	86	3	5.7	24	21	4	0.04	0.2	0.18	0.06	<0.01	8	<0.1
APES 9	1215	0.50	<10	7	95	<5	84	5	6.8	23	20	5	0.04	0.3	0.16	0.08	0.01	8	<0.1
APES 10	1000	0.80	<10	8	110	6	79	3	2.6	15	13	5	0.07	0.4	0.09	0.03	<0.01	10	<0.1
APES 11	1020	0.60	NS	8	110	9	80	4	3.8	24	21	4	0.03	0.3	0.17	0.05	<0.01	7	<0.1
APES 12	1035	0.80	<10	8	100	5	85	1	5	23	20	5	0.02	0.3	0.16	0.05	0.01	96	<0.1
APES 13	1050	0.60	<10	7	100	<5	88	2	6.1	11	11	<1	0.05	0.4	0.18	0.06	0.02	8	<0.1
APES 14	1256	0.55	<10	42	240	9	170	6	6	97	94	5	0.04	0.5	0.04	0.09	0.01	21	<0.1
APES 15	1327	1.10	<10	28	190	8	120	<1	3.7	30	27	5	0.02	0.3	<0.01	0.04	<0.01	9	<0.1
APES 16	1358	1.20	<10	14	130	6	93	<1	4.1	28	25	5	0.03	0.3	0.01	0.04	<0.01	7	<0.1
APES 17	1449		<10	20	160	7	120	4	5.5	29	27	4	0.03	0.3	<0.01	0.05	<0.01	8	<0.1
APES 18	1213		<10	99	500	22	280	8	7.1	21	27	4	0.03	0.3	<0.01	0.05	<0.01	11	<0.1
APES 19	1143	1.00	<10	71	400	14	220	4	4.3	20	19	2	0.02	0.3	<0.01	0.04	<0.01	8	<0.1
APES 20	1114	1.00	<10	52	300	11	170	6	4.3	22	20	4	0.05	0.3	<0.01	0.04	<0.01	8	<0.1
APES 21	1045	0.95	<10	40	250	13	150	4	5.8	23	20	5	0.02	0.3	<0.01	0.04	<0.01	7	<0.1
APES 22	1004	0.80	<10	43	260	9	160	6	6.1	19	16	4	0.03	0.3	<0.01	0.04	<0.01	8	<0.1
APES 23	1100	0.70	<10	1500	4600	170	2800	5	2.2	5	5	<1.0	0.03	0.5	<0.01	0.02	<0.01	18	<0.1
APES 24	1030	0.70	<10	1200	4000	170	2400	5	2.2	2	2	<1	0.13	0.5	<0.01	0.02	<0.01	16	<0.1
APES 25	1000	0.75	<10	1200	3800	130	2400	<1	2.6	6	5	<1	0.15	0.4	<0.01	0.02	<0.01	16	<0.1
APES 26	1440	0.80	20	470	1800	77	1000	8	3.6	14	14	<1	0.04	0.3	<0.01	0.03	<0.01	12	<0.1
APES 27	1000	0.80	<10	440	1600	68	920	6	3.6	13	13	<1	0.04	0.3	<0.01	0.03	<0.01	11	<0.1
APES 28	1045	0.70	<10	220	840	31	480	4	4.4	15	15	<1	0.04	0.3	<0.01	0.04	<0.01	9	<0.1
APES 29	1110	0.80	<10	140	540	24	320	5	6.1	11	9	3	0.02	0.2	<0.01	0.04	<0.01	8	<0.1
APES 30	1145	1.10	<10	68	320	19	190	6	4.7	6	5	<1	0.03	0.4	<0.01	0.04	<0.01	8	<0.1
APES 31	1405	0.70	<10	350	1200	46	720	7	4	14	14	<1	0.02	0.4	<0.01	0.03	<0.01	10	<0.1
APES 32	1340	0.70	10	190	820	30	460	1	3.8	17	16	<1	0.01	0.4	<0.01	0.03	<0.01	9	<0.1
APES 33	1315	0.90	<10	15000	490	22	280	5	4.6	15	13	4	0.02	0.4	<0.01	0.04	<0.01	8	<0.1
APES 34	1245	0.50	10	300	1200	39	660	11	7.3	88	94	<1	0.03	0.6	<0.01	0.05	<0.01	13	<0.1
APES 35	1120	0.40	<10	800	2700	88	1600	37	9.8	26	26	<1.0	0.01	0.9	<0.01	0.04	<0.01	15	<0.1
APES 36	1050	0.40	<10	800	2900	120	1700	35	9	25	27	<1	<0.01	1.0	<0.01	0.04	<0.01	16	<0.1
APES 37	1020	0.45	20	1200	3900	150	2400	38	8.3	19	19	1	0.01	1.0	<0.01	0.05	<0.01	18	<0.1
APES 38	1000	0.50	<10	160	700	27	410	8	5.5	8	7	<1	0.01	0.4	<0.01	0.05	<0.01	11	<0.1
APES 39	1025	0.70	<10	130	520	19	320	9	5.3	18	20	<1	0.01	0.4	<0.01	0.05	<0.01	120	<0.1
APES 40	1055	0.50	<10	130	590	21	370	13	6.8	40	39	2	0.01	0.6	<0.01	0.05	<0.01	13	<0.1
APES 41	1120	0.50		130	550	20	350	9	7	30	31	<1	<0.01	0.5	<0.01	0.05	<0.01	12	<0.1
APES 42	1135	0.70	<10	310	1100	39	680	24	7.6	29	29	<1	0.01	0.5	<0.01	0.05	<0.01	12	<0.1
APES 43	1100	1.00	<10	190	740	29	450	5	5	18	19	<1	0.01	0.4	<0.01	0.04	<0.01	11	<0.1
APES 44	1035	1.10	<10	130	560	22	340	6	4.3	18	18	1	0.01	0.3	<0.01	0.04	<0.01	10	<0.1
APES 45	1205	0.60	<10	2900	8300	330	5800	20	9.3	35	38	4	0.01	0.7	<0.01	0.04	<0.01	8	<0.1
APES 46	1000	0.50	<10	800	2900	99	1800	25	8.9	49	50	<1	0.01	0.6	<0.01	0.04	<0.01	12	<0.1
APES 47	1005	1.00	<10	1900	5800	240	3700	10	6.9	14	15	<1	0.02	0.6	<0.01	0.04	<0.01	8	<0.1
APES 48	1103	1.10	<10	4300	12000	490	9800	10	5.2	7	8	<1	0.02	0.5	<0.01	0.04	<0.01	5	<0.1
APES 49	1130	1.10	<10	4300	12000	490	8800	12	5.8	9	9	<1	0.02	0.4	<0.01	0.04	<0.01	6	<0.1
APES 50	1200	1.10	<10	4200	12000	480	7900	15	7	21	23	<1	0.01	0.5	<0.1	0.04	<0.01	5	<0.1
APES 51	1247	0.50	<10	5300	16000	710	13000	17	7.5	36	33	5	0.02	0.4	<0.01	0.04	0.01	<5	<0.1
APES 52	1211	1.00	<10	9200	24000	1100	18000	8	3.3	13	12	2	0.03	0.4	<0.01	0.03	0.01	<5	<0.1
APES 53	1140	1.10	<10	9500	24000	1100	26000	9	2.2	11	10	1	0.02	0.5	<0.01	0.03	<0.01	<5	<0.1

Appendix III. Chemical and biological data for A/P Synoptic Study, July 25, 1989

Station Number	Time	Secchi (meters)	Fecal coliform (#/100ml)	Chlorides (mg/l)	Conductance (uMhos/cm)	Sulfate (mg/l)	Residue, T (mg/l)	Residue, susp (mg/l)	Turbidity (NTU)	Chl a un (µg/l)	Chl a corr (µg/l)	Pheo (µg/l)	NH3 as N (mg/l)	TKN as N (mg/l)	NO2 + NO3 (mg/l)	P, total (mg/l)	PO4 (mg/l)	TOC (mg/l)	Sulfide mg/l
APES 54	1111	0.90	<10	8500	22000	1100	20000	4	2.2	13	12	2	0.02	0.5	<0.01	0.03	<0.01	<5	<0.1
APES 55	1021	1.10	<10	10000	26000	1300	29000	11	2.4	10	9	1	0.04	0.4	<0.01	0.03	<0.01	<5	<0.1
APES 56	1200	1.80	<10	11000	30000	1600	29000	5	2	7	6	<1	<0.01	0.4	0.01	0.03	0.02	<5	<0.1
APES 57	1130	1.70	<10	12000	29000	1400	30000	35	6.8	6	5	1	0.01	0.4	<0.01	0.05	0.02	<5	<0.1
APES 58	1100	1.50	<10	9300	25000	1300	32000	7	2.6	4	4	1	0.01	0.4	<0.01	0.03	0.01	<5	<0.1
APES 59	1030	1.10	<10	9900	26000	1100	28000	21	7.4	4	4	<1	0.01	0.4	<0.01	0.04	0.01	<5	<0.1
APES 60	1000	1.00	<10	5700	18000	920	24000	21	13	8	8	2	0.01	0.4	<0.01	0.05	0.01	<5	<0.1
APES 61	1000	0.50	<10	9400	24000	1300	18000	11	11	16	15	2	0.01	0.4	<0.01	0.08	0.03	<5	<0.1
APES 62	1112	1.20	<10	12000	25000	1500	24000	6	2.1	4	4	<1	<0.01	0.3	<0.01	0.04	0.02	<5	<0.1
APES 63	1157	1.20	<10	11000	24000	1400	20000	4	1.9	10	9	2	<0.01	0.3	<0.01	0.04	0.01	<5	<0.1
APES 64	1226	1.20	<10	11000	24000	1400	23000	7	2.4	8	8	<1	0.01	0.4	<0.01	0.06	0.02	<5	<0.1
APES 65	1253	0.80	<10	11000	25000	1400	21000	22	5	15	14	3	<0.01	0.3	<0.01	0.07	0.03	<5	<0.1
APES 66	1320	0.40	<10	10000	24000	1200	25000	24	12	7	6	2	<0.01	0.5	<0.01	0.07	0.03	<5	<0.1
APES 67	1145	1.20	<10	11000	26000	1600	36000	9	2.3	1	1	<1	0.01	0.4	<0.01	0.04	0.02	<5	<0.1
APES 68	1210	1.10	<10	12000	27000	1400	37000	15	2.1	2	2	<1	0.03	0.4	<0.01	0.05	0.03	<5	<0.1
APES 69	1240	0.90	<10	9800	23000	1200	24000	28	6	7	6	2	0.05	0.5	<0.01	0.06	0.03	<5	<0.1
APES 70	1255	0.65	<10	10000	24000	1100	36000	23	2.3	3	3	<1	0.01	0.3	<0.01	0.06	0.03	<5	<0.1
APES 71	1105	1.10	<10	10000	26000	1500	35000	7	2.8	2	2	<1	0.04	0.4	<0.01	0.07	0.03	<5	<0.1
APES 72	1035	1.10	<10	9900	26000	1400	28000	7	2.2	4	3	<1	0.02	0.4	<0.01	0.06	0.04	<5	<0.1
APES 73	1010	0.80	<10	9500	25000	1000	23000	6	2.9	3	3	<1	0.02	0.5	<0.01	0.06	0.04	<5	<0.1
APES 74	1000	0.60	<10	7900	21000	51	21000	12	4.7	7	7	<1	0.09	0.5	<0.01	0.06	0.02	<5	<0.1
APES 75	1200	1.20	<10	12000	26000	1500	31000	8	3.4	13	12	2	0.01	0.4	<0.01	0.06	0.04	<5	<0.1
APES 76	1125	1.30	<10	11000	25000	1400	29000	3	1.7	12	11	2	0.01	0.4	<0.01	0.07	0.03	<5	<0.1
APES 77	1050	1.20	<10	10000	24000	1400	25000	5	2.7	11	10	2	0.01	0.3	<0.01	0.06	0.04	<5	<0.1
APES 78	1020	1.30	<10	9500	26000	1200	28000	6	2.2	10	9	2	0.01	0.3	<0.01	0.07	0.05	<5	<0.1
APES 79	1000	1.00	<10	8100	22000	1000	24000	10	2.8	12	11	2	0.01	0.3	<0.01	0.09	0.06	<5	<0.1
APES 80	1235	1.30	<10	9900	2700	1300	29000	5	1.6	18	18	<1	0.01	0.3	<0.01	0.07	0.04	<5	<0.1
APES 81	1310	1.40	<10	9800	21000	1100	23000	10	4.9	13	13	<1	0.01	0.4	<0.01	0.09	0.05	<5	<0.1
APES 82	1347	1.30	<10	8100	18000	1000	18000	5	1.9	10	9	1	0.01	0.4	<0.01	0.1	0.07	<5	<0.1
APES 83	1440	1.50	<10	7200	19000	980	21000	5	2.4	13	12	2	0.01	0.4	<0.01	0.11	0.08	<5	<0.1
APES 84	1000	1.00	<10	9200	20000	1100	31000	12	2.2	25	27	<1	0.04	0.4	0.01	0.1	0.06	<5	<0.1
APES 85	1030	1.10	<10	9400	22000	1200	19000	5	2	17	16	<1	0.02	0.5	0.01	0.09	0.06	<5	<0.1
APES 86	1050	1.00	<10	9500	21000	1200	18000	7	3.2	12	11	2	0.02	0.5	0.01	0.09	0.05	<5	<0.1
APES 87	1110	1.00	<10	9600	21000	930	18000	10	3	8	8	2	0.01	0.4	0.01	0.08	0.04	<5	<0.1
APES 88	1145	0.80	<10	7500	18000	930	14000	10	3.8	9	8	2	0.02	0.4	<0.01	0.15	0.1	<5	<0.1
APES 89	1230	1.00	<10	7300	18000	960	16000	4	1.9	6	5	1	0.01	0.4	0.01	0.13	0.1	<5	<0.1
APES 90	1240		<10	7200	18000	920	16000	9	2.1	28	28	1	0.01	0.6	0.01	0.14	0.1	<5	<0.1
APES 91	1300	1.00	<10	6800	21000	980	23000	7	2	31	10	37	0.01	0.4	0.01	0.14	0.09	<5	<0.1
APES 92	1330	0.50	<10	4900	14000	630	11000	8	4.1	35	33	5	0.01	0.5	<0.01	0.19	0.12	5	NS
APES 93	1345	0.70	<10	5000	14000	890	11000	4	3.3	26	25	1	0.01	0.5	<0.01	0.19	0.12	6	NS
APES 94	1355	0.80	<10	4800	14000	620	11000	6	3.7	51	49	5	0.01	0.6	0.01	0.19	0.13	6	NS
APES 95	1415	0.70	<10	4500	14000	120	10000	5	3.1	33	33	<1	0.01	0.5	<0.01	0.19	0.13	6	NS
APES 96	1200	0.70	<10	3600	10000	460	6500	9	5	50	45	8	<0.01	0.6	<0.01	0.2	0.12	7	<0.1
APES 97	1120	0.90	<10	4800	13000	590	14000	10	4.1	83	75	14	0.01	0.6	<0.01	0.21	0.14	<5	<0.1
APES 98	1100	0.75	<10	4000	11000	470	13000	11	4.9	97	94	5	0.01	0.6	<0.01	0.24	0.14	<5	<0.1
APES 99	1015	0.65	<10	4300	12000	570	8100	10	4.4	88	88	1	0.01	0.8	<0.01	0.26	0.15	<5	<0.1
APES 100	1235	0.75	20	290	1200	33	740	5	10	13	11	4	0.05	0.5	0.39	0.18	0.08	6	<0.1
APES 101	1255	0.85	50	430	1600	52	1000	6	9.2	15	13	5	0.05	0.4	0.4	0.2	0.09	10	<0.1
APES 102	1310	0.65	<10	2100	6000	240	5000	16	9.4	260	250	13	<0.01	0.6	0.1	0.28	0.16	9	<0.1
APES 103	1410	0.55	40	34	180	6	160	6	12	9	8	2	0.02	0.5	0.29	0.16	0.06	8	<0.1
APES 104	1430	0.65	20	14	100	<5	110	6	12	8	8	1	0.02	0.5	0.31	0.16	0.06	9	<0.1
APES 105	1445	0.70	30	20	130	5	130	6	12	1	<1	<1	0.03	0.4	0.32	0.18	0.06	16	<0.1
APES 106	1055	0.90	<10	5900	18000	820	12000	10	4.9	6	6	<1	0.01	0.4	<0.01	0.15	0.11	<5	<0.1

Appendix III. Chemical and biological dat ? Synoptic Study, July 25, 1989

Station Number	Time	Secchi (meters)	Fecal coliform (#/100ml)	Chlorides (mg/l)	Conductance-l (uMhos/cm)	Sulfate (mg/l)	Residue, T (mg/l)	Residue, susp (mg/l)	Turbidity (NTU)	Chl a tri (µg/l)	Chl a corr (µg/l)	Pheo (µg/l)	NH3 as N (mg/l)	TKN as N (mg/l)	NO2 + NO3 (mg/l)	P, total (mg/l)	PO4 (mg/l)	TOC (mg/l)	Sulfide mg/l
APES 107	1040	1.00	<10	6100	15000	750	11000	8	4.7	11	10	1	0.01	0.6	<0.01	0.12	0.09	<5	<0.1
APES 108	1020	1.00	<10	6400	18000	860	12000	9	4.2	12	12	<1	0.01	0.5	<0.01	0.11	0.08	<5	<0.1
APES 109	1000	0.80	<10	6500	18000	810	12000	12	2.7	7	7	<1	0.01	0.6	<0.01	0.12	0.09	<5	<0.1
APES 110	1200	0.60	<10	4400	13000	580	8900	11	6.1	16	15	2	<0.01	0.5	<0.01	0.26	0.2	5	<0.1
APES 111	1135	0.90	<10	4300	13000	580	8700	9	3.5	23	23	1	<0.01	0.5	<0.01	0.29	0.21	5	<0.1
APES 112	1120	0.80	<10	4200	14000	610	9100	9	3.3	24	24	<1	<0.01	0.5	<0.01	0.15	0.1	6	<0.1
APES 116	1235	0.60	<10	3300	11000	450	6300	14	6.9	11	10	2	0.01	0.5	<0.01	0.3	0.22	300	<0.1
APES 117	1250	0.60	<10	2700	10000	390	6300	12	6.4	12	13	<1	0.01	0.6	<0.01	0.3	0.23	7	<0.1
APES 118	1305	0.80	<10	3200	10000	430	6600	5	3.2	15	15	<1	<0.01	0.5	<0.01	0.27	0.22	5	<0.1
APES 119	1320	0.60	<10	4200	11000	540	7900	10	4.6	5	5	<1	0.01	0.7	<0.01	0.26	0.18	5	<0.1
APES 113	1243		<10	3300	9800	420	10000	7	3.8	37	33	6	<0.01	0.6	0.01	0.1	0.03	<5	<0.1
APES 114	1403	0.65	<10	2400	7300	260	6900	8	4.4	41	38	7	<0.01	0.7	0.09	0.08	0.02	8	<0.1
APES 115	1146	0.45	10	1100	3000		2000	4	3.6	2	1	2	0.1	0.7	0.51	0.08	0.04	21	<0.1
APES 120	1305	0.35	<10	150	4500	160	2800	15	9.3	63	58	9	0.01	0.6	<0.01	0.28	0.14	10	<0.1
APES 121	1320	0.45	<10	1700	5100	190	3200	6	6.3	55	54	2	0.01	0.5	<0.01	0.25	0.16	8	<0.1
APES 122	1340	0.45	<10	2200	6400	270	4100	<1	5.8	23	21	3	0.01	0.5	0.01	0.28	0.2	7	<0.1
APES 123	1220	0.30	10	190	770	22	490	45	14	46	42	8	0.01	0.5	0.12	0.18	0.04	13	<0.1
APES 124	1200	0.35	<10	110	430	12	250	7	18	21	23	<1	0.01	0.4	0.24	0.17	0.03	11	<0.1
APES 125	1140	0.35	<10	480	1700	55	980	10	10	34	31	5	0.03	0.6	0.08	0.2	0.07	12	<0.1
APES 126	1055	0.30	<10	74	330	10	230	13	16	52	48	8	0.01	0.6	0.02	0.2	0.05	15	<0.1
APES 127	1040	0.40	10	80	86	<5	110	<1	16	7	7	<1	0.1	0.4	0.39	0.15	0.01	NS	<0.1
APES 128	1010	0.45	40	<1	86	<5	120	11	19	2	2	<1	0.11	0.5	0.42	0.14	0.02	15	<0.1

Station Number	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Nickel (µg/l)	Lead (µg/l)	Zinc (µg/l)	Aluminum (µg/l)	Beryllium (µg/l)	Cobalt (µg/l)	Iron (µg/l)	Manganese (µg/l)	Arsenic (µg/l)	Mercury (µg/l)
APES 1	<2.0	<25	<2.0	<10	<10	<10	650	<25	<50	2400	<25	<10	<0.2
APES 2	<2.0	<25	3.4	<10	<10	<10	630	<25	<50	3200	<25	<10	<0.2
APES 3	<2.0	<25	2.1	<10	<10	<10	640	<25	<50	2000	<25	<10	<0.2
APES 4	<2.0	<25	2.2	<10	<10	<10	230	<25	<50	900	79	<10	<0.2
APES 5	<2.0	<25	<2.0	<10	<10	<10	300	<25	<50	830	83	<10	<0.2
APES 6	<2.0	<25	<2.0	<10	<10	<10	250	<25	<50	920	76	<10	<0.2
APES 7	<2.0	<25	2.2	<10	<10	14	260	<25	<50	240	46	<10	<0.2
APES 8	<2.0	<25	<2.0	<10	<10	<10	290	<25	<50	960	<25	<10	<0.2
APES 9	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	78	<25	<10	<0.2
APES 10	<2.0	<25	<2.0	<10	<10	<10	130	<25	<50	490	<25	<10	<0.2
APES 11	<2.0	<25	3.8	<10	<10	<10	190	<25	<50	640	<25	<10	<0.2
APES 12	<2.0	<25	4.3	<10	<10	<10	270	<25	<50	820	<25	<10	<0.2
APES 13	<2.0	<25	<2.0	<10	<10	<10	400	<25	<50	1100	<25	<10	<0.2
APES 14	<2.0	<25	<2.0	<10	<10	<10	280	<25	<50	560	65	<10	<0.2
APES 15	<2.0	<25	<2.0	<10	<10	<10	150	<25	<50	410	<25	<10	<0.2
APES 16	<2.0	<25	12	<10	<10	<10	170	<25	<50	1600	<25	<10	<0.2
APES 17	<2.0	<25	8.6	<10	<10	<10	190	<25	<50	540	<25	<10	<0.2
APES 18	<2.0	<25	2.1	<10	<10	<10	270	<25	<50	480	<25	<10	<0.2
APES 19	<2.0	<25	<2.0	<10	<10	<10	170	<25	<50	380	<25	<10	<0.2
APES 20	<2.0	<25	5.6	<10	<10	<10	260	<25	<50	700	<25	<10	<0.2
APES 21	<2.0	<25	2.7	<10	<10	<10	290	<25	<50	620	<25	<10	<0.2
APES 22	<2.0	<25	<2.0	<10	<10	<10	380	<25	<50	670	<25	<10	<0.2
APES 23	<2.0	<25	2	<10	<10	<10	75	<25	<50	160	<25	<10	<0.2
APES 24	<2.0	<25	<2.0	<10	<10	<10	100	<25	<50	150	<25	<10	<0.2
APES 25	<2.0	<25	2	<10	<10	<10	120	<25	<50	190	<25	<10	<0.2
APES 26	<2.0	<25	2.2	<10	<10	<10	64	<25	<50	130	<25	<10	<0.2
APES 27	<2.0	<25	<2.0	<10	<10	<10	62	<25	<50	120	<25	<10	<0.2
APES 28	<2.0	<25	<2.0	<10	<10	<10	280	<25	<50	240	<25	<10	<0.2
APES 29	<2.0	<25	<2.0	<10	<10	<10	190	<25	<50	300	<25	<10	<0.2
APES 30	<2.0	<25	3.2	<10	<10	<10	170	<25	<50	340	<25	<10	<0.2
APES 31	<2.0	<25	<2.0	<10	<10	<10	100	<25	<50	130	<25	<10	<0.2
APES 32	<2.0	<25	<2.0	<10	<10	<10	100	<25	<50	170	<25	<10	<0.2
APES 33	<2.0	<25	2.1	<10	<10	<10	120	<25	<50	260	<25	<10	<0.2
APES 34	<2.0	<25	<2.0	<10	<10	<10	100	<25	<50	190	40	<10	<0.2
APES 35	<2.0	<25	2.9	<10	<10	<10	130	<25	<50	190	43	<10	<0.2
APES 36	<2.0	<25	3.4	<10	<10	<10	110	<25	<50	150	44	<10	<0.2
APES 37	<2.0	<25	<2.0	<10	<10	<10	130	<25	<50	200	55	<10	<0.2
APES 38	<2.0	<25	<2.0	<10	<10	<10	230	<25	<50	340	<25	<10	<0.2
APES 39	<2.0	<25	3.6	<10	<10	<10	210	<25	<50	360	<25	<10	<0.2
APES 40	<2.0	<25	<2.0	<10	<10	<10	300	<25	<50	420	<25	<10	<0.2
APES 41	<2.0	<25	2.8	<10	<10	<10	290	<25	<50	420	<25	<10	<0.2
APES 42	<2.0	<25	<2.0	<10	<10	<10	420	<25	<50	340	<25	<10	<0.2
APES 43	<2.0	<25	2.4	<10	<10	<10	240	<25	<50	290	<25	<10	<0.2
APES 44	<2.0	<25	<2.0	<10	<10	<10	220	<25	<50	330	<25	<10	<0.2
APES 45	<2.0	<25	<2.0	<10	<10	<10	190	<25	<50	280	36	<10	<0.2
APES 46	<2.0	<25	2.1	<10	<10	<10	230	<25	<50	210	28	<10	<0.2
APES 47	<2.0	<25	2.6	<10	<10	<10	210	<25	<50	230	44	<10	<0.2
APES 48	<2.0	<25	<2.0	<10	<10	<10	130	<25	<50	130	<25	<10	<0.2
APES 49	<2.0	<25	2	<10	<10	<10	160	<25	<50	150	29	<10	<0.2
APES 50	<2.0	<25	<2.0	<10	<10	<10	180	<25	<50	200	32	<10	<0.2
APES 51	<2.0	<25	<2.0	<10	<10	<10	260	<25	<50	260	<25	<10	<0.2
APES 52	<2.0	<25	<2.0	<10	<10	<10	62	<25	<50	75	<25	<10	<0.2
APES 53	<2.0	<25	<2.0	<10	<10	<10	92	<25	<50	390	<25	<10	<0.2
APES 54	<2.0	<25	6.7	<10	<10	<10	55	<25	<50	98	<25	<10	<0.2
APES 55	<2.0	<25	<2.0	<10	<10	<10	52	<25	<50	65	<25	<10	<0.2
APES 56	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	<25	<10	<0.2
APES 57	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	<25	<10	<0.2
APES 58	<2.0	<25	2.1	<10	<10	<10	<50	<25	<50	<50	<25	<10	<0.2
APES 59	<2.0	<25	<2.0	<10	<10	<10	280	<25	<50	170	<25	<10	<0.2
APES 60	<2.0	<25	2.1	<10	<10	<10	210	<25	<50	120	<25	<10	<0.2
APES 61	<2.0	<25	<2.0	<10	<10	<10	810	<25	<50	450	<25	<10	<0.02
APES 62	<2.0	<25	<2.0	<10	<10	<10	80	<25	<50	100	<25	<10	<0.02
APES 63	<2.0	<25	2.2	<10	<10	<10	100	<25	<50	68	<25	<10	<0.2
APES 64	<2.0	<25	<2.0	<10	<10	<10	100	<25	<50	74	<25	<10	<0.2
APES 65	<2.0	<25	<2.0	<10	<10	<10	300	<25	<50	190	<25	<10	<0.2
APES 66	<2.0	<25	2.2	<10	32	<10	860	<25	<50	490	<25	<10	<0.2
APES 67	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	<25	<10	<0.2
APES 68	<2.0	<25	2.1	<10	<10	<10	<50	<25	<50	<50	<25	<10	<0.2
APES 69	<2.0	<25	2.9	<10	<10	<10	290	<25	<50	160	<25	<10	<0.2

Appendix IV. Metals data from the A/P Synoptic Study, July 25, 1989

Station Number	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Nickel (µg/l)	Lead (µg/l)	Zinc (µg/l)	Aluminum (µg/l)	Beryllium (µg/l)	Cobalt (µg/l)	Iron (µg/l)	Manganese (µg/l)	Arsenic (µg/l)	Mercury (µg/l)
APES 70	<2.0	<25	<2.0	<10	<10	<10	53	<25	<50	<50	<25	<10	<0.2
APES 71	<2.0	<25	2.6	<10	<10	<10	<50	<25	<50	<50	<25	<10	<0.2
APES 72	<2.0	<25	2.5	<10	<10	<10	<50	<25	<50	<50	<25	<10	<0.2
APES 73	<2.0	<25	2.1	<10	<10	<10	56	<25	<50	<50	<25	<10	<0.2
APES 74	<2.0	<25	<2.0	<10	<10	<10	150	<25	<50	77	<25	<10	<0.2
APES 75	<2.0	<25	<2.0	<10	<10	<10	100	<25	<50	98	<25	<10	<0.2
APES 76	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	110	<25	<10	<0.2
APES 77	<2.0	<25	9.1	<10	<10	<10	87	<25	<50	120	<25	<10	<0.2
APES 78	<2.0	<25	<2.0	<10	<10	<10	65	<25	<50	67	<25	<10	<0.2
APES 79	<2.0	<25	<2.0	<10	<10	<10	120	<25	<50	90	<25	<10	<0.2
APES 80	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	120	<25	<10	<0.2
APES 81	<2.0	<25	2.2	<10	<10	<10	180	<25	<50	180	<25	<10	<0.2
APES 82	<2.0	<25	<2.0	<10	<10	<10	63	<25	<50	99	<25	<10	<0.2
APES 83	<2.0	<25	<2.0	<10	<10	<10	75	<25	<50	54	<25	<10	<0.2
APES 84	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	33	<10	<0.2
APES 85	<2.0	<25	2.6	<10	<10	<10	<50	<25	<50	<50	28	<10	<0.2
APES 86	<2.0	<25	<2.0	<10	<10	<10	54	<25	<50	62	29	<10	<0.2
APES 87	<2.0	<25	<2.0	<10	<10	<10	71	<25	<50	74	45	<10	<0.2
APES 88	<2.0	<25	<2.0	<10	<10	<10	170	<25	<50	84	99	<10	<0.2
APES 89	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	60	<10	0.64
APES 90	<2.0	<25	2	<10	<10	<10	<50	<25	<50	<50	44	<10	<0.2
APES 91	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	39	<10	<0.2
APES 92	<2.0	<25	<2.0	<10	<10	<10	43	<25	<50	72	100	<10	<0.2
APES 93	<2.0	<25	2	<10	<10	<10	<50	<25	<50	<50	74	<10	<0.2
APES 94	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	75	69	<10	<0.2
APES 95	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	67	<10	<0.2
APES 96	<2.0	<25	<2.0	<10	<10	<10	110	<25	<50	180	92	<10	<0.2
APES 97	<2.0	<25	<2.0	<10	<10	<10	60	<25	<50	74	54	<10	<0.2
APES 98	<2.0	<25	6.5	<10	<10	<10	76	<25	<50	120	49	<10	<0.2
APES 99	<2.0	<25	2.6	<10	<10	<10	72	<25	<50	89	49	<10	<0.2
APES 100	<2.0	<25	3	<10	<10	<10	700	<25	<50	1000	120	<10	<0.2
APES 101	<2.0	<25	3.9	<10	<10	<10	670	<25	<50	930	150	<10	<0.2
APES 102	<2.0	<25	<2.0	<10	<10	<10	230	<25	<50	370	180	<10	<0.2
APES 103	<2.0	<25	3.5	<10	<10	<10	620	<25	<50	1100	51	<10	<0.2
APES 104	<2.0	<25	4.4	<10	<10	<10	790	<25	<50	1200	45	<10	<0.2
APES 105	<2.0	<25	2.5	<10	<10	<10	770	<25	<50	1200	48	<10	<0.2
APES 106	<2.0	<25	<2.0	<10	<10	<10	110	<25	<50	90	50	<10	<0.2
APES 107	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	<25	<10	<0.2
APES 108	<2.0	<25	<2.0	<10	<10	<10	69	<25	<50	<50	<25	<10	<0.2
APES 109	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	<25	<10	0.47
APES 110	<2.0	<25	<2.0	<10	<10	<10	240	<25	<50	120	67	<10	<0.2
APES 111	<2.0	<25	<2.0	<10	<10	32	<50	<25	<50	<50	38	<10	<0.2
APES 112	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	34	<10	<0.2
APES 116	<2.0	<25	2.4	<10	<10	<10	220	<25	<50	130	87	<10	<0.2
APES 117	<2.0	<25	<2.0	<10	<10	<10	210	<25	<50	140	98	<10	<0.2
APES 118	<2.0	<25	<2.0	<10	<10	<10	<50	<25	<50	<50	57	<10	<0.2
APES 1,3	<2.0	<25	<2.0	<10	<10	<10	130	<25	<50	87	74	<10	<0.2
APES 113	<2.0	<25	2.4	<10	<10	<10	120	<25	<50	130	56	<10	<0.2
APES 114	<2.0	<25	20	<10	<10	<10	190	<25	<50	220	68	<10	<0.2
APES 115	<2.0	<25	2.3	<10	<10	<10	450	<25	<50	710	44	<10	<0.2
APES 120	<2.0	<25	<2.0	<10	<10	<10	290	<25	<50	350	120	<10	<0.2
APES 121	<2.0	<25	<2.0	<10	<10	<10	140	<25	<50	220	71	<10	<0.2
APES 122	<2.0	<25	<2.0	<10	<10	<10	140	<25	<50	240	93	<10	<0.2
APES 123	<2.0	<25	<2.0	<10	<10	<10	990	<25	<50	1200	110	<10	<0.2
APES 124	<2.0	<25	<2.0	<10	<10	<10	1100	<25	<50	1300	83	<10	<0.2
APES 125	<2.0	<25	4.8	<10	<10	<10	580	<25	<50	760	220	<10	<0.2
APES 126	<2.0	<25	7.4	<10	<10	<10	800	<25	<50	1100	36	<10	<0.2
APES 127	<2.0	<25	2.8	<10	<10	<10	1400	<25	<50	1800	55	<10	<0.2
APES 128	<2.0	<25	4.3	<10	<10	<10	1300	<25	<50	1700	60	<10	<0.2