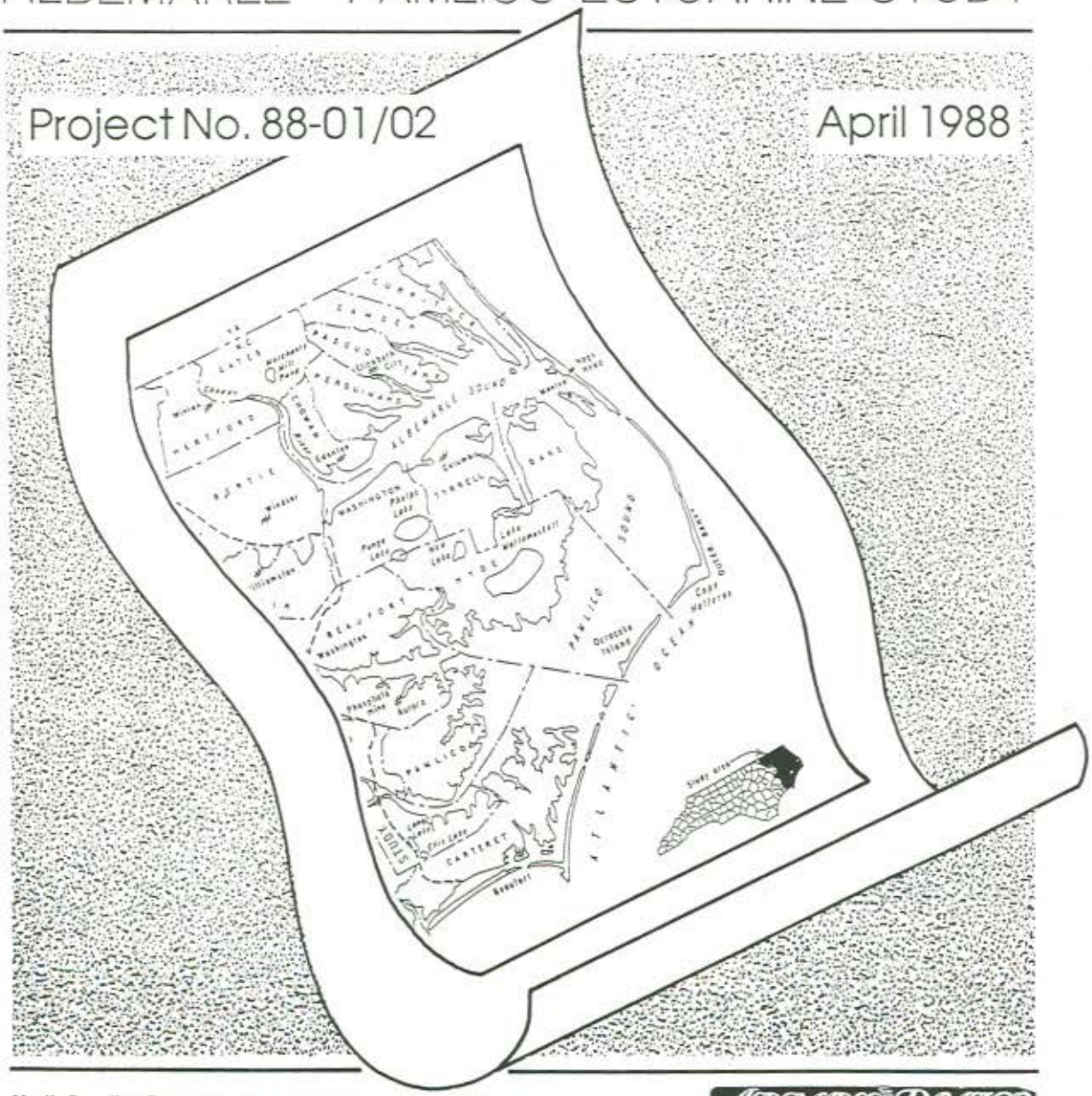
BASELINE WATER QUALITY MONITORING PLAN

ALBEMARLE - PAMLICO ESTUARINE STUDY

Project No. 88-01/02

April 1988



North Carolina Department
of Environment, Health,
and Natural Resources

Funding Provided by
Environmental Protection Agency
National Estuary Program

ALBEMARLE-PAMLICO

ALBEMARLE-PAMLICO ESTUARINE STUDY

BASELINE WATER QUALITY MONITORING PLAN

Edited by
Robert E. Holman, Ph.D.
Program Director

Project No. 88-01/02

April, 1988

(Revised June, 1989)

TABLE OF CONTENTS

BASELINE WATER QUALITY MONITORING PLAN

Background

The baseline water quality monitoring plan was developed from the existing ambient monitoring programs in North Carolina. These broad programs include The Division of Environmental Management's biannual 305(b) Document, the Division of Marine Fisheries annual Review of DMF Survey and U.S. Geological Survey's annual Water Resource Data-N.C. report. Staff members from each of these agencies as well as other appropriate state and federal agencies met on many occasions in early 1988 to develop the baseline monitoring plan. The plan attempts to provide data on information gaps that exist in water quality monitoring efforts and a means to evaluate the long-term effectiveness of the management strategies implemented.

As part of the negotiated designation agreement between the U. S. Environmental Protection Agency and the A/P Study, a milestone of March, 1988, was identified for a final baseline monitoring plan to be completed. This program was implemented beginning in October, 1988. The following plan resulted from the combined expertise of appropriate state and federal agency staff (U.S. Environmental Protection Agency [EPA], U.S. National Oceanic and Atmospheric Administration [NOAA], N.C. A/P Study, N.C. Division of Environmental Management [DEM], and N.C. Division of Marine Fisheries [DMF]), and represents probably the most comprehensive baseline program ever implemented in the southeastern United States.

EPA guidance for conducting a National Estuarine Program Study was used to augment the Department of Natural Resources and Community Development's ongoing ambient monitoring program. That program is conducted in part for preparing North Carolina's Water Quality Inventory required by **Section 305(b)** of the Clean Water Act. Data will be utilized by the A/P Study for the following purposes:

A) construct a comprehensive baseline dataset to characterize the water quality, sediment and biological resources of the Albemarle-Pamlico system, basinwide;

B) evaluate the spatial and temporal heterogeneity inherent in parameters of concern in this system, to allow adequate evaluation of temporal trends in historical and A/P Study-generated datasets;

C) evaluate and characterize episodic events of great concern (fish kills, anoxia, etc.) which currently escape systematic review;

D) provide ground-truth and calibration to remotely sensed water quality datasets expected to be used to validate land

use/land cover-driven watershed models and to understand large-scale hydrologic phenomena; and

E) be used to develop by November, 1992, a continuing monitoring program which is intended to evaluate the long-term status of this important estuarine system.

This baseline monitoring program was designed at the specific request of EPA, in response to the Office of Marine and Estuarine Protection's interpretation of the 1987 amendments to the Clean Water Bill requirements. A/P Study supplemental monitoring funds were utilized to activate this program. Considerable cost-sharing by program collaborators (especially USGS) has been included to maximize the return from this effort.

PROGRAM COMPONENTS

The comprehensive baseline monitoring plan has seven principal components which include:

1) implementation of a trained citizens' monitoring program;

2) emergency response capabilities to chronicle episodic events;

3) continuous monitors for specific parameters sited at locations of known importance or risk;

4) expansion in time and space of the existing ambient water quality monitoring network, especially into open water areas;

5) survey of fish tissue toxicants and review of ongoing characterization of sediment studies;

6) conduct a one-time synoptic water quality study basinwide;

7) measurements of sediment oxygen demand (SOD) in critical areas.

Each of these components is critical to the adequate characterization of the dynamic parameters of greatest concern in this system. Figure 1 indicates the monitoring stations of the Citizens' Water Quality Monitoring (CWQM), U.S. Geological Survey and N.C. Division of Environmental Management's ambient stations which are three major components to characterize the long-term status of this estuarine system. It must be noted that this monitoring plan is changeable due to the evolution of the A/P Study and new information that becomes available during the study period.

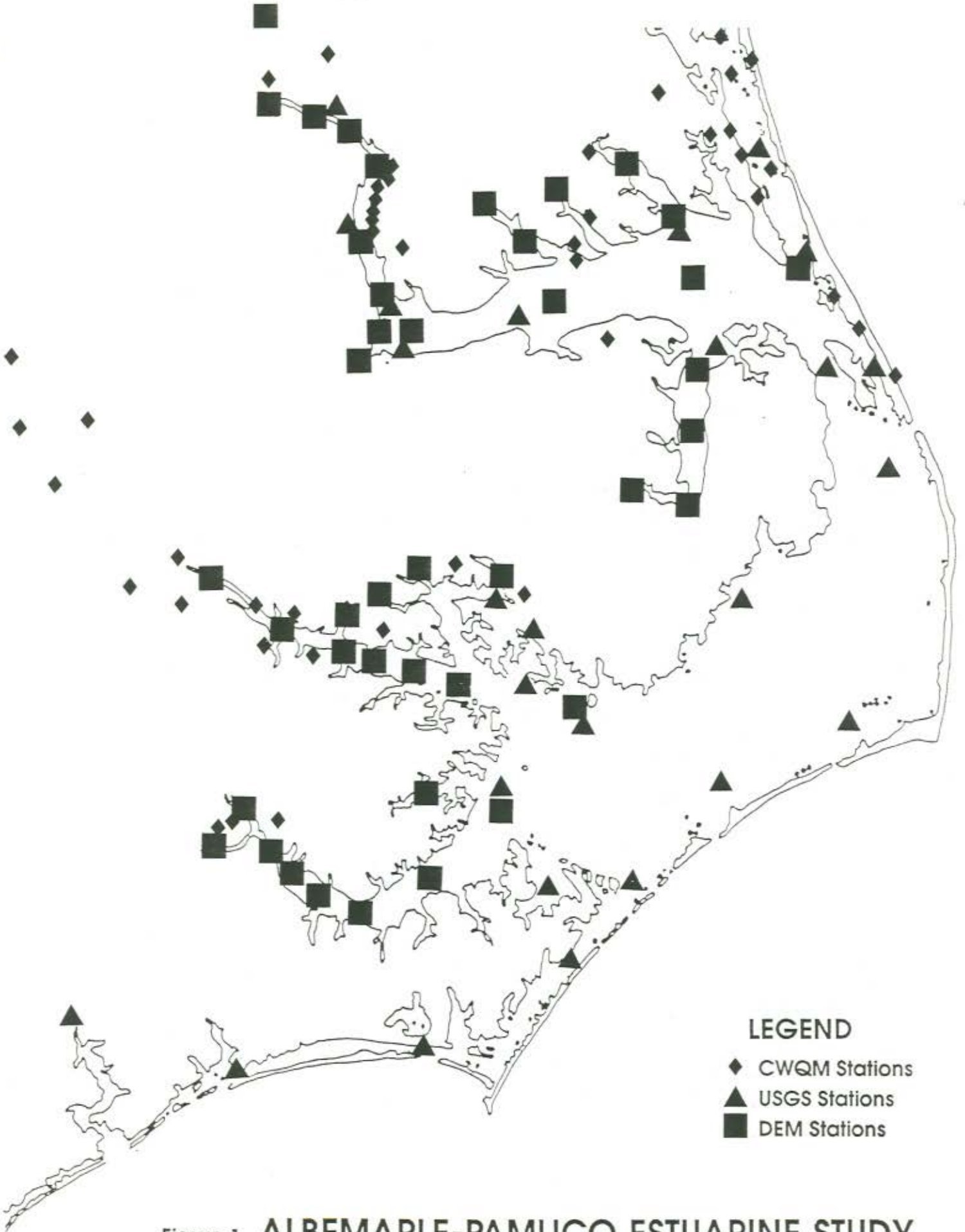


Figure 1. **ALBEMARLE-PAMLICO ESTUARINE STUDY**
Water Quality Monitoring Stations

CITIZENS' WATER QUALITY MONITORING PROGRAM
Pamlico-Tar River Foundation

The Pamlico-Tar River Foundation (PTRF) was funded by the A/P Study in October, 1987, to design and implement a pilot program for Citizens' Water Quality Monitoring (CWQM) water quality monitoring using volunteers on the Tar-Pamlico basin. The goals of the project were to: (1) provide general public participation in the estuarine study; and (2) develop a credible scientific database to supplement the current monitoring of water quality by government agencies.

In planning the program, PTRF solicited input from the Policy, Technical and Citizen's Advisory Committees of the Albemarle-Pamlico Estuarine Study (A/P Study), as well as North Carolina agency water quality professionals. To insure scientific validity, a support committee of area scientists was consulted. A final facet of the planning was an exhaustive review of existing lay monitoring programs. The Citizen Program for the Cheseapeake Bay (CPCB) was adopted as a prototype.

PTRF equipped and trained 16 volunteers who began collecting samples in April, 1988, at nearshore sites in the Tar-Pamlico watershed. They introduced the program and methodology to other interested parties in the A/P Study region. Water and air temperature are determined with a field thermometer; pH, with a wide-range color comparator kit; dissolved oxygen, with a micro-winkler titration kit; salinity by means of a specific gravity hydrometer; and turbidity or limit of visibility, by means of Secchi disk depth measurement.

At the upstream, fresh water sites salinity is not measured, but nitrate-nitrogen and phosphate are, both by use of color comparator kits. Each monitor follows strict procedures and records their test results on a standardized form. The form is mailed to the project coordinator for verification and entry into a computer file.

Quality assurance began with informed planning and continues through every aspect of the program. Volunteers are trained at workshops held in different areas throughout the A/P Study Region. Follow-up calls and visits are made to the monitors to answer questions and discuss any problems. In addition, on August 6, 1988, and on June 14, 1989 PTRF held "quality control session" workshops, with state and federal officials, to review and test sampling and data handling procedure.

This program has captured the imagination of people throughout the estuarine region and it has been funded on a larger scale. PTRF has continued to be the organization to administer the formative stages of the program. A full-time project coordinator has been on-staff since October 1988. The program expansion began on October 1, 1988, and included the entire A/P Study region. By June, 1989, there were a total of 64 sites with an expected number of approximately 85 sites by the end of 1989. Table 1 and Figure 2 indicates the location of the citizens' monitoring stations as of March 1989.

EMERGENCY RESPONSE CAPABILITY
Division of Marine Fisheries and
Division of Environmental Management

The Pamlico Environmental Response Team (PERT) was created in June, 1988, to address the increasing environmental problems of the Pamlico River. Over the past ten years the area has experienced numerous fish kills, chronic low dissolved oxygen levels, fish disease, crab disease, algae blooms, loss of submerged aquatic vegetation and other symptoms of degraded water quality. These events indicate a decline in the overall health of the estuary.
Generally, the N.C. Division of Environmental Management (DEM) and the Division of Marine Fisheries (DMF) staff in the Washington Regional Office of NRCD have worked together to respond to events. With the creation of PERT, a full-time four member team is working to respond to problems of the Pamlico River. Jess Hawkins and Raleigh Bland of DMF comprise one-half of the team and Barry Adams and Cathy Tyndall of DEM complete the team.

Since their formation in June, 1988, the team has responded to fish kills and algae blooms and has implemented a sampling system utilized by PERT members to gather water quality data and to tie into special studies and routine water sampling on the Pamlico. A main function of PERT has been to monitor and coordinate studies being conducted by universities, state and federal agencies and local citizen groups. Although not directly funded by the A/P Study, the team also works closely with the A/P Study to coordinate and offer help or suggestions in Pamlico-related projects. PERT members have been involved in studying the Agricultural Cost Share Program, agricultural practices and animal operations affecting the Tar-Pamlico River Basin.

PERT has actively been involved in a cooperative effort between DMF and the North Carolina State University School of Veterinary Medicine. This effort involves planning and implementing research activities related to the ulcerative mycosis fish disease project.

TABLE 1. Citizens' Monitoring Stations

STATION NO.	LATITUDE			LONGITUDE		
11A	76	15	17.10	35	54	56.39
11CS	75	57	11.54	36	20	33.61
11P	76	48	38.72	35	31	15.95
13A	76	22	58.51	36	4	52.57
13CS	75	54	59.93	36	23	14.81
14A	76	23	39.46	36	5	16.33
14CS	75	47	39.77	36	4	37.02
15CS	75	57	59.18	36	25	40.49
16A	75	38	18.83	35	57	26.26
18A	75	41	33.89	36	3	3.43
19P	76	38	58.88	35	31	6.05
1A	76	13	9.23	36	20	10.13
1C	76	41	54.91	36	14	4.85
1CSV	75	55	1.99	36	40	17.51
1N	77	8	47.31	35	3	34.65
1P	77	3	35.32	35	32	34.95
1T	78	18	11.68	36	5	49.95
2C	76	41	36.70	36	14	8.57
2CSV	76	1	59.37	36	43	14.22
2N	77	8	5.26	35	4	9.56
2P	77	1	52.37	35	31	43.43
2T	77	46	9.51	35	57	51.97
3A	76	13	1.86	36	18	9.41
3C	76	42	12.30	36	13	52.57
3CS	75	59	30.02	36	31	36.04
3N	77	2	57.13	35	5	12.47
3T	77	32	56.28	35	55	42.90
4C	76	42	31.31	36	13	28.57
4CS	76	5	57.95	36	29	28.59
4T	77	32	31.85	36	0	10.29
5A	76	19	58.49	36	8	6.58
5C	76	42	44.93	36	13	6.48
5P	77	1	54.11	35	30	10.44
5T	77	22	38.10	35	37	3.66
6C	76	42	56.32	36	12	47.60
6CS	76	0	49.45	36	26	56.66
6T	77	13	39.23	35	36	31.51
7A	76	54	24.76	36	30	30.73
7C	76	43	1.68	36	12	10.91
7CS	75	49	48.38	36	22	8.63
7P	76	57	42.47	35	30	19.91
7T	77	12	13.24	35	35	6.20
8C	76	40	21.41	36	11	23.85
9A	76	57	16.20	36	26	6.82
9CS	75	54	14.32	36	19	50.04
9T	77	6	27.11	35	34	15.84

KEY:
A-Albemarle Sound P-Pamlico R. N-Neuse R. CSV-Currituck Sound(Va)
CS-Currituck Sound C-Chowan R. T-Tar R.

Figure 2. Citizen's Monitoring Station Locations

Members of the team have assisted the Veterinary School's research technicians in capturing and transporting Atlantic menhaden to holding pens and tanks placed at designated study points along the Pamlico River. Research information from the fish tank and pen monitoring project should yield information related to the geographic distribution of the disease and possible associated water quality parameters.

PERT is also cooperating with the N.C. State Veterinary School and the National Marine Fisheries Service in the A/P Study's investigation of blue crab disease. By examining diseased and healthy crab specimens, investigators hope to determine whether biological agents are present which may be important in protecting against bacterial invasion and disease.

A fisherman monitoring network is operating along the river from Washington to South Creek to Belhaven. Currently, 13 fishermen are recording useful data such as weather details, pounds of fish and crabs caught, and the number of diseased animals captured. The data are incorporated into the PERT database.

The PERT team is also coordinating with the Citizens' Monitoring Program. Water quality information is being exchanged by the two groups in order to supplement the state's ambient water quality network. This data will be utilized to help determine the water quality trends within the A/P Study area.

CONTINUOUS MONITORS
U. S. Geological Survey

Background

The hydrologic and water-quality database for the rivers of North Carolina extends back over 50 years at many locations. A continuous record of water quality information collected at regular intervals is, however, somewhat rare for much of the state's estuarine waters, as it is for much of the nation's estuarine resources. An investment in estuarine water-quality data collection and analysis should prove to be just as profitable as similar historical and ongoing riverine efforts.

The first clear statements of the need for coordinated estuarine monitoring programs were the result of a National Academy of Sciences (1970) Workshop in 1970 (Pearce and Despres-Patanjo, 1988). Proceedings from a second workshop in 1977 (National Academy of Sciences, 1977) noted that monitoring data can provide information to (1) control waste discharges, (2) measure trends in water quality, (3) detect the response of organisms to changes in habitat quality, and (4) detect new environmental problems in their early stages.

A network of continuous water-quality monitors are located at a number of critical locations throughout the Albemarle-Pamlico (A/P) Sounds: (1) to establish baseline water-quality conditions and evaluate the effectiveness of management actions as stipulated by the Designation Agreement, and (2) to gain an understanding of the temporal and spatial dynamics of water-quality and related biological processes in the A/P Sounds in particular, and in estuarine systems in general. Such a system of continuous monitors of water quality has been installed in the A/P system by the U.S. Geological Survey (USGS). This expansive network of monitors must be maintained to meet existing commitments and needs.

Salinity, temperature, and dissolved oxygen are three estuarine water-quality parameters which are spatially and temporally variable, which are physically, chemically, and biologically significant, and which are monitorable using in situ probes. For example, salinity varies with tides, freshwater inputs, and flow conditions, all of which vary with time and location. Because of the density field created by salinity gradients, salinity affects (and is affected by) the hydrodynamics of the system so that there is a coupling between salinity and flow conditions. Salinity fields are also important biological factors affecting species productivity and diversity. Likewise, dissolved oxygen changes in response to flows, to the salinity-controlled density field, to diurnal variations in community metabolism, and to variable water-quality loadings. Dissolved oxygen is an important indicator of waste loadings and is critical to the biological health of the system.

Fish kills, typically resulting from oxygen-depleted waters, are not an uncommon happening in some areas of the Albemarle-Pamlico region. In order to better understand these events and perhaps reduce the frequency and magnitude of the kills, it is crucial to determine the water-quality conditions which precipitated the kills. Usually, however, these incidents are reported to resource managers many hours or even days after the event occurred. Consequently, by the time sampling is initiated, water-quality conditions may have changed or, more likely, the waters responsible for the kill will have moved and be impossible to locate. Real-time, continuous water-quality information near locations which have historically experienced fish kills is needed to predict the onset of critical conditions and to prepare for emergency response to the conditions.

Objectives

The objective of this investigation is to provide water-quality information which is needed to determine baseline water-quality

conditions, to evaluate the effects of management actions and to provide insight into the dynamics of water-quality processes. More specifically, the objectives are as follows:

1) Implement and maintain a network of water-quality sensors at about 40 sites in the Albemarle-Pamlico region, with continuous monitoring of temperature, conductivity, and dissolved oxygen

2) Install and maintain real-time data-transmission instrumentation as funding becomes available.

3) Provide an annual summary and analysis of the water-quality data to evaluate spatial and temporal trends in water-quality conditions, to develop a better understanding of A/P physical, chemical, and biological processes, and to provide insight into estuarine dynamics in general.

Approach

Data-collection sites were selected in coordination with representatives of the Division of Environmental Management (DEM), the Division of Marine Fisheries (DMF), and, in some cases, local agencies. Site selection was also discussed with other researchers conducting investigations in A/P waters.

Twenty-six of these sites are listed in Table 2 and shown in Figure 3. Five of the installations are on bridges. Pilings to support the instrumentation will be installed at three locations (Currituck Sound Big Narrows Lt. 1, Rose Bay Lt. 6, and Rose Bay Lt. 2). The remaining 18 installations have been placed on Coast Guard multi-pile aids-to-navigation.

Continuous water-quality monitoring is also occurring as part of the A/P Study-USGS cooperative investigation of flows and flow patterns in the Pamlico River and in the Neuse River. The sites are shown in Figures 4 and 5, and identified in Table 3.

The monitoring program in the Pamlico and Neuse Rivers was originally designed to provide information needed to determine flow rates. The program was later revised to provide information which is compatible with the data collected at the 27 sites described in this document. The combined monitoring network, which includes 37 sites at which dissolved oxygen is measured at three depths, and conductivity 15 measured at two depths, and temperature is measured at one point, provides excellent spatial and temporal coverage of the waters of the Albemarle-Pamlico system. Conductivity measurements are presently being expanded to readings at three depths. The network may be expanded to 40 sites as funding becomes available.

TABLE 2

USGS Continuous Water-Quality Monitoring Site Locations

NUMBER	SITE	LAT (NORTH)	LONG (WEST)
1	Chowan R. Lt. 22	36°21'48"	76°46'42"
2	Chowan R. Lt. 5	36°10'02"	76°44'38"
3	Chowan R. Hwy. 17 Bridge	36°01'10"	76°40'20"
4	Roanoke R. Lt. 1	35°57'17"	76°39'52"
5	Albemarle S. Lt. 3	36°00;06"	76°23'36"
6	Pasquotank R. Slue Lt. 1	36°09'06"	76°01'18"
7	Alligator R. Lt. 8	35°55'58"	75°39'47"
8	Currituck S. Big Narrows Lt. 1	36°17'38"	75°51'32"
9	Currituck S. Hwy. 158 Bridge	36°05'15"	75°46'06"
10	Croatan S. Hwy. 264 Bridge	35°55'06"	75°44'50"
11	Roanoke S. Channel Lt. 22	35°53'00"	75°37'30"
12	Old House Channel Lt. 24	35°42'53"	75°37'45"
13	Stumpy Pt. Warning Lt. E	Could not be used	
14	Far C. Lt. 1FC	35°30'30"	75°57'24"
15	Rollinson Channel Lt. 42RC	35°16'42"	75°44'18"
16	Pungo R. Channel Lt. 18	35°31'04"	76°29'48"
17	Rose Bay Lt. 6	35°26'55"	76°25'07"
18	Rose Bay Lt. 2	35°22'25"	76°25'38"
19	Swanquarter Bay Ent. Lt. 1SQ	35°17'42"	76°18'24"
20	Neuse R. Junction Lt.	35°08'42"	76°30'06"
21	Nine Foot Shoal Channel Lt. 9	35°08'30"	76°02'30"
22	West Bay Lt. 7	34°59'18"	76°24'18"
23	Core S. Lt. 9	34°58'47"	76°13'06"
24	Core S. Lt. 27	34°50'37"	76°22'00"
25	Core C. Lt. 29	Not Permitted	
26	Hwy. 70 Bridge at Morehead City	34°43'16"	76°41'40"
27	Bogue Inlet Ch. Lt. 17	34°49'20"	77°06'26"
28	New R. Lt. 12	Not Permitted	
29	New R. Hwy. 17 Bridge	34°45'11"	77°26'04"

Figure 3. USGS Continuous Water-Quality Monitoring Site Locations. (Site numbers identified in Table 2.)

TABLE 3

USGS Continuous Water-Quality Monitoring Site
In The Pmlico And Neuse Rivers

	SITE	LAT(NORTH)	LONG(WEST)
Pamlico River			
1	Pamlico R. Channnel Lt. 16	35°30'30"	77°01'12"
2	Pamlico R. Lt. 5	35°25'48"	76°50'30"
3	Pamlico R. Lt. 4	35°24'47"	76°45'52"
4	Pamlico R. Lt. 3	35°21'24"	76°38'48"
5	Goose C. Lt. 6	35°19'54"	76°37'06"
8	Pungo R. Junction Lt. PR	35°22'42"	76°33'24"
Neuse River			
9	Neuse R. Channel Lt. 22	35°04'48"	77°00'24"
10	Neuse R. Channel Lt. 11	34°59'56"	76°56'36"
11	Neuse R. Channel Lt. 9	34°56'54"	76°48'36"
12	Adams C. Lt. 4	34°57'24"	76°40'54"
14	Neuse R. Lt. 7	35°00'30"	76°39'42"

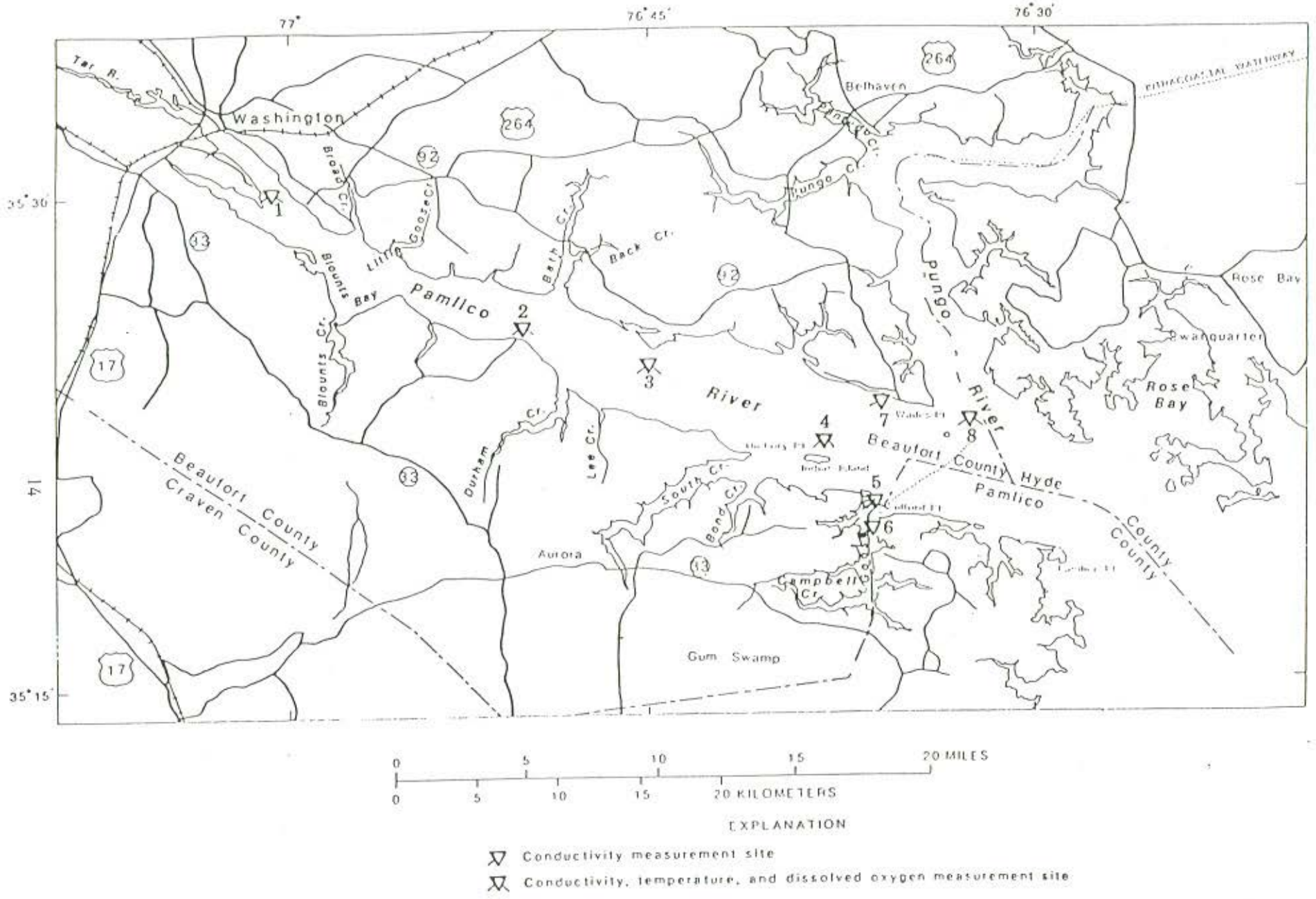


Figure 4.--Pamlico River water-quality measurement sites.

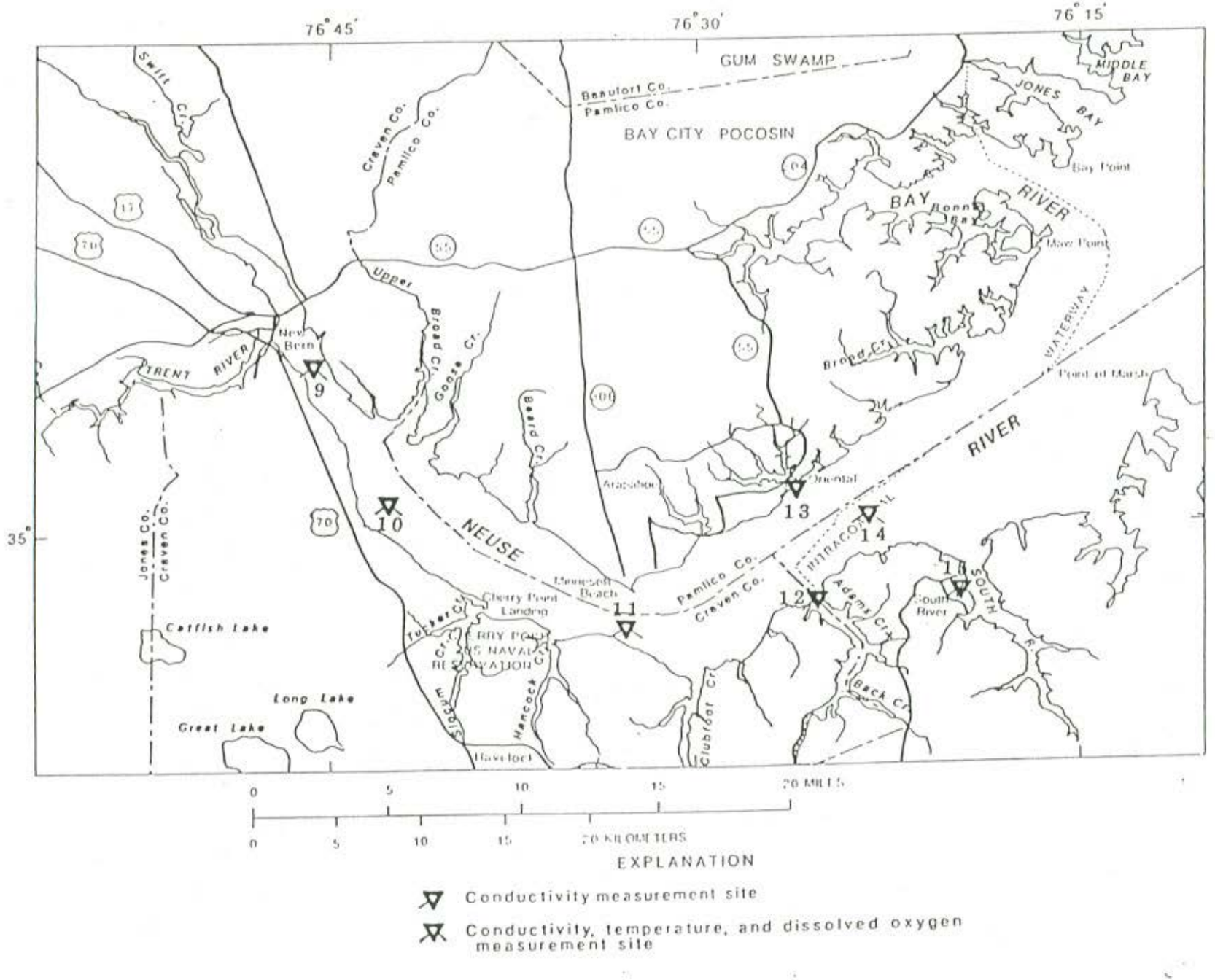


Figure 5.--Neuse River water-quality measurement sites.

Data Collection

Water quality will be measured using the USGS Water-Quality Mini-Monitor. The eight-channel Mini-Monitor is capable of measuring conductivity, temperature, dissolved oxygen, and pH. For this investigation, the typical arrangement will be dissolved oxygen measured at three depths, conductivity measured at three depths, and temperature measured at one depth. Salinity will be determined from the conductivity and temperature data. Salinity-corrected dissolved-oxygen values will also be determined.

The Mini-Monitors will be controlled using an electronic data logger. The data logger will also store data for subsequent retrieval. Readings will be taken at 15-minute intervals. The data logger and the Mini-Monitor operate on 12-volt batteries.

As funds become available, selected sites will be equipped with data-collection platforms (DCPs) capable of transmitting data to satellite for relay to ground stations. Data transmissions will occur about every three to four hours. It may be possible to move the DCPs from site to site as needs dictate.

The instruments will be housed in a water-tight fiberglass shelter. The fiberglass shelter is lightweight and corrosion resistant. The data loggers will be further protected by a water-tight aluminum instrument box placed inside the fiberglass shelter. Probes will be placed in PVC pipes extending downward from the shelter. One pipe will enclose the two or three probes for monitoring at one particular depth. Consequently, three pipes will be utilized. The pipes will be attached to the pilings both above and below the water surface.

The instruments will be serviced every two to three weeks. Probes will be cleaned and field-calibrated at that time. USGS quality-control and quality-assurance procedures will be followed for instrument maintenance and calibration, data collection, and employee training.

Data Analysis

Data will be officially published annually. Prior to publication, the data will be thoroughly checked and quality assured. Preliminary data will be available to resource managers upon request. The necessary arrangements will also be made to provide resource managers direct access to the USGS water-quality database.

Spatial variations in the water-quality data will be evaluated.

Areas which appear to have oxygen-depleted waters and which have depressed salinities will be identified. Likewise, sites at which vertical stratification occurs will be identified.

Evaluation of temporal variations in dissolved oxygen and salinity will also be conducted. Seasonally, the occurrence of long-term trends (after sufficient data have been collected) and the frequency of stratification will be determined.

Temporal and spatial variations will also be examined in relation to meteorological and tidal data collected as part of the USGS investigation of flows and flow patterns in the Pamlico and Neuse estuaries. This evaluation will be a first step toward linking water-quality variations to physical processes.

AMBIENT, SYNOPTIC AND BIOLOGICAL MONITORING
Division of Environmental Management

Background

The ambient, synoptic and biological monitoring elements of the baseline monitoring plan are designed to account for spatial variability within the system with as much resolution as is feasible within fiscal limitations. Temporal variability can only be addressed through continuation of baseline data collection. Comprehensive baseline information is useful to researchers conducting intensive work within localized areas in interpreting their results relative to spatial and temporal variability within the system. Such data is also useful on a regional or national basis in comparisons of baseline data in large estuarine systems. Another primary benefit within these elements is the acquisition of nutrient data within a large estuary in coordination with a relatively large effort by USGS to identify water movement. The combined information should enhance future efforts to develop nutrient budgets.

Objectives

The Division of Environmental Management's comprehensive baseline effort has four main objectives:

1) expand ambient sampling network of pertinent water quality parameters to assess existing conditions and measure spatial and temporal heterogeneity within the system;

2) survey of fish tissue toxicants and review ongoing characterization of sediment studies;

3) conduct a synoptic water quality study basinwide;

4) measure sediment oxygen demand (SOD) in critical areas

Approach

Expand Ambient Water Quality Network

An extensive review of existing and historical water quality information was conducted to assess needs within the ambient network. The location of tide gages and continuous monitoring sites by USGS were also considered in selection of new sites and reactivation of old sites. New stations were transect arranged, in the areas of highest concern, to correspond with flow modeling efforts and maximize spatial coverage. The coordinated plan results in a network of physical, chemical, and biological information with maximum utility by researchers and managers.

Expanded Ambient Water Quality Network
Parametric Coverage

Dissolved Oxygen	Total Organic Carbon	Sulfide
Temperature	Turbidity	NH_3 as N
pH	Chloride	TKN as N
Conductivity	Chlorophyll-a Tri	$NO_2 + NO_3$
Salinity	Chlorophyll-a Corr	P Total
Residue Total	Pheophytin-a	PO_4
Residue Suspended	Selected metals	Sulfate

Sampling frequency varies with parametric coverage but generally involves collections once monthly throughout the network, with twice monthly collections at selected stations during the summer months. Locations of stations within the existing and expanded network are presented in Table 4 and Figure 6.

Survey of Fish Tissue Toxicants/Sediment Characterization

The majority of existing data relative to fish/shellfish tissue contaminants were generated with localized surveys. DEM implemented a comprehensive baseline program in 1989 to determine baseline levels of synthetic organic chemicals and metals in the biota of the estuary. This effort includes 12 primary stations, 9 secondary stations, and 5 stations near boat repair facilities as seen in Figure 7. Selection of stations entailed review of historical information and coordination with appropriate agencies, especially DMF.

Fish tissue analyses may best reflect the impact and accumulation of anthropogenic substances. This work will provide comparative data with studies being conducted by the U.S. Fish and Wildlife Service on a baseline contaminants study of the Albemarle-Pamlico peninsula and the counties north of the Albemarle Sound (fish, reptiles, birds). Due to expense of these analyses and historical lack of laboratories capable to producing comparable data, the national database is relatively small. Therefore, utility of this information will be well beyond the A/P Study area. Assessment of

TABLE 4

EXPANDED AMBIENT NETWORK STATION LOCATIONS 1989

MAP #*	STATION #	STATION LOCATION	LAT			LON		
1	02050079	CHOWAN RIVER NR RIDDICKSVILLE NC	36	31	54	76	55	17
2	02053244	CHOWAN RIVER AT US HWY 13 AT WINTON, NC	36	26	10	76	57	15
3	0205325510	CHOWAN RIVER @ CHANNEL MARKER #27 NR RAYS BEACH, NC	36	22	15	76	50	15
4	02053574	CHOWAN RIVER AT CHANNEL MARKER #16 NR GATESVILLE, NC	36	34	24	76	44	06
5	0205360615	CHOWAN R DS HOLIDAY ISLAND NR HARRELLSVILLE	36	16	30	76	41	00
6	02053632	CHOWAN RIVER AT COLERAIN, NC	36	11	42	76	44	05
7	02053652	CHOWAN RIVER @ US HWY 17 @ EDENHOUSE NC	36	02	50	76	41	50
8	02081145	ALBEMARLE SOUND NR EDENTON NC (TRANSECT)	35	59	30	76	36	30
9	02081172	ALBEMARLE SOUND NR HARVEY NECK NC (TRANSECT)	36	01	20	76	18	30
10	0208114330	ALBEMARLE SOUND NR BLACK WALNUT, NC ()	35	57	55	76	39	50
11	02081141	ROANOKE RIVER AT NC HWY 45 NEAR SANS SOUCI, NC	35	53	51	76	43	49
12	02043892	PERQUIMANS RIVER AT SR 1336 AT HERTFORD, NC	36	11	40	76	28	00
13	02043884	LITTLE RIVER NEAR WEEKSVILLE, NC	36	07	54	76	12	42
14	02043906	PERQUIMANS RIVER AT HARVEY POINT NEAR HERTFORD, NC	36	06	48	76	17	10
15	02043862	PASQUOTANK RIVER AT ELIZABETH CITY, NC	36	16	15	76	08	06
16	02043878	PASQUOTANK RIVER NEAR OLD TRAP, NC	36	12	05	76	03	20
17	0208117840	ALLIGATOR RIVER AT US HWY 64 NEAR ALLIGATOR, NC	35	54	00	76	00	30
18	0208117830	ALLIGATOR R 3MI AB CATFISH PT NR FRY PAN LNDG	35	48	00	76	01	00
19	0208117820	ALLIGATOR R @ NEWPORT NEWS PORT NR GUM NECK	35	40	05	76	02	25
20	0208117810	ALLIGATOR R US CHERRY RIDGE LNDG NR GUM NECK NC	35	41	58	76	09	20
21	0208455650	PUNGO RIVER AT US HWY 264 NEAR PONZER, NC	35	34	25	76	30	00
22	0208455850	PANTEGO CREEK AT NC HWY 92 AT BELHAVEN, NC	35	32	30	76	38	15
23	0208457020	PUNGO CREEK AT NC HWY 92 AT SIDNEY CROSSROADS, NC	35	29	50	76	40	20
24	02084534	BATH CREEK AT NC HWY 92 NEAR BATH, NC	35	28	30	76	49	05
25	0208451950	PAMLICO RIVER AT MOUTH OF BROAD CREEK (TRANSECT)	35	27	52	76	57	19
26	02084472	PAMLICO RIVER @ US HWY 17 WASHINGTON, NC	35	32	33	77	03	43
27	0208454450	PAMLICO RIVER AT HICKORY POINT (TRANSECT)	35	22	23	76	38	47
28	02092682	NEUSE RIVER AT MOUTH NEAR PAMLICO, NC	35	02	42	76	35	15
29	02092674	NEUSE RIVER AT MILE #12 NEAR ORIENTAL, NC	34	59	45	76	41	10
30	02092586	NEUSE R AT MOUTH OF BROAD CRK NR THURMAN NC	35	02	30	76	59	00
31	02092162	NEUSE RIVER AT US HWY 17 AT NEW BERN, NC	35	06	42	77	01	37
32	02092500	TRENT RIVER AT SR 1129 NEAR TRENTON, NC	35	03	54	77	27	24
A	02042955	CURRITUCK SOUND AT POINT HARBOR, NC	36	05	12	75	46	00
B	M390000	ALBEMARLE SOUND NR FROG ISLAND (TRANSECT)	36	04	20	76	04	00
D	O8498000	PAMLICO RIVER @ LT 5 NR CORE POINT (TRANSECT)	35	25	50	76	46	07
E	O8650000	PAMLICO RIVER @ LT 4 NR GUM POINT (TRANSECT)	35	24	15	76	45	55
F	O9825000	PAMLICO RIVER @ PUNGO R. MARKER PR (TRANSECT)	35	21	00	76	29	00
G	O9850000	PAMLICO SOUND @ GREAT ISLAND MARKER 1	35	17	35	76	14	05
H	J9950000	BAY RIVER @ FL #5 NR VANDEMERE	35	10	02	76	39	01
I	J9530000	NEUSE RIVER LT 9 NR MINNESOTT BEACH	34	56	07	76	48	31
J	J8910000	NEUSE RIVER LT 11 NR RIVERDALE	34	59	57	76	56	40
K	J8900800	NEUSE RIVER @ LT 22 NR FAIRFIELD HARBOUR, NC	35	04	48	77	00	25
	02047370	NOTTAWAY RIVER AT US HWY 258 NEAR RIVERDALE, VA.	36	34	00	76	56	47
	02050065	BLACKWATER RIVER @ HORSESHOE BEND @ CHERRY GROVE, VA.	36	34	35	76	55	06
	0205007750	BLACKWATER RIVER 150YDS US MTH NR WYANOKE NC	36	32	48	76	55	03
	02053500	AHOSKIE CREEK AT NC HWY 350 AT AHOSKIE, NC	36	16	50	77	00	00
	0205356401	CHINKAPIN CREEK TRIB @ SR 1432 NR HARRELLSVILLE, NC	36	15	36	76	51	23
	02053569	WICCACON RIVER AT NC HWY 45 NEAR HARRELSVILLE, NC	36	18	38	76	49	52
	02053200	POTECASI CREEK AT NC HWY 11 NEAR UNION, NC	36	22	14	77	01	36
	0205321790	MEHERRIN RIVER AT SR 1175 (PARKERS FERRY) NR COMO, NC	36	26	16	76	57	12
	02043882	LITTLE RIVER AT US HWY 17 AT WOODVILLE, NC	36	14	30	76	19	30
	0208455655	INTRACOASTAL WATERWAY AT US HWY 264 NR SCRANTON, NC	35	33	25	76	26	25
	02081166	SCUPPERNONG RIVER AT SR 1105 NEAR COLUMBIA, NC	35	52	42	76	20	15
	02081185	KENDRICKS (MACKEY'S) CREEK AT SR1300 AT MACKEY'S, NC	35	55	45	76	36	40
	02081022	ROANOKE RIVER AT NC HWY 11 NEAR LEWISTON, NC	36	00	50	77	12	55
	02081054	ROANOKE RIVER AT US HWYS 13-17 AT WILLIAMSTON, NC	35	50	30	77	02	30
	02081135	ROANOKE RIVER 1.3 MI ABOVE WELCHES CK NR PLYMOUTH, NC	35	52	07	76	47	06
	02081101	CASHIE RIVER AT SR 1219 NEAR LEWISTON, NC	36	07	25	77	07	18
	02083800	CONETOE CREEK AT SR 1409 NEAR BETHEL HILL, NC	35	46	33	77	27	45
	02084160	CHICOD CREEK AT SR 1760 NEAR SIMPSON, NC	35	33	47	77	13	43
	02084171	TAR RIVER AT SR 1565 NEAR GRIMESLAND, NC	35	34	30	77	10	30
	02084392	TRANTERS CREEK AT SR 1403 NEAR WASHINGTON, NC	35	33	50	77	05	15
	02084540	DURHAM CREEK AT SR 1949 AT EDWARD, NC	35	19	25	76	52	26
	02084557	VAN SWAMP AT NC HWY 32 NEAR HOKE, NC	35	43	39	76	44	49
	02091814	NEUSE RIVER AT SR 1470 NEAR FORT BARNWELL, NC	35	18	55	77	18	30
	02091836	NEUSE RIVER AT SR 1400 AT STREETS FERRY, NC	35	12	30	77	07	20
	02092092	NEUSE RIVER BELOW SWIFT CREEK NEAR ASKIN, NC	35	11	25	77	05	55
	02092109	NEUSE R @ MTH OF NARROWS NR WASHINGTON FKS NC	35	09	30	77	04	35
	02091970	CREEPING SWAMP AT NC HWY 43 NEAR VANCEBORO, NC	35	23	30	77	13	46
	02092000	SWIFT CREEK AT SR 1478 NEAR VANCEBORO, NC	35	20	42	77	11	45
	02092084	SWIFT CREEK AT MOUTH NEAR ASKIN, NC	35	11	45	77	06	00
	0209257120	WEST PRONG BRICE CREEK AT SR 1101 NEAR RIVERDALE, NC	34	58	08	77	02	56
	0209256050	TRENT RIVER ABOVE REEDY BRANCH NEAR RHEMS, NC	35	04	30	77	07	05
* STATIONS SHOWN ON MAP HAVE A LETTER OR NUMBER IN THE MAP # COLUMN. A LETTER INDICATES AN EXPANDED NETWORK STATION.								

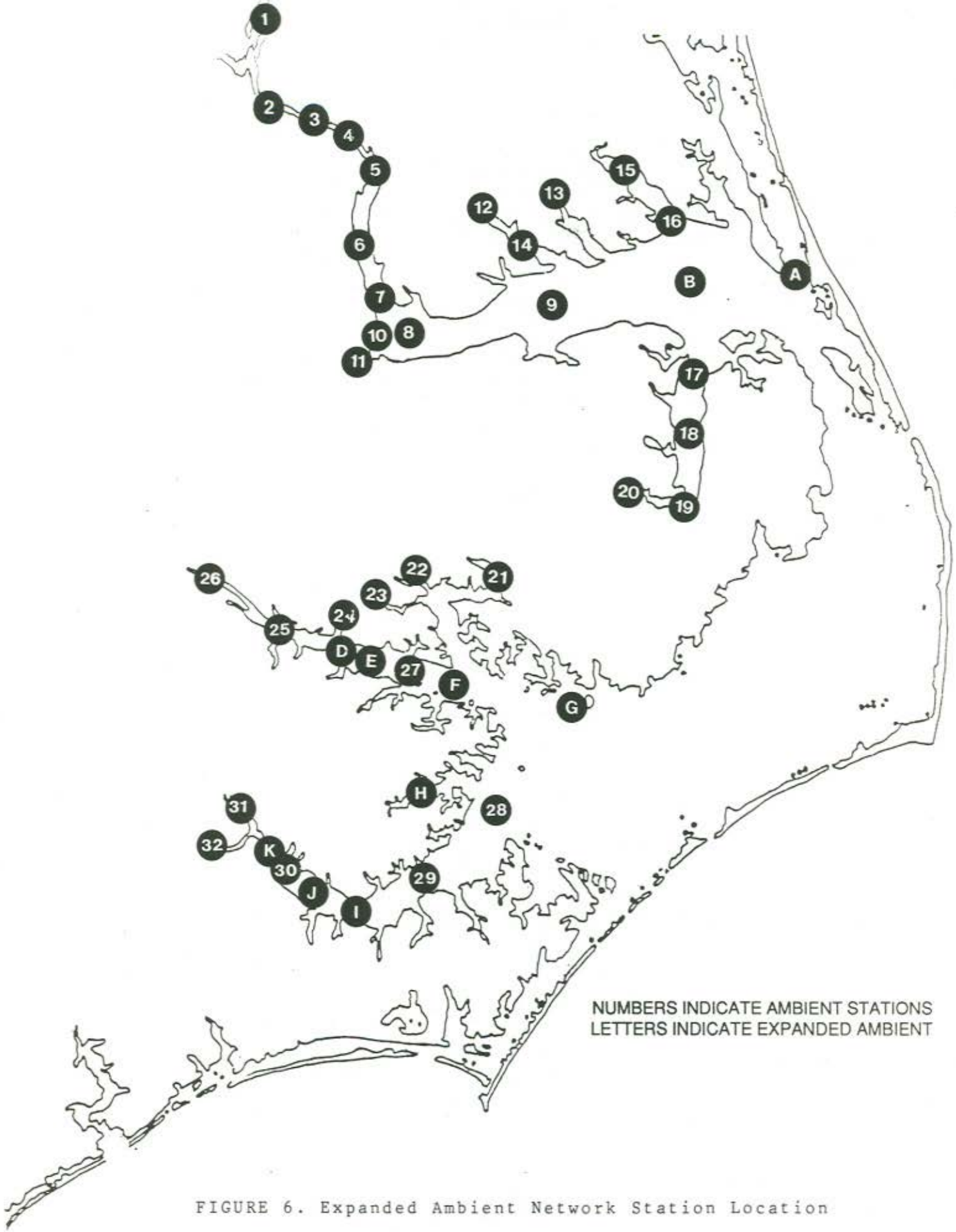


FIGURE 6. Expanded Ambient Network Station Location

PAMLICO/ALBEMARLE FISH TISSUE SAMPLING SITES

FIGURE 7

Primary Stations

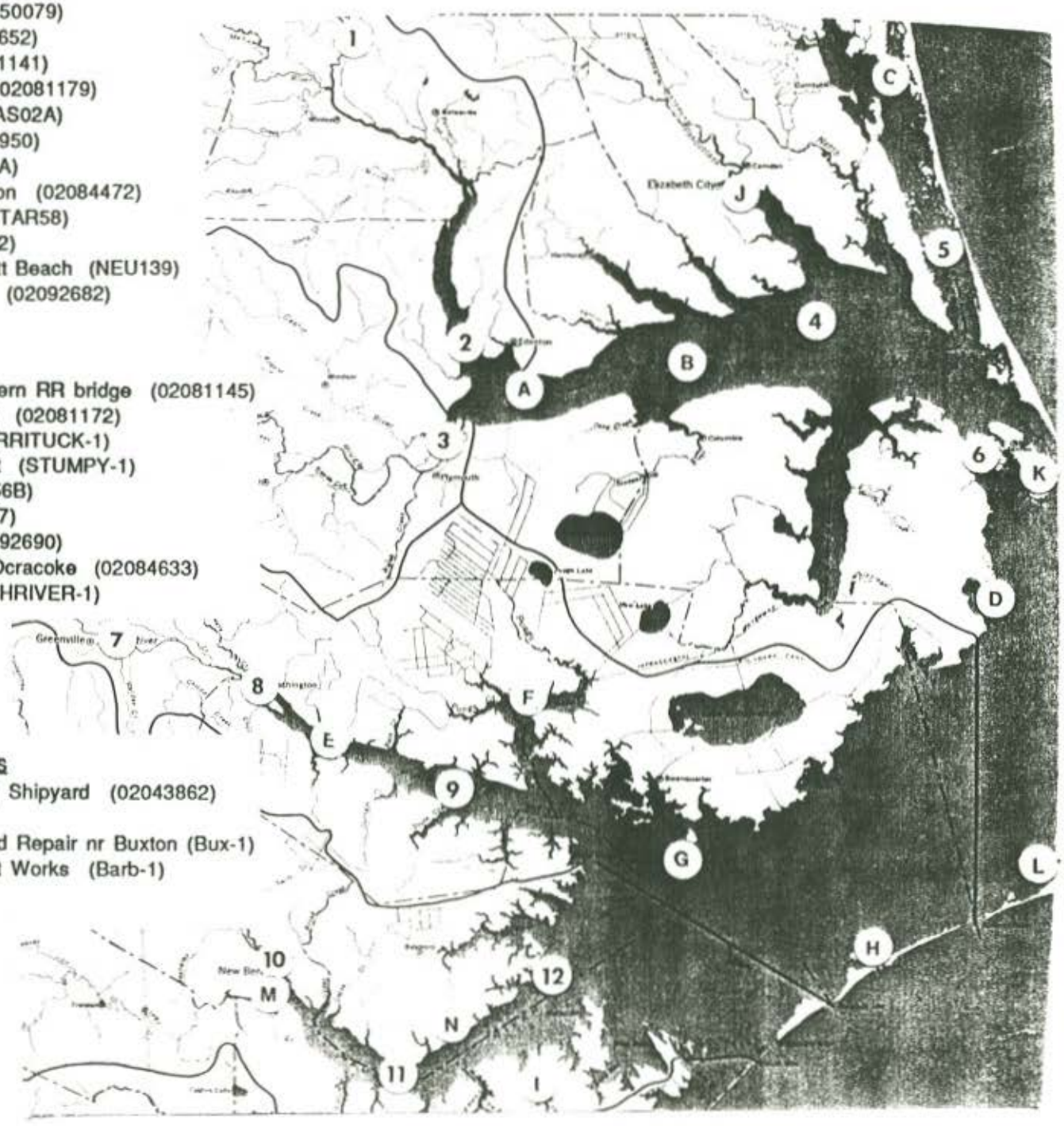
1 Chowan River at Riddicksville (02050079)
2 Chowan River at Edenhouse (02053652)
3 Roanoke River at Sans Souci (02081141)
4 Albemarle Sound near Frog Island (02081179)
5 Currituck Sound at Harbor Point (PAS02A)
6 Croatan Sound at Manteo (0208117950)
7 Tar River at Greenville (TSTAR120A)
8 Pamlico River at US-17 in Washington (02084472)
9 Pamlico River near Garrison Point (TAR58)
10 Neuse River at New Bern (02092162)
11 Neuse River at mile 20 near Minnesott Beach (NEU139)
12 Neuse River at Mouth near Pamlico (02092682)

Secondary Stations

A Albemarle Sound at Norfolk & Southern RR bridge (02081145)
B Albemarle Sound near Harvey Point (02081172)
C Currituck Sound near Currituck (CURRITUCK-1)
D Stumpy Point Bay near Stumpy Point (STUMPY-1)
E Pamlico River in Blounts Bay (TAR56B)
F Pungo River near Durants Point (P17)
G Pamlico Sound at Great Island (02092690)
H Pamlico Sound at Knoll Island near Ocracoke (02084633)
I South River near South River (SOUTHRIVER-1)

Stations near Boat Repair Facilities

J Pasquotank River near Elizabeth City Shipyard (02043862)
K Mill Creek near Wanchese (Mill-2)
L Pamlico Sound nr Scotts Boatyard and Repair nr Buxton (Bux-1)
M Trent River at mouth nr Barbour Boat Works (Barb-1)
N Whitaker Creek nr Oriental (Whit-1)



1989 survey results as well as review of results from other university and agency research will be utilized in finalizing the location and parametric coverage involved in the 1989-1990 survey.

Fish Tissue Parametric Coverage

Metals

Cadmium	Chromium
Mercury	Nickel
Lead	Arsenic
Selenium	Copper

Synthetic organics

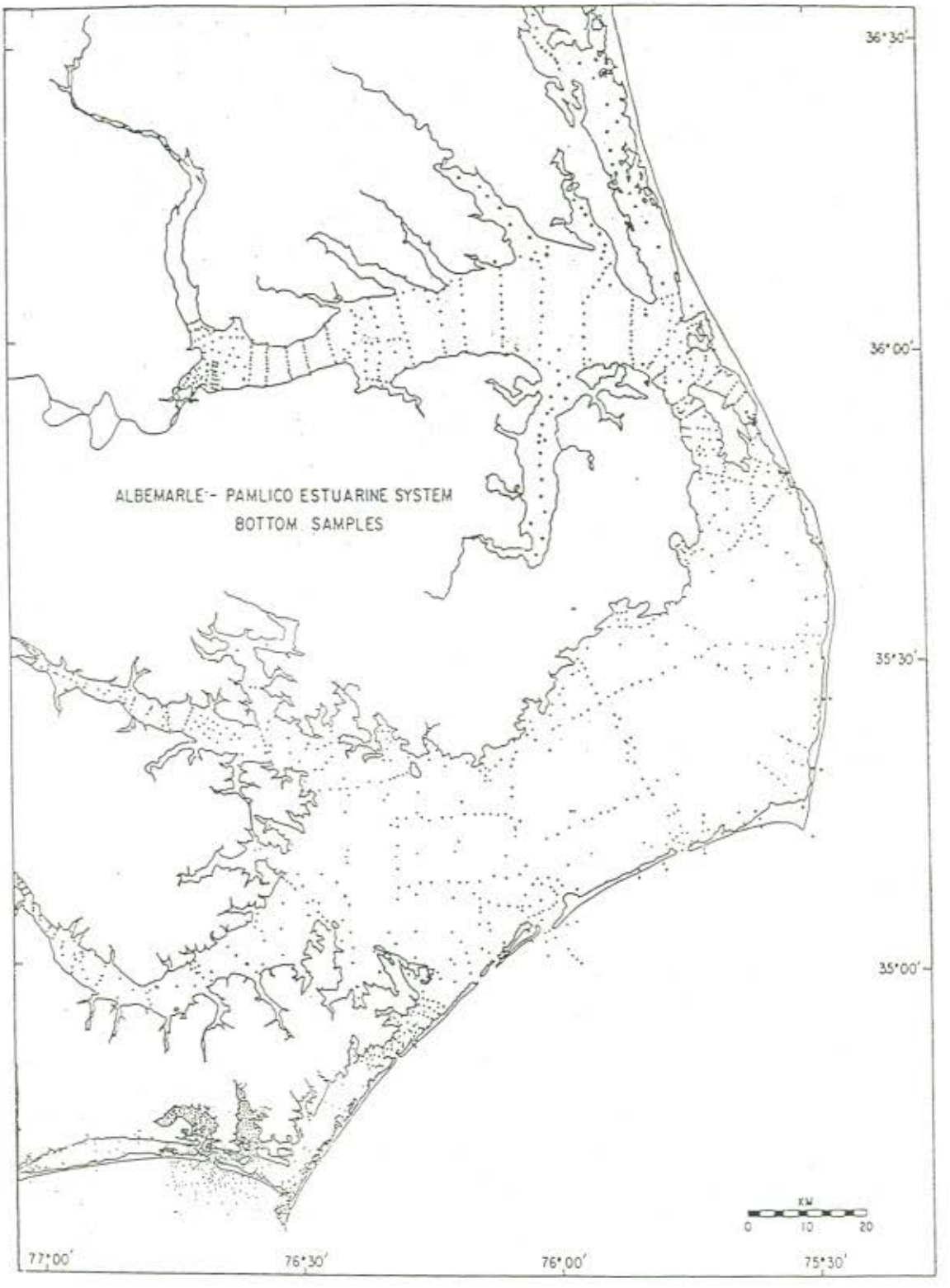
Aldrin	Dieldrnin	p,p'DDE
p,p'DDD	p,p'DDT	Endrin
Heptachlor	Heptachlor epoxide	Lindane
Endosulfan	Toxaphene	Chlorodane's
PCBs	Pentachlorophenol	Dioxin

Deposition of anthropogenic contaminants onto sediments below our surface waters provides a mechanism for concentrations of heavy metals and other toxicants may be found in the sediments when they would be below detectable levels in the water column. The estuarine areas (especially the fresh-salt water interface) are especially susceptible to deposition of these materials. Review of ongoing research efforts by Dr. John Wells (UNC-Institute of Marine Science) to define the distribution, composition and dynamics of the water column and bottom sediment along with Dr. Stanley Riggs (ECU-Dept. of Geology) work to define the heavy metals found in organic-rich muds of the estuarine system will be conducted. Figure 8 shows the distribution of bottom samples taken over the last 30 years. This information should be helpful in identifying spatial heterogeneity of sediment contamination within the A/P Study area. It is also a means of measuring the extent of impacts within priority areas. Recommendations will be made as to additional collections needed and possible regulatory action.

Synoptic Water Quality Studies

While the amount of water quality data available from the Albemarle-Pamlico system is large, relatively little is available from the open water areas of the system. Little is known about spatial heterogeneity in water quality parameters throughout the basin. The NRCD staff working group strongly recommends conducting at least one synoptic study of all portions of the system to characterize baseline variability. Forty continuous sampling points are inadequate to address spatial variability. Without adequate information on spatial variability, no time series data (historical or A/P Study generated) can be properly analyzed or understood. Such data will be instrumental in the selection of continuous monitoring locations as well as the expanded ambient monitoring program.

FIGURE 8. Composite Distribution of Bottom Samples



A secondary benefit is the calibration of remotely sensed water quality data, both NOAA AVHRR satellite images and Landsat TM images. It will also allow 30 meter resolution for certain water quality parameters (temperature, suspended sediment, algal pigments and probably salinity), but must be calibrated by real-time "ground truth" verification data. The proposed synoptic study will be scheduled to coincide with the satellite imagery in order to accomplish both goals. We expect to use continuous monitoring data to cue the synoptic study, to guarantee that representative seasonal conditions exist.

Consultation with the Division of Environmental Management personnel who conducted similar limited studies on the Chowan/Albemarle and on the Neuse River was obtained in designing this effort. More than one survey should be scheduled to demonstrate that the chosen sampling time is not in someway unique, to account for seasonal variability and to provide a safety factor should conditions preclude effective satellite imaging. However, to keep this request to target levels only one study is proposed. Other study funds will be used to repeat the process later if such funds become available.

Synoptic Water Quality Studies
Parametric Coverage

Coverage details will be discussed between agencies and researchers but are likely to include:

*Dissolved Oxygen	Total Organic Carbon	Sulfide
*Temperature	Turbidity	NH_3 as N
pH	Chloride	TKN as N
*Conductivity	Chlorophyll-a Tri	NO_2 + NO_3
*Salinity	Chlorophyll-a Corr	P Total
Residue Total	Pheophytin-a	PO_4
Residue Suspended	Sulfate	Metals

The actual synoptic study will occur during a one-day period in July or August, 1989. Approximately 128 stations will be sampled as seen in Table 4 and Figure 9. Samples will be taken of the entire vertical water column (parameter dependent*) and accomplished within a narrow sampling window of 4 to 5 hours.

Sediment Oxygen Demand Surveys

The importance of bottom sediments on oxygen balance of estuaries have been recognized for many years. Sediment Oxygen Demand (SOD) is one of the more significant variables in water quality modeling designed to determine assimilative capacity of our waters.

The SOD test is performed by placing an SOD chamber on the bottom sediment and securing it against water infiltration. A dissolved oxygen sensor inside the chamber measures the rate of decrease in

TABLE 5

Albemarle Pamlico Estuary Synoptic Study

Sampling Crew	Station Number	Location	%	Latitude	Longitude
1	APES 1	Chowan River at Edenhouse	75%	360235	764215
1	APES 2	Chowan River at Edenhouse	50%	360250	764150
1	APES 3	Chowan River at Edenhouse	25%	360300	764130
1	APES 4	Roanoke River at Mouth Marker G "5"	50%	355640	764130
1	APES 5	Albemarle Sound from Edenton to Albemarle Beach	90%	355635	763800
1	APES 6	Albemarle Sound from Edenton to Albemarle Beach	75%	355745	763800
1	APES 7	Albemarle Sound from Edenton to Albemarle Beach	50%	355850	763800
1	APES 8	Albemarle Sound from Edenton to Albemarle Beach Marker "AS"	25%	360010	763735
1	APES 9	Edenton Bay at Marker fl "2"		360200	763705
1	APES 10	Albemarle Sound from Sandy Pt to Leonards Pt	80%	355800	762940
1	APES 11	Albemarle Sound from Sandy Pt to Leonards Pt	60%	355845	763000
1	APES 12	Albemarle Sound from Sandy Pt to Leonards Pt	40%	355930	763030
1	APES 13	Albemarle Sound from Sandy Pt to Leonards Pt	20%	360010	763050
2	APES 14	Albemarle Sound in Bull Bay at Marker "1"		355655	761935
2	APES 15	Albemarle Sound from Snug Harbor to Bull Bay	75%	355950	762050
2	APES 16	Albemarle Sound from Snug Harbor to Bull Bay	50%	360210	762150
2	APES 17	Albemarle Sound from Snug Harbor to Bull Bay	25%	360325	762240
2	APES 18	Albemarle Sound from Stevenson Pt to Ship Pt	90%	360020	760920
2	APES 19	Albemarle Sound from Stevenson Pt to Ship Pt	75%	360210	760945
2	APES 20	Albemarle Sound from Stevenson Pt to Ship Pt	50%	360330	761000
2	APES 21	Albemarle Sound from Stevenson Pt to Ship Pt	25%	360440	761000
2	APES 22	Albemarle Sound from Stevenson Pt to Ship Pt at Marker "1" PA	10%	360555	761020
4	APES 23	Alligator River at Marker "37"		354022	760150
4	APES 24	Alligator River at Marker "22"		354805	760330
4	APES 25	Alligator River at US - 64	50%	355400	760035
3	APES 26	Alligator River at Marker G "7" PA		355640	755920
3	APES 27	Albemarle Sound from Wade Pt to Alligator River	90%	355930	760005
3	APES 28	Albemarle Sound from Wade Pt to Alligator River	75%	360200	760120
3	APES 29	Albemarle Sound from Wade Pt to Alligator River	50%	360410	760215
3	APES 30	Albemarle Sound from Wade Pt to Alligator River	25%	360705	760300
3	APES 31	Albemarle Sound from Alligator R to North R Marker "S"		360105	755745
3	APES 32	Albemarle Sound from Alligator R to North R Marker "AS"		360340	755605
3	APES 33	Albemarle Sound from Alligator R to North R Marker "N"		360600	755450
3	APES 34	Albemarle Sound from Alligator R to North R Marker G "171" PA		360915	755330
6	APES 35	Currituck Sound at NC-158		360515	754545
6	APES 36	Currituck Sound off Thorofare Island		361000	754735
6	APES 37	Currituck Sound off Dew Island		361230	754840
5	APES 38	Albemarle Sound from Point Harbor to Caroon Pt Marker R"2" PA		355745	754735
5	APES 39	Albemarle Sound from Point Harbor to Caroon Pt Marker "MG)		360010	754830
5	APES 40	Albemarle Sound from Point Harbor to Caroon Pt	50%	360200	754820
5	APES 41	Albemarle Sound from Point Harbor to Caroon Pt	25%	360340	754810
7	APES 42	Croatan Sound at Marker RM		354805	754200
7	APES 43	Croatan Sound at Marker 4M "8" PA		355200	754255
7	APES 44	Croatan Sound at Marker 3M "4" PA		355435	754435
7	APES 45	Roanoke Sound at Marker G "9"		354910	753535
7	APES 46	Roanoke Sound at Marker G "33" PA		355600	753920
8	APES 47	Pamlico Sound from Sandy Pt to Oregon Inlet-Marker FIR 5M "2"		353900	754300
8	APES 48	Pamlico Sound from Sandy Pt to Oregon Inlet	25%	354105	753945
8	APES 49	Pamlico Sound from Sandy Pt to Oregon Inlet-Marker FIR 3M "24OH"		354250	753750
8	APES 50	Pamlico Sound from Sandy Pt to Oregon Inlet-Marker R 4M14 "PA"		354440	753620

TABLE 5

Albemarle Pamlico Estuary Synoptic Study

Sampling Crew	Station Number	Location	%	Latitude	Longitude
1	APES 1	Chowan River at Edenhouse	75%	360235	764215
1	APES 2	Chowan River at Edenhouse	50%	360250	764150
1	APES 3	Chowan River at Edenhouse	25%	360300	764130
1	APES 4	Roanoke River at Mouth Marker G "5"	50%	355640	764130
1	APES 5	Albemarle Sound from Edenton to Albemarle Beach	90%	355635	763800
1	APES 6	Albemarle Sound from Edenton to Albemarle Beach	75%	355745	763800
1	APES 7	Albemarle Sound from Edenton to Albemarle Beach	50%	355850	763800
1	APES 8	Albemarle Sound from Edenton to Albemarle Beach Marker "AS"	25%	360010	763735
1	APES 9	Edenton Bay at Marker fi "2"		360200	763705
1	APES 10	Albemarle Sound from Sandy Pt to Leonards Pt	80%	355800	762940
1	APES 11	Albemarle Sound from Sandy Pt to Leonards Pt	60%	355845	763000
1	APES 12	Albemarle Sound from Sandy Pt to Leonards Pt	40%	355930	763030
1	APES 13	Albemarle Sound from Sandy Pt to Leonards Pt	20%	360010	763050
2	APES 14	Albemarle Sound In Bull Bay at Marker "1"		355655	761935
2	APES 15	Albemarle Sound from Snug Harbor to Bull Bay	75%	355950	762050
2	APES 16	Albemarle Sound from Snug Harbor to Bull Bay	50%	360210	762150
2	APES 17	Albemarle Sound from Snug Harbor to Bull Bay	25%	360325	762240
2	APES 18	Albemarle Sound from Stevenson Pt to Ship Pt	90%	360020	760920
2	APES 19	Albemarle Sound from Stevenson Pt to Ship Pt	75%	360210	760945
2	APES 20	Albemarle Sound from Stevenson Pt to Ship Pt	50%	360330	761000
2	APES 21	Albemarle Sound from Stevenson Pt to Ship Pt	25%	360440	761000
2	APES 22	Albemarle Sound from Stevenson Pt to Ship Pt at Marker "1" PA	10%	360555	761020
4	APES 23	Alligator River at Marker "37"		354022	760150
4	APES 24	Alligator River at Marker "22"		354805	760330
4	APES 25	Alligator River at US - 64	50%	355400	760035
3	APES 26	Alligator River at Marker G "7" PA		355640	755920
3	APES 27	Albemarle Sound from Wade Pt to Alligator River	90%	355930	760005
3	APES 28	Albemarle Sound from Wade Pt to Alligator River	75%	360200	760120
3	APES 29	Albemarle Sound from Wade Pt to Alligator River	50%	360410	760215
3	APES 30	Albemarle Sound from Wade Pt to Alligator River	25%	360705	760300
3	APES 31	Albemarle Sound from Alligator R to North R Marker "S"		360105	755745
3	APES 32	Albemarle Sound from Alligator R to North R Marker "AS"		360340	755605
3	APES 33	Albemarle Sound from Alligator R to North R Marker "N"		360600	755450
3	APES 34	Albemarle Sound from Alligator R to North R Marker G "171" PA		360915	755330
6	APES 35	Currituck Sound at NC-158		360515	754545
6	APES 36	Currituck Sound off Thorofare Island		361000	754735
6	APES 37	Currituck Sound off Dew Island		361230	754840
5	APES 38	Albemarle Sound from Point Harbor to Caroon Pt Marker R"2" PA		355745	754735
5	APES 39	Albemarle Sound from Point Harbor to Caroon Pt Marker "MG)		360010	754830
5	APES 40	Albemarle Sound from Point Harbor to Caroon Pt	50%	360200	754820
5	APES 41	Albemarle Sound from Point Harbor to Caroon Pt	25%	360340	754810
7	APES 42	Croatan Sound at Marker RM		354805	754200
7	APES 43	Croatan Sound at Marker 4M "8" PA		355200	754255
7	APES 44	Croatan Sound at Marker 3M "4" PA		355435	754435
7	APES 45	Roanoke Sound at Marker G "9"		354910	753535
7	APES 46	Roanoke Sound at Marker G "33" PA		355600	753920
8	APES 47	Pamlico Sound from Sandy Pt to Oregon Inlet-Marker FIR 5M "2"		353900	754300
8	APES 48	Pamlico Sound from Sandy Pt to Oregon Inlet	25%	354105	753945
8	APES 49	Pamlico Sound from Sandy Pt to Oregon Inlet-Marker FIR 3M "24OH"		354250	753750
8	APES 50	Pamlico Sound from Sandy Pt to Oregon Inlet-Marker R 4M14 "PA"		354440	753620

TABLE 5

Albemarle Pamlico Estuary Synoptic Study

Sampling Crew	Station Number	Location	%	Latitude	Longitude
8 - A	APES 51	Pamlico Sound from Long Shoal Pt to Rodanthe Marker 7 MLS	90%	353400	754400
8 - A	APES 52	Pamlico Sound from Long Shoal Pt to Rodanthe	75%	353420	754100
8 - A	APES 53	Pamlico Sound from Long Shoal Pt to Rodanthe	50%	353450	753800
8 - A	APES 54	Pamlico Sound from Long Shoal Pt to Rodanthe	25%	353510	753500
8 - A	APES 55	Pamlico Sound from Long Shoal Pt to Rodanthe - Marker 4MICC	10%	353600	753115
9	APES 56	Pamlico Sound from Pingleton Pt to Hatteras- Marker 5M "1"	90%	351830	753730
9	APES 57	Pamlico Sound from Pingleton Pt to Hatteras	75%	352300	754230
9	APES 58	Pamlico Sound from Pingleton Pt to Hatteras	50%	352605	754540
9	APES 59	Pamlico Sound from Pingleton Pt to Hatteras	25%	352930	754830
9	APES 60	Pamlico Sound from Pingleton Pt to Hatteras- Marker FL 4M	10%	353250	755120
9 - A	APES 61	Pamlico Sound off Englehard at Marker FL 4M		352730	755550
9 - A	APES 62	Pamlico Sound from Wysocking Bay to Hatteras- Marker FL 7M "1"	90%	351645	754420
9 - A	APES 63	Pamlico Sound from Wysocking Bay to Hatteras	75%	351900	754930
9 - A	APES 64	Pamlico Sound from Wysocking Bay to Hatteras	50%	352050	755350
9 - A	APES 65	Pamlico Sound from Wysocking Bay to Hatteras- Marker FL 7M	25%	352215	755730
9 - A	APES 66	Pamlico Sound from Wysocking Bay to Hatteras- Marker G "5"	10%	352310	760145
10	APES 67	Pamlico Sound from Bluff Pt to Ocracoke-Marker FLR "14"	90%	350920	760035
10	APES 68	Pamlico Sound from Bluff Pt to Ocracoke-Marker BL	70%	351235	760425
10	APES 69	Pamlico Sound from Bluff Pt to Ocracoke-Marker FL 4M	30%	351650	760615
10	APES 70	Pamlico Sound from Bluff Pt to Ocracoke-Marker FL 4M	10%	351925	760715
10	APES 71	Pamlico Sound from Juniper Bay to Portsmouth I.-Marker FL G 5M "5"		350920	760930
10	APES 72	Pamlico Sound from Juniper Bay to Portsmouth I.-Marker FL 2 6M "LM"		351400	761335
10	APES 73	Pamlico Sound from Juniper Bay to Portsmouth I.-Marker FL G 5M "1"		351740	761400
10	APES 74	Pamlico Sound from Juniper Bay to Portsmouth I.-MarkerG "3" PA		352125	761450
11	APES 75	Swanquarter to Core Sound	90%	350412	761610
11	APES 76	Swanquarter to Core Sound - Marker QK F1 5M	75%	350820	761640
11	APES 77	Swanquarter to Core Sound	50%	351150	761715
11	APES 78	Swanquarter to Core Sound - Marker 4M "M"	25%	351430	761750
11	APES 79	Swanquarter to Core Sound - Marker FL G "ISQ" PA	10%	351745	761830
11	APES 80	Pamlico Sound from Great Island to West Bay	80%	350620	762210
11	APES 81	Pamlico Sound from Great Island to West Bay-Marker 5M "1"5PA	50%	351030	762245
11	APES 82	Pamlico Sound from Great Island to West Bay	30%	351455	762335
11	APES 83	Pamlico Sound from Great Island to West Bay-Marker FL 4M PA	10%	351830	762345
15	APES 84	Neuse River from Maw Pt to Point of Marsh-Marker 7M "NR"	80%	350640	762835
15	APES 85	Neuse River from Maw Pt to Point of Marsh	60%	350750	762920
15	APES 86	Neuse River from Maw Pt to Point of Marsh-Marker 5M	40%	350840	763005
15	APES 87	Neuse River from Maw Pt to Point of Marsh-Marker FL G "1"	20%	350950	763200
15	APES 88	South River at Mouth - Marker "WR3"		345850	763500
15	APES 89	Neuse River from Cockle Pt to South River	75%	350025	763535
15	APES 90	Neuse River from Cockle Pt to South River	50%	350135	763630
15	APES 91	Neuse River from Cockle Pt to South River	25%	350305	763725
15	APES 92	Neuse River from Janeiro to Temple - Marker FL G "3"	80%	345515	764535
15	APES 93	Neuse River from Janeiro to Temple	60%	345650	764530
15	APES 94	Neuse River from Janeiro to Temple	40%	345755	764537
15	APES 95	Neuse River from Janeiro to Temple	10%	345900	764530

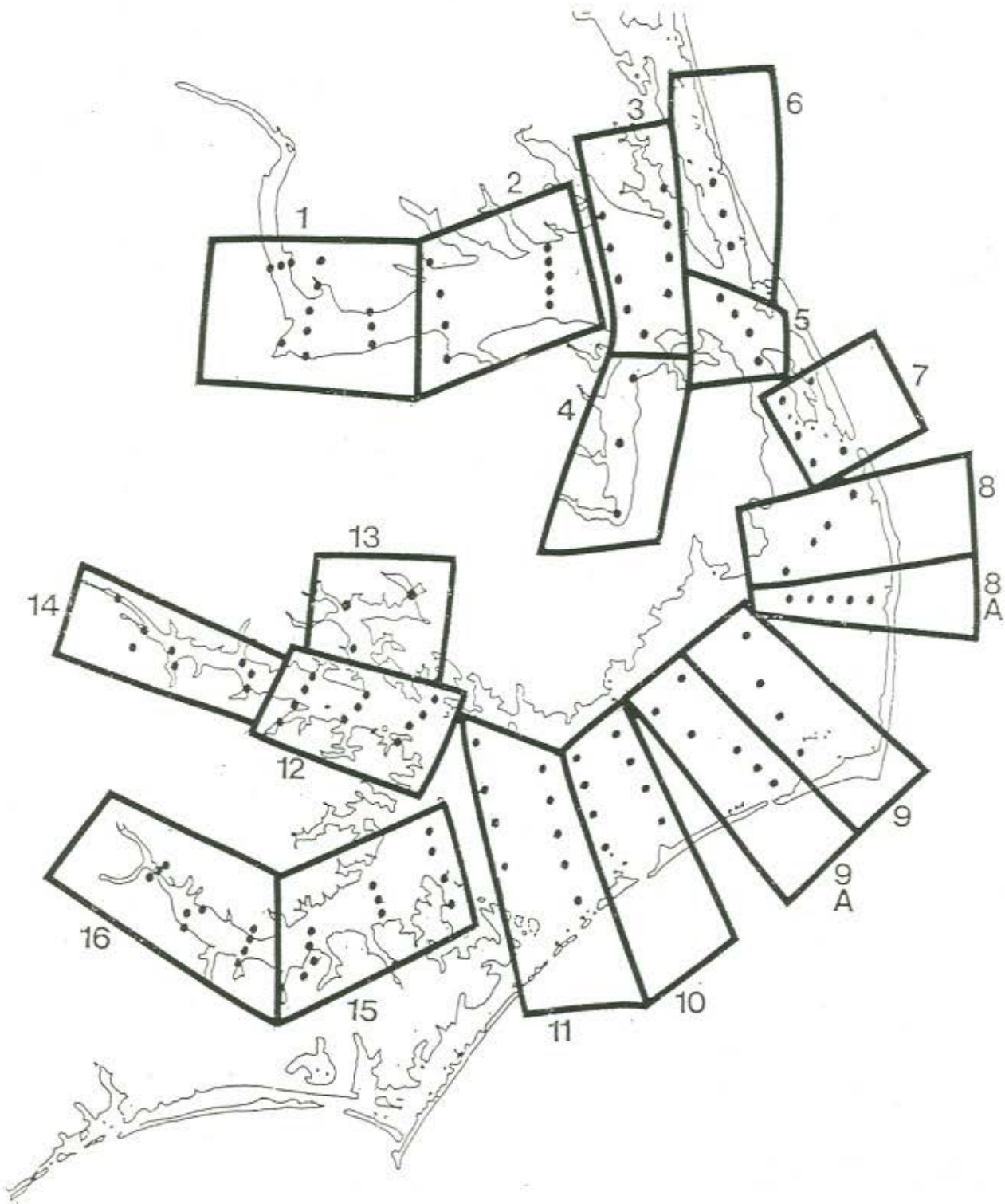
TABLE 5

Albemarle Pamlico Estuary Synoptic Study

Sampling Crew	Station Number	Location	%	Latitude	Longitude
16	APES 96	Neuse River from Beard Cr to Slocum Cr.	90%	345745	765342
16	APES 97	Neuse River from Beard Cr to Slocum Cr.	60%	345825	765330
16	APES 98	Neuse River from Beard Cr to Slocum Cr.	40%	345905	765310
16	APES 99	Neuse River from Beard Cr to Slocum Cr.	10%	345950	765250
16	APES 100	Neuse River from Rowland Pt to Fisher Ldg Pt-Marker FL G 4M "17"	75%	350125	765812
16	APES 101	Neuse River from Rowland Pt to Fisher Ldg Pt	50%	350207	765750
16	APES 102	Neuse River from Rowland Pt to Fisher Ldg Pt-Marker FL R 3M "2"	25%	350255	765725
16	APES 103	Neuse River at US-17 at New Bern	75%	350635	770150
16	APES 104	Neuse River at US-17 at New Bern	50%	350645	770135
16	APES 105	Neuse River at US-17 at New Bern	25%	350650	770117
12	APES 106	Pamlico River from Rose Bay to Pamlico Pt-Marker G "1" PA	75%	351905	762900
12	APES 107	Pamlico River from Rose Bay to Pamlico Pt	50%	352015	762810
12	APES 108	Pamlico River from Rose Bay to Pamlico Pt	25%	352120	762710
12	APES 109	Rose Bay at Mouth - Marker FL R 3M "2"		352225	762630
12	APES 110	Pamlico River from Pungo River to Goose Cr- Marker G "5" PA	90%	351955	763655
12	APES 111	Pamlico River from Pungo River to Goose Cr	50%	352130	763500
12	APES 112	Pamlico River from Pungo River to Goose Cr- Marker QR 5 M "PR"	10%	352240	763330
12	APES 116	South Creek at Mouth - Marker G "7" PA		352115	764217
12	APES 117	Pamlico River from Mare Pt to Hickory Pt-Marker G "1"	75%	352150	764035
12	APES 118	Pamlico River from Mare Pt to Hickory Pt-Marker G "1"	50%	352300	764010
12	APES 119	Pamlico River from Mare Pt to Hickory Pt-Marker G "1"	25%	352347	763935
13	APES 113	Pungo River at Marker FL R 4M "4"		352655	763430
13	APES 114	Pungo River at Marker G "11" PA		353120	763510
13	APES 115	Pungo River at Marker R "24"		353300	762755
14	APES 120	Pamlico River from Bath Cr to Durham Cr	90%	352453	764930
14	APES 121	Pamlico River from Bath Cr to Durham Cr	50%	352558	764920
14	APES 122	Pamlico River from Bath Cr to Durham Cr- Marker FL G "1"	10%	352700	764915
14	APES 123	Pamlico River from Broad Cr to Blounts Bay	75%	352707	765735
14	APES 124	Pamlico River from Broad Cr to Blounts Bay-Marker 4M "9"	50%	352745	765737
14	APES 125	Pamlico River from Broad Cr to Blounts Bay-Marker FL G "1"	25%	352845	765725
14	APES 126	Chocowinity Bay at Mouth		352947	770140
14	APES 127	Pamlico River near Hills Pt - Marker FL R "16"		353025	770115
14	APES 128	Pamlico River at US-17 at Washington	50%	353233	770342

FIGURE 9

STATION LOCATION OF SYNOPTIC STUDY



oxygen that is used by organic materials in the bottom sediments over a given time. The SOD test usually involves seven chambers, two blank chambers and five replicate chambers. The blank chambers, used to determine water column respiration rate, have aluminum bottoms which prevent bottom sediment from contacting water sealed inside the chamber. The replicate chambers have open bottoms sealed against the sediment allowing the internal water to circulate over the bottom. The rate of oxygen change in the replicate chambers minus the water column respiration equals SOD.

DEM has worked closely with EPA in developing a SOD chamber that is smaller and easier to use than existing models. Preliminary surveys using the chamber have provided excellent results. As critical areas of oxygen depletion are identified, measurements of SOD will be crucial in modeling sediment contribution to the oxygen deficit. Figure 10 depicts the North Carolina SOD chamber.

Data Collection

All parametric coverage, including biological, chemical, and physical measurements will be collected in accordance with Standard Operating Procedures as outlined in:

Standard Operating Procedures Manual
Biological Monitoring Program
Biological Services Unit
North Carolina Division of Environmental Management

Standard Operating Procedures Manual
Physical and Chemical Monitoring
Intensive Survey Unit
North Carolina Department of Environmental Management

Data Analysis

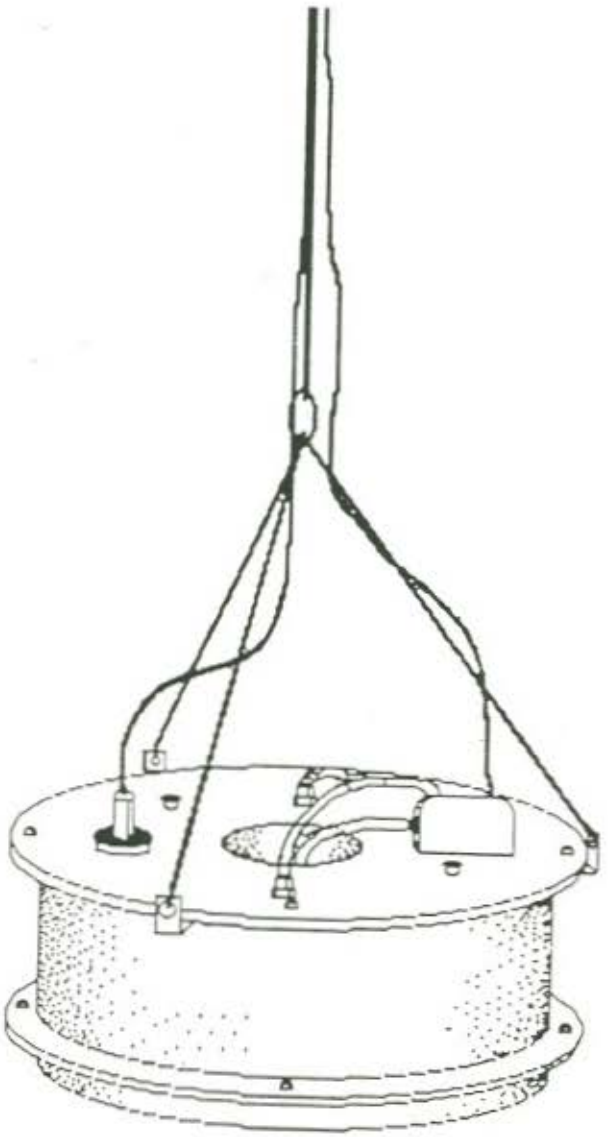
Expanded Ambient Water Quality Network - These data will be placed in the EPA Storet database. The format for Storet is compatible with the NRCD Land Resources Information System. Access to these data will be made available to other researchers who can use them as required by their study objectives.

Fish Tissue Analysis - All fish tissue data will be placed in the EPA Storet database for access by other researchers. This data also will be summarized in a final report.

Synoptic Water Quality Study - These data will be placed in the DEM database. The format for DEM is compatible with the NRCD Land Resources Information System. Access to these data will be made available to other researchers. This data will also be summarized in a final report.

FIGURE 10

North Carolina Sediment Oxygen Demand Chamber



Sediment Oxygen Demand - The primary use of this data is for water quality model calibration. These data will provide valuable information for the development of management strategies in the A/P Study area. A summary of the data will be issued as a final report.