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SOURCE DOCUMENT

for the

ALBEMARLE-PAMLICO ESTUARINE STUDY

5-YEAR PLAN

State of North Carolina
Department of Natural Resources and Community Development

512 North Salisbury Street • Raleigh, North Carolina 27611

James G. Martin, Governor
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CHAPTER I

STATEMENT OF PURPOSE

I.1 Background

The Albemarle-Pamlico Estuarine Study will be conducted under the auspices of the National Estuarine Program within the Environmental Protection Agency (EPA) as a cooperative venture involving both federal and state agencies. It is the seventh in a series of studies that began with the Chesapeake Bay in 1976. Initial phases of the project are guided by a cooperative agreement between EPA and the North Carolina Department of Natural Resources and Community Development (NRCD), executed on July 11, 1986.

Key elements of the cooperative agreement include creation of a seven member policy committee having full authority for project administration and responsible for overall direction of the project, creation of a technical committee with 18 members responsible for detailed execution of study design, and assignment of planning responsibilities to NRCD. Pursuant to the EPA-NRCD agreement, material presented this document outlines a five year plan of study.

I.2 Purpose of Study

Albemarle and Pamlico Sounds constitute one of the most imposing estuarine systems in the United States. Physically, the system dominates the North Carolina coast, with more than 2,900 square miles of surface water area, including deep shoreline indentations arising from the Roanoke, Chowan, Alligator, Pamlico, and Neuse Rivers. Biologically, the shallow bays and tributaries of the sounds, and their fringing marshes provide an enormous nursery capacity that supports a wide variety of aquatic species, many of which are migratory. Economically, the Albemarle and Pamlico Sounds are the region's key resource base for commercial fishing, tourism, recreation, and resort development; the sounds contribute indirectly to economic benefits derived from agriculture, forestry, and mining in the area.

The natural integrity and productivity of estuaries are affected, sometimes profoundly, by the activities of man. As economic development in the coastal area and in the watersheds draining to the coastal area grows more intense, questions about man's impact on the estuarine system have gained urgency. Presently, however, answers are uncertain. Finding realistic, workable means to mediate conflicts between human uses of the estuary, as well as understanding interactions between human uses and the natural systems, are challenges not fully met.

It is clear that fundamental choices are being made, whether wisely or unwisely, by conscious choice or by inadvertence, which will determine the long-term productivity and quality of the Albemarle-Pamlico system. These choices are the cumulative result of thousands of private business and individual decisions as influenced by three levels of government which have varying degrees of authority and hundreds of programs.

There exists no monolithic bureaucracy to "manage the estuarine system for society's benefit", nor a single agency with powers to impose a common purpose upon all who affect the estuarine system. The hope for systematic and rational resource management lies in unification of knowledge and understanding, and in voluntary cooperation among institutions. The presumption of this project is that relevant scientific knowledge, acquired in a timely fashion, translated into practical terms, and widely shared among the elements of an otherwise fragmented management structure, will drive this fragmented structure toward a coherent and effective policy.

The purpose of the Albemarle-Pamlico Estuarine Study is to enable resource managers to better preserve the natural productivity of the estuarine area by expanding relevant knowledge about the impact of human uses upon its physical, biological, and social systems.

I.3 Approach

The first basic premise for the approach embodied in this plan is that environmental problems in estuaries arise from human activities. "Problems" that are not anthropic in origin (for example, flooding due to hurricane storm surge) represent inherent limitations due to natural conditions and are beyond the scope of this project. Successful management of the estuarine system depends on a thorough knowledge of interrelationships among human activities and resulting changes in environmental factors, which in turn cause observable modifications in the natural resource system. These modifications are, for the purposes of this study, most significant when the changes in environmental factors directly affect other human activities, i.e., when there is conflict among competing human uses.

To facilitate the quantification of these interrelationships, human activities are grouped, in this analysis, into ten "uses" of the estuarine system: commercial fishing, recreational fishing, wildlife resources, tourism and recreation, waste disposal, agriculture, forestry, residential and commercial development, mining and industrial development, and national defense. This list includes those uses which are predominately "affected" by the estuarine system (the first four) and those predominately "affecting" some aspect of the estuarine system (the final six above). These uses cover the full range of human interactions with the estuarine system. Therefore, all environmental problems in the estuaries are viewed in this plan as the consequence of conflicts among uses. For example, agricultural activities adversely affect the productivity of fisheries when nonpoint source runoff containing sediment, nutrients and pesticide residues impairs nursery area function, contributes to nutrient-driven eutrophication,etc. All environmental problems in the system represent manifestations or symptoms of conflicts among societal uses. This use-conflict approach emphasizes the need to find causal links between environmental problems and human activities and to evaluate management strategies for solving the problems.

The second basic premise of the plan is that appropriate targets for the study are those environmental problems which are management-sensitive. Therefore, all research funded must be directly pertinent to specific management objectives. Research supported will include primary

scientific research (when science can provide understanding of a key link in a causal chain) and secondary research on the implications of various potential management strategies. For each targeted environmental concern, research is proposed in this plan which will clarify causal relationships between environmental problems and human activities and which will assess alternatives to allow efficient management of the resources involved.

During the development of this document, the major existing societal uses of the estuaries were first characterized (Chapter III). Then, significant conflicts between uses were examined to identify general topic areas of particular concern (Chapter IV). The general topic areas formed the framework for a description of existing management programs and methods (Chapter V), and for the identification by resource managers of specific management-related problems which could be addressed by this project. These manager-specified problems were translated into researchable questions by ten groups of researchers expert in specific fields. The questions for research were reviewed, edited, and ranked by NRCD and by the Technical and Policy Committees which are guiding this study. Consequently, all funded investigations should contribute directly to improved estuarine management capabilities. Likewise, the plan should lead to the enactment of a reasonable implementation plan which will maintain the long-term natural productivity of these valuable estuaries and allow continued balanced use of our rich natural resources. Chapter VI identifies these research themes, which must be pursued to enable more effective management by existing institutions.

The remaining chapters in this document describe special efforts that will be made to manage research data, to involve the public in research-related activity, and to schedule research projects in a timely fashion under a systematic set of procedures.

CHAPTER II

ENVIRONMENTAL DESCRIPTION OF THE ALBEMARLE-PAMLICO ESTUARINE SYSTEM

II.1 General Setting

For the purposes of this study, the study area (Figure II-1) includes Albemarle, Pamlico, Core, and Bogue Sounds. The study area extends upstream in tributary basins to the seaward-most impoundment, or, if there is no impoundment, to the upstream boundary of the drainage basin, or, if the basin extends into Virginia, to the North Carolina-Virginia state line. The seaward limit of the study area is the Atlantic Ocean shoreline.

The Albemarle-Pamlico estuarine system itself contains the second largest estuarine surface water area in the United States (ca. 2,900 mi^2) (Figure II-1). This system consists of two large coastal lagoons (Albemarle and Pamlico Sounds) with their associated fringing habitats (beaches, marshes, bluffs, and swamp forests) and rivers (Neuse, Pamlico, Pungo, Alligator, Roanoke, Chowan and others). These waterbodies represent ancient river valleys flooded by the rising sea level during the last several thousand years. The underlying geologic setting is similar throughout the system. Stratigraphy of sediments underlying both land and water areas is relatively consistent, although beds vary in thickness from place to place. Rainfall averages about 50 inches a year throughout the system, with higher values in summer and winter than in the fall and spring. The mean-monthly daily-high air temperatures for the region range from about 7°C (45°F) in January to over 32°C (90°F) in July. Thunderstorms cause high winds and rainfalls in summer months. The entire region is exposed to hurricanes.

Other environmental features of the Albemarle-Pamlico system vary regionally to create local habitats of quite different character. Some of the differences between the two major sounds are summarized in Table II-1 (modified from Giese, et al. 1985).

There is no direct link between Albemarle Sound and the open sea. As a consequence, and because of the relatively high freshwater inflow rate, Albemarle Sound salinities are low compared to those of Pamlico Sound. Albemarle and Pamlico Sounds also differ from each other in depth distribution (Figure II-2). Albemarle Sound averages over 18 ft deep in a central axial basin whereas Pamlico Sound has two basins separated by Bluff Shoal. The northern Pamlico basin averages 24 ft deep at its center, but the southern basin averages only 18 ft deep.

The texture of bottom sediments in the two sounds is also quite different. The axial basin of Albemarle Sound has clay at its center with gradually coarser textured sediments (silt, very fine sand, and fine sand) progressively closer to shore. Textures as coarse as medium sand are found only near eroding headlands close to the seaward limit of the Sound. In Pamlico Sound, however, medium sand is found near the ocean inlets (Oregon, Hatteras and Ocracoke), and all along Bluff Shoal. The central portion of both the northern and the southern basins contains silt, but most of the Sound has a fine to very fine sand bottom. Fringing habitats of both Sounds include

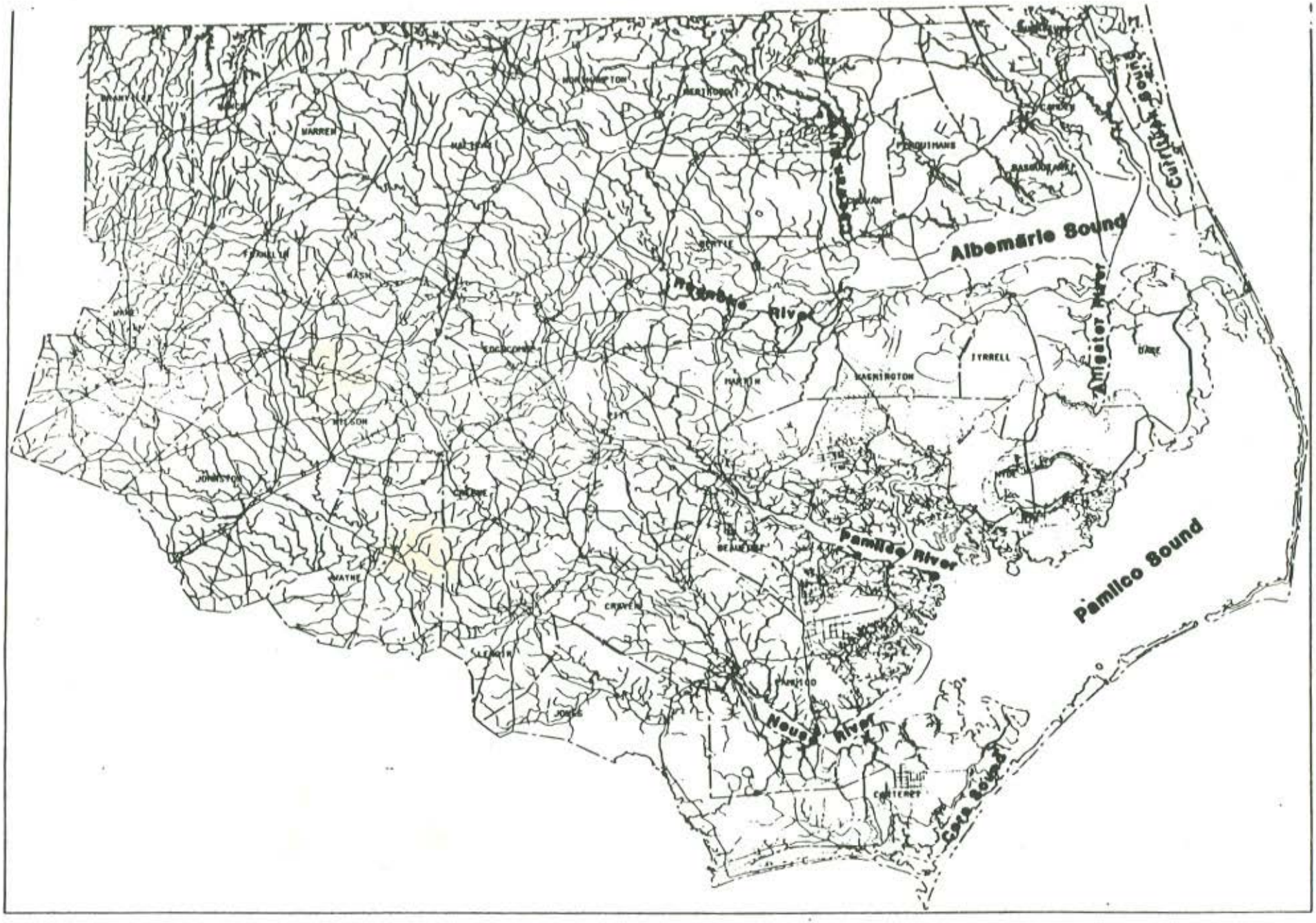


Figure II-1. Study area for the Albemarle-Pamlico Estuarine Study, including drainage basins upstream to first impoundments, drainage basin boundaries, or North Carolina/Virginia state line.

TABLE II-1

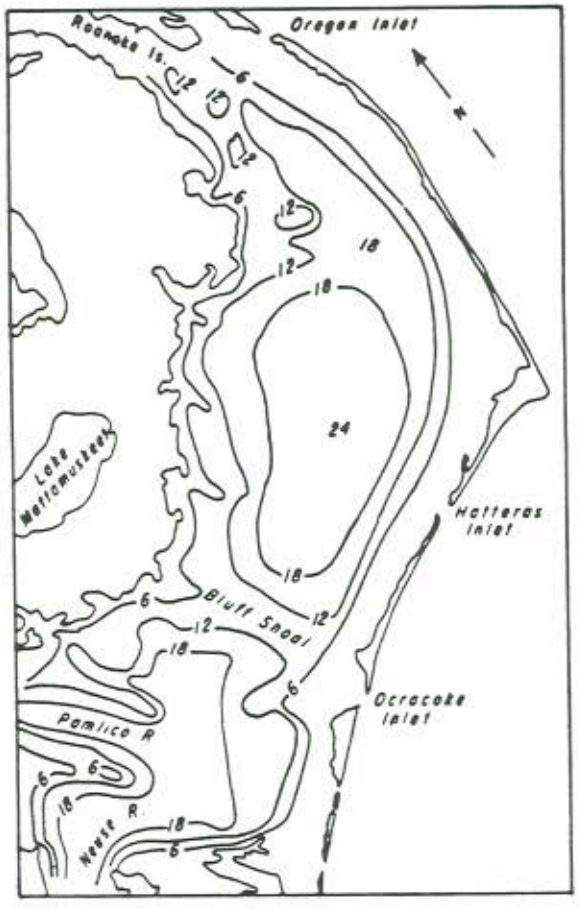
CHARACTERISTICS OF ALBEMARLE AND PAMLICO SOUNDS
(from Giese et al., 1985; NC Division of Marine Fisheries, unpubl. data)

	Albemarle	Pamlico
Surface Water Area (mi^2)	900	2,000
Watershed Area (mi^2)	18,360	12,520
Percent area of state inshore total	26	56
Net Freshwater Inflow (ft^3/sec)	17,000	32,000*
Volume of Sound (billion ft^3)	231	915
(million acre ft.)	5.3	21
Average time for inflow to equal volume	6 weeks	14 weeks
Salinity	low	moderate to high
Fisheries	anadromous and fresh	marine
Percent catch of state total	14.0	78.0
Percent value of state total	5.0	73.0

*Pamlico includes Albemarle Inflow

NOTE: The Albemarle Sound area includes Currituck and Croatan Sounds and the Pamlico Sound area includes Core and Roanoke sounds. Tributaries are also included. Landings are based on 1968-1985 data.

a.



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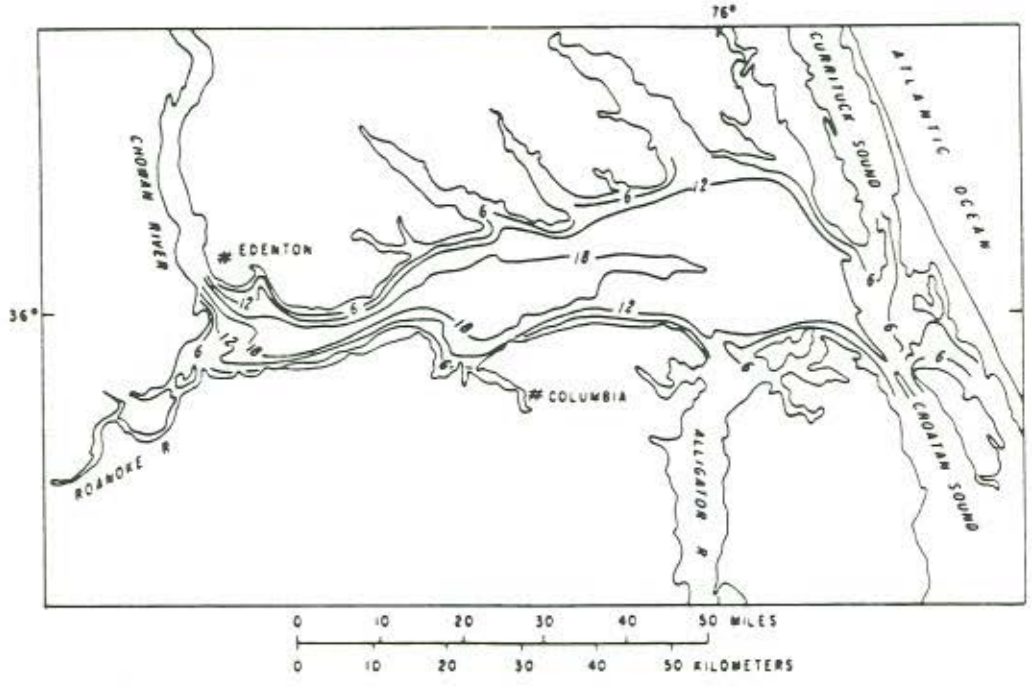


Figure II-2. Depths of Pamlico (a.) and Albemarle (b.) Sounds (Giese et al, 1985)

beaches, salt marshes, bluffs, and swamp forests. The lower salinity of Albemarle Sound is reflected in a higher percentage of swamp forest and a lower percentage of salt marsh border relative to the Pamlico Sound fringe.

Water quality in the rivers draining into the Albemarle-Pamlico estuarine system is generally acceptable for public and industrial use although all rivers suffer from occasional excesses of both color and iron (Giese et al., 1985). Much of the lower drainage basins contain freshwater swamps which produce highly colored humic acid compounds. The distribution of water quality parameters within the lower reaches of the rivers draining into the two sounds differs as a function of salinity stratification. Salinity stratification is uncommon and low oxygen levels in bottom waters are rare in Albemarle Sound. Salinity stratification is far more common in lower reaches of rivers draining into Pamlico Sound than in similar rivers in the Albemarle or in the open waters of Pamlico Sound itself.

Biological characteristics of the Albemarle-Pamlico system vary from place to place and are changing through time. In the relatively recent past, low salinities and shallow depths supported large populations of submerged aquatic vegetation and fresh and brackish water animals in Albemarle Sound. Few areas of submerged aquatic vegetation still exist, and once productive fisheries for herring, striped bass and white perch have declined dramatically. Upstream flow regulation in the Roanoke River and declining water quality in the Chowan River probably have contributed to these changes. In the Pamlico Sound, areas of submerged aquatic vegetation have also declined over the last 20 years, possibly for reasons different from those that seem to have caused the decline in Albemarle Sound. Fishery harvests from Pamlico Sound doubled during the 1970's, but have declined significantly through the 1980's. The species constituting these harvests have changed from year to year. The causes for identified changes in the biota of the Albemarle-Pamlico system are thought to be related to human impact on water quality. It is not known how specific human activities impact the natural systems to cause the observed changes. Thus, current knowledge does not allow effective management of the system's aquatic resources. The Albemarle-Pamlico Estuarine Study is designed to provide some of this needed knowledge.

II.2 Water Quality

The distribution of dissolved chemicals in waters of the Albemarle-Pamlico estuarine system is related to freshwater input, local transport processes, basin-wide circulation and on-going chemical reactions (including adsorption and desorption). Transport and circulation are, in turn, controlled by freshwater inputs, meterological conditions, salinity patterns, shoreline configurations, and bathymetry. Distributions of salt (salinity) and biologically significant nutrient salts (phosphate, nitrate, ammonia, etc.) have been measured in previous studies. Few systematic measurements of toxic compounds or other environmental contaminants have been made.

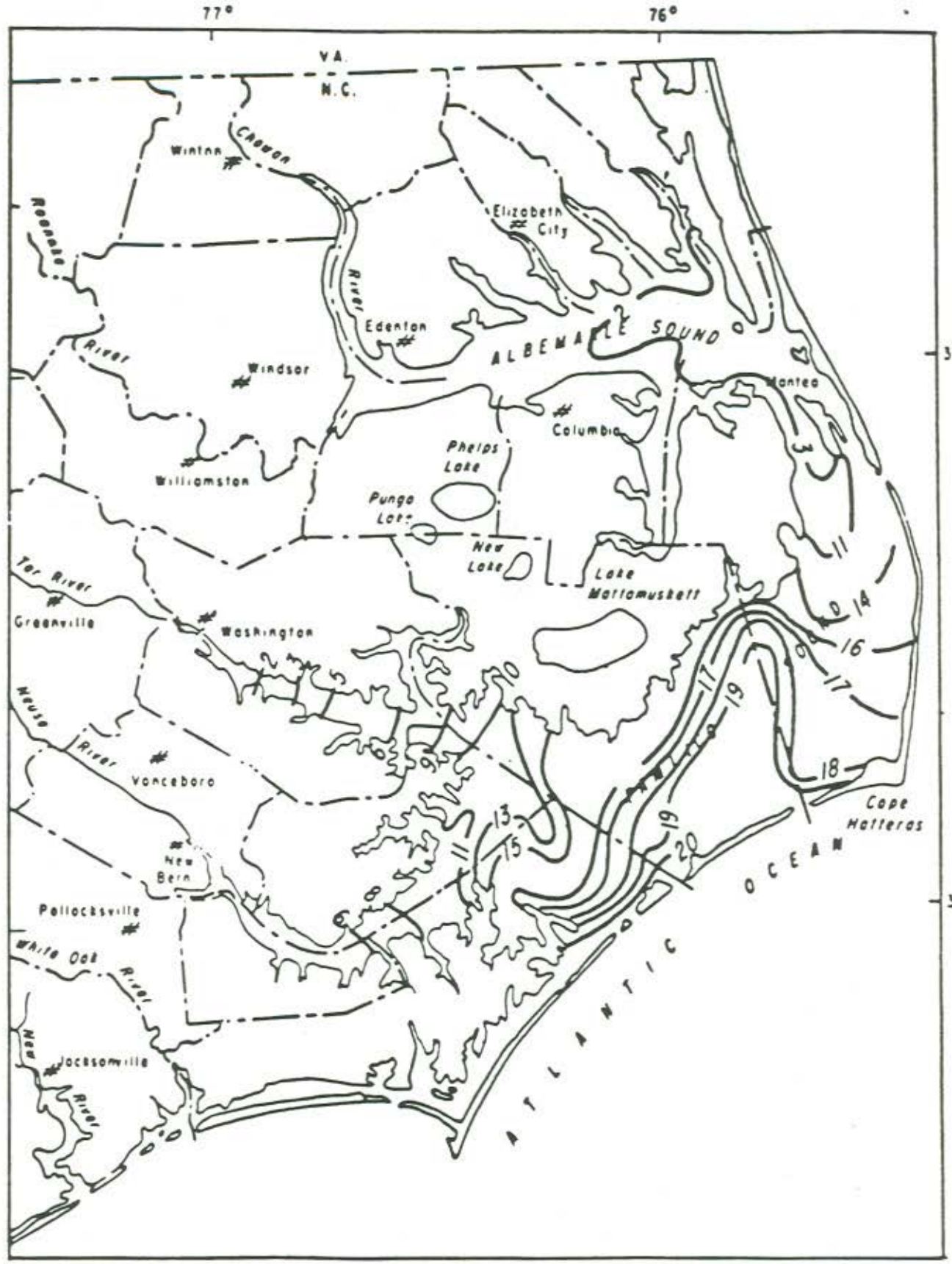
Salinities vary greatly in both space and time within the Albemarle-Pamlico system. Albemarle Sound has much lower salinities than Pamlico Sound, but both sounds exhibit significant temporal and spatial salinity variations.

Salinities in Albemarle Sound do not normally exceed 5 parts per thousand (^{o}/oo) and are generally lowest in spring and highest in the fall. High winds and low inflows can, however, cause salinities to occasionally exceed industrial water use standards at such upstream points as Elizabeth City, Winton and Williamston.

Salinities in Pamlico Sound normally exceed 15^{o}/oo. Average salinities of over 10^{o}/oo occur 15-20 miles upstream of the points where the Neuse and Tar-Pamlico Rivers join the Sound (Figure II-3). Temporal and spatial variation of salinities in Pamlico Sound is greater than in Albemarle Sound, and the temporal variation seems to be affected by complex circulation patterns. For example, daily salinity changes of up to 13^{o}/oo may occur during any time of the year as a result of wind-induced circulation in bays that border the lower Pamlico River (Pietrafesa et al., 1986). In addition, measureable salt content occurs far up the tributary rivers as a result of wind-induced circulation. Maximum salt water intrusion measured for the Neuse River is 65 miles upstream from the mouth, and reached 37 miles upstream from the mouth several times between 1955 and 1979 (Giese, et al., 1985). Such events are rare, however, so Pamlico Sound tributary water is suitable for industrial use much of the time at locations much closer to the mouth. Extrapolation of U.S. Geological Survey data suggests that Neuse River water has a salinity less than 0.45 ^{o}/oo more than 95% of the time at a location only 7.5 miles upstream from New Bern.

Evidence suggests that significant declines in salinity have occurred in the Albemarle-Pamlico region since the 1940's. Historical data are sparse, and changes in analytical techniques and spatial and temporal distributions of samples cause their reliability to be suspect. Analyses do, however, seem to indicate an almost 50% decline in "mean annual salinity" in the region (Figure II-4) between 1948 and 1980. (Mean annual salinity is the gross average of all salinity measurements made at all locations within the sound during a given year.) Even if this apparent trend is exaggerated as a result of systematic bias, the basic result has great significance for the shallow estuarine embayments which serve as receiving waters for canal drainage and as nursery areas for many estuarine species. The cause for this apparent decrease in salinities has not, however, been clearly identified. Hence, present management decisions concerning nursery areas and causal drainage are based on incomplete and inadequate information.

Distribution of biologically significant nutrient salts has been studied in both Albemarle and Pamlico Sounds. Both sounds generally have phosphorus concentrations similar to, or higher than those found in other highly productive estuaries of the eastern U.S., i.e. 2.5 ug at /L (Ketchum, 1969). Albemarle Sound phosphate concentrations typically range from lows of 1 ug at /L in September to highs of over 4 ug at /L in January, but seldom exceed 5 ug at/L (Bowden and Hobbie, 1977). Phosphate concentrations in open Pamlico Sound are less well known, but are thought to be similar to those in the Albemarle Sound. Phosphate concentrations near the mouths of tributaries to these sounds are much higher than concentrations in the waters. Paerl (1982) found phosphate levels ranging from around 2 to over 200 ug at /L in the lower Chowan River, and Hobbie and Smith (1975) found levels ranging from 2 to 10 ug at /L in the lower Neuse River.



AVERAGE SURFACE SALINITY OF PAMLICO SOUND, N.C. AREA WATERS BY CONTOURS (—19—) (April).

Figure II-3. Average April surface salinities (Epperly and Ross, 1986)

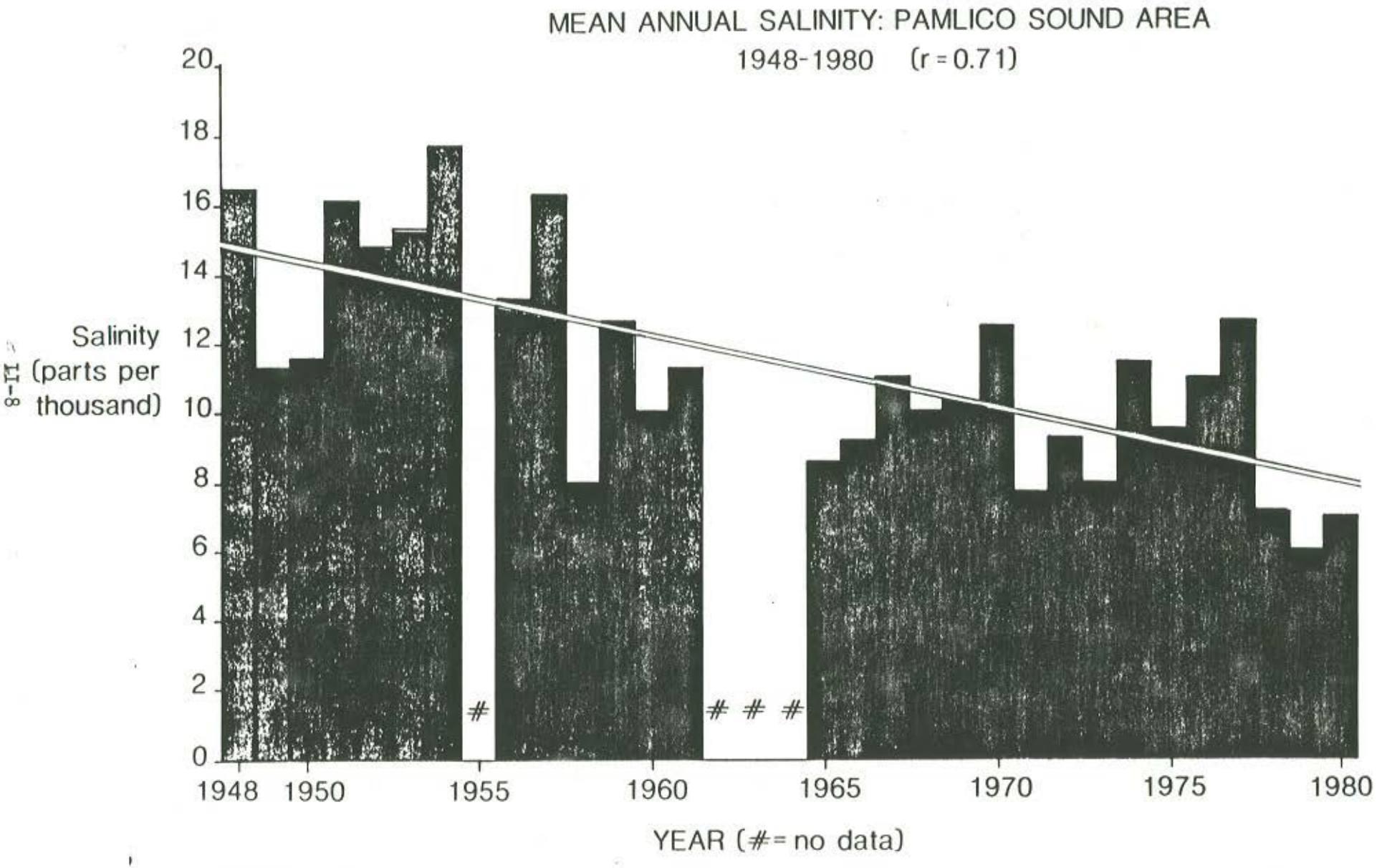


Figure II-4. Historical changes in "mean annual salinity" for the Pamlico Sound region (after Sholar, 1980)

Nitrogen occurs in several dissolved forms (nitrate, nitrite, ammonia) in natural waters, and all forms are found in the Albemarle-Pamlico estuarine system. Nitrogen concentrations vary seasonally and temporally from undetectable levels to over 80 ug at NO3-N/L. Although the temporal and spatial distribution of nitrogen is not fully known for the Albemarle-Pamlico system, it seems apparent that concentrations of these salts are sufficient to support heavy growth of algae for much of the year. Such growths (algal blooms) have already occurred regularly in the lower Chowan and Neuse Rivers and have reduced the usefulness of these waters for recreational use and fishery harvests.

The dissolved oxygen concentrations in the Albemarle-Pamlico estuarine system are generally high and capable of sustaining fish and other aquatic animals. Concentrations generally range from 4-9 ml O_2/L with highs occuring during cold months and lows in warm months. A combination of conditions (some natural and some anthropogenic), however, can lead to oxygen depletion events in segments of an estuary. Oxygen depletion occurs most commonly in the lower reaches of tributary rivers such as the Chowan, Alligator, Pamlico and Neuse, but low-oxygen fish kills can occur throughout the Albemarle-Pamlico system. There is a general impression among scientists and laymen alike that these events are becoming more frequent, but reliable data to support that impression are not available. There also is a general lack of understanding of which *sets* of conditions cause algal blooms and the often resulting anoxia, i.e., nutrient concentrations interact with hydrologic conditions in an as yet poorly defined way.

II.3 Biological Characteristics

Phytoplankton are important biological components of estuaries in general, and the Albemarle and Pamlico Sound systems are no exception. There have been few reports of direct phytoplankton cell counts in Albemarle Sound (DEM, 1986d). Phytoplankton assemblages are dominated by dinoflagellates, blue-green algae and diatoms that are typical in oligohaline estuaries. Few measurements of phytoplankton abundances have been made in Pamlico Sound, but the Pamlico River estuary and the Neuse River estuary have been extensively studied in years past. The phytoplankton assemblage in Pamlico Sound is considerably more diverse than it is in Albemarle Sound. Samples in the Pamlico indicate that phytoplankton populations are high during the winter and again during late summer. Chlorophyll measurements in Albemarle Sound indicate that the phytoplankton populations are highest in the spring and summer.

Submerged aquatic vegetation is important in the shallow areas of most estuaries. Although submerged aquatic vegetation is no longer abundent in the Albemarle Sound, large areas of submerged aquatic vegetation reportedly occurred in the sound many years ago, particularly in the western end of the sound. The submerged aquatic vegetation in Pamlico Sound varies from year to year, with abundance presently at a low level after a dramatic decline between 1976 and 1985 in the Pamlico River (Davis *et al.*, 1985).

Few studies have been made to characterize zooplankton populations in either sound (Rulifson, 1986). This represents a gap in knowledge since

zooplankton are important links in the estuarine food web. The one zooplankton survey done in Pamlico Sound indicates that a copepod is an important part of the zooplankton population and serves as an important fish food organism. In addition, very little is known about the benthic populations in Albemarle Sound except that there are dense populations of the freshwater clam, Rangia cuneata, which have been harvested from time to time and marketed for the production of clam chowder. One extensive study of the benthos of the Pamlico River estuary in western Pamlico Sound indicates that the benthos population there is highly variable and dominated by molluscs (Tenore, 1972).

Commercially and recreationally important fish and shellfish have received most of the attention of investigators in Albemarle and Pamlico Sounds. The diversity of nektonic populations in Albemarle Sound is relatively low compared to other estuaries. The distribution and population of fish and shellfish are highly variable. Four life-history strategies (anadromous, catadromous, migratory and indigenous) are at work in various proportions in the two sounds. In Albemarle Sound much of the fishery is dominated by anadromous fish populations such as the blueback herring, the alewife, the striped bass, and the American shad. Several species, including the anchovy, the catfishes, white perch, and yellow perch, are indigenous to Albemarle Sound and occupy the estuary year round. In contrast to the more oligohaline Albemarle Sound, the anadromous fish population in the Pamlico Sound is relatively low. The majority of the nekton population in Pamlico Sound are migratory, and the community is dominated by the croaker, spot, weakfish, menhaden, flounder, shrimp and blue crabs. One catadromous species, the American eel, supports an important commercial fishery in both sounds during certain periods of the year.

II.4 Environmental Processes of the Albemarle-Pamlico Estuarine System

Previous portions of this chapter have described characteristics of the Albemarle-Pamlico estuarine system without particular emphasis on environmental processes. This section briefly summarizes the processes that operate to produce the characteristics previously described, including processes now thought to control circulation of water, sedimentary dynamics, chemical cycling, and ecological systems dynamics.

II.4.1 Circulation

Circulation of water in the Albemarle-Pamlico estuarine system is driven by land runoff, ocean tides, bathymetry, salinity distributions, and wind. Land runoff rates in the major tributaries well upstream of the influence of tides are measured by existing gaging stations maintained by the U.S. Geological Survey. The rates and routes of local runoff are, however, poorly known.

In most cases the habitats bordering the sounds are only slightly above sea level. It is presumed that extensive agricultural clearing and drainage operations have had two major hydrological effects: 1) speeding the movement of rainfall from the land to nearby estuaries and 2) lowering ground-water

levels from one to four feet below the land surface (Heath, 1975). These changes alter water quality in the estuaries, increase subsidence of the land surface and increase saltwater encroachment into freshwater aquifers.

Ocean tides have a small but important impact on the Albemarle-Pamlico estuarine system. Tidal range is only about two feet at the ocean inlets and drops to less than a foot a few miles inside Pamlico Sound. The importance of the tides is their regularity and the large volumes of water that they move through the shallow system. Tidal flow volumes are usually large relative to freshwater inflows. Wind has two major effects on circulation patterns: 1) wind generates waves that mix waters vertically, thereby reducing stratification and 2) winds induce flows of water from one part of the system to another.

II.4.2 Sedimentary Dynamics

Sediments in the Albemarle-Pamlico estuarine system can be traced to present river input, past river input, ocean sediment transported from the continental shelf, and materials (primarily mollusc shells) that have formed in place. The processes that influence distribution of these sediments are the same as those that influence water circulation, but only as they have operated through long periods of time. Thus, a particular sedimentary deposit reflects present conditions at its surface, but past conditions in its interior. This means that such deposits are a record of past environmental conditions in the Albemarle-Pamlico system. Since man has recorded little of the Albemarle-Pamlico's environmental history, the sedimentary record offers one possible source of information on historic conditions in the sounds. To do so requires that the operation of the sedimentary dynamics of the system be understood. This knowledge is directly useful to management of the Albemarle-Pamlico because of the tight linkage between sediments and water quality.

Sedimentary particles in the water column are the greatest source of surfaces with which dissolved chemicals can interact. Some chemicals adsorb onto these surfaces (pesticides, some heavy metals, etc.), others desorb from these surfaces (organic matter, nutrients, etc.). Both processes are expedited by microbial action, and both occur even when the sedimentary particles have settled to the estuarine floor and become part of the bottom. This settled condition may be short-lived, however, since shallow water sediments can be resuspended into the water column.

Little is known of the sedimentary dynamics of the Albemarle-Pamlico estuarine system in specific terms. A general knowledge of the sediment distribution pattern exists, but the conditions that have caused this are unknown. The rates and routes of sediment input from rivers and oceans have not been quantified. The conditions that will resuspend bottom sediments back into the water are poorly understood. It is known that some geochemical processes remove chemicals dissolved in water between particles of bottom sediments (pore waters) and transport the chemicals into the overlying water. It is not known where these geochemical processes occur at environmentally significant rates within the Albemarle-Pamlico system.

II.4.3 Chemical Cycling

Chemical cycling reflects water circulation and sedimentary dynamics as well as present and past chemical inputs from land runoff, the ocean and the atmosphere. This combination of controlling processes makes chemical cycling a complex and poorly understood aspect of the Albemarle-Pamlico estuarine system. There are three classes of chemicals that are of concern to human use of the Albemarle-Pamlico system: nutrients, metals, and toxic compounds. High nutrient concentrations stimulate excessive algal growth with direct effects on human use (unsightly water surface and unpleasant smells, oxygen depletion, reduced fishing, etc.). Metals (particularly mercury) can concentrate in fish tissue making them unfit for human consumption, and, at low concentrations, alter the food chain from one with valuable components (striped bass, river herring, crabs) to one with less valuable species (catfish, mullet, menhaden). Toxic pollutants alter food chains and may concentrate in species consumed by humans as well as directly affect non-target species (young crabs and shrimp are notoriously sensitive to many products used to control insect pests, for example).

Nutrients, metals, and toxic compounds may enter the Albemarle-Pamlico from rivers, local runoff, and the atmosphere. Chemicals leave the system through the ocean inlets and through chemical reactions, but the rate of these losses is probably small in comparison with the amounts that settle to the bottom and are thereby stored within the system. Estimations of water budgets, water replacement time and sedimentation rates suggest that most chemical input is likely to be stored in the bottom sediments of the system.

The input rates and removal rates for chemicals of interest are not known. The techniques for obtaining this information are available, but the methods have not been systematically applied to the Albemarle-Pamlico system. As a result, it is not known if the system is in "steady state" with respect to damaging chemicals or if the concentration of these chemicals is increasing in the system. Knowledge of resuspension and recycling processes indicate that chemicals in the sediments are generally not stored permanently, but can move back into the water column. The demonstrable decline in fishery harvest for the system is usually attributed to declining water quality (Johnson, 1982). Solid scientific evidence to support that interpretation is not now available. Such evidence might be found through study of chemical distribution in the recent sedimentary record.

II.4.4 Ecosystem Dynamics

It is important to understand the trophic structure and food webs of estuaries in order to characterize the interrelationships that exist between various biological and physical/chemical parameters of the ecosystem. There have been no specific studies of the trophic structure and food chain partitioning conducted for Albemarle Sound, although food habits for yearling and adult striped bass have been studied. Several isolated food preference studies have been conducted in Pamlico Sound, especially for some of the more popular migratory fish like the croaker and spot.

Primary nurseries in estuaries are typically shallow, nearshore areas that support large populations of growing postlarvae and juvenile fishes and

shellfish during their first year of life. Nursery ground utilization and its role in fisheries production has long been recognized as one of the more important functions of estuaries. The area of nursery grounds usually represents only a small portion of the total estuarine system, which is particularly true for Pamlico Sound. The western portion of Albemarle Sound is the primary nursery area for juvenile striped bass while the mouths of tributaries and the fringing shoreline serves as important nursery areas for some of the anadromous fish species (Figure II-5). Since Pamlico Sound is a major habitat for migratory species, the primary nursery areas along the shores of the sound are very important (Figure II-5). In fact, some of the primary nurseries along the northern and western shores of Pamlico Sound may be among the most productive primary nursery areas in the world.

The total fishery yield in Albemarle Sound has been declining during the past two decades. Much of this decline has been in the river herring fishery which consists of blueback herring and alewife. The catch of some of the indigenous species in Albemarle Sound has remained relatively consistent over the years. The commercial fisheries catch in Pamlico Sound, on the other hand, increased steadily during the decade of the 1970's and has been declining during the 1980's. The makeup of that catch has changed significantly, with edible finfish increasing from about 28 percent of the total in 1970 to nearly half of the total value in the 1980's. In is not known exactly how much pressure the increased fishing intensity is placing on the resources, especially in regard to the management of estuarine nursery areas.

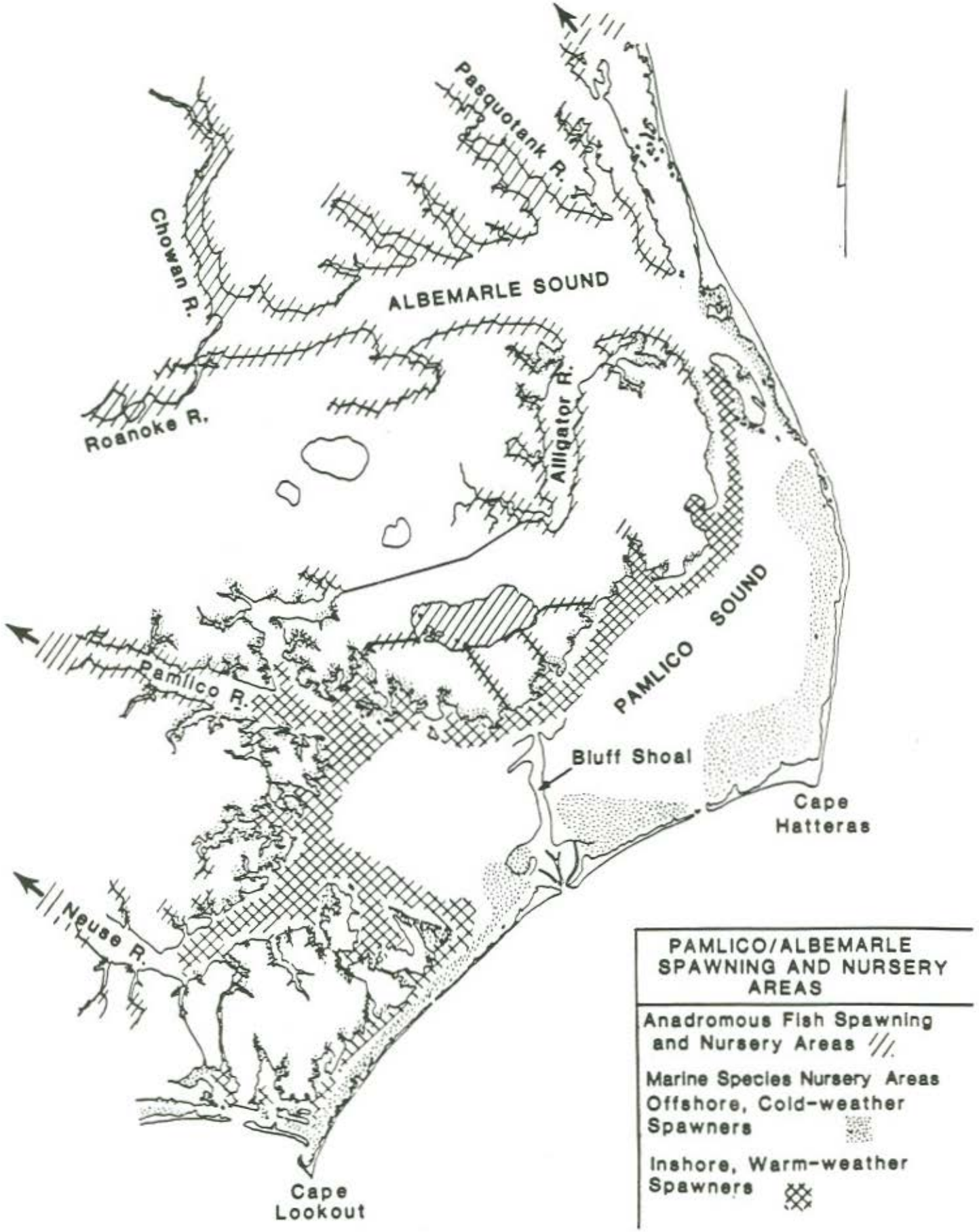


Figure II-5. Nursery habitats in the Albemarle-Pamlico region (Epperly and Ross, 1986)

CHAPTER III

HUMAN USES OF THE ESTUARINE SYSTEM

III.1 Introduction

This chapter describes human activities in the Albemarle-Pamlico region, and identifies societally and environmentally important trends. The broad spectrum of human actions which impinge upon or are affected by the estuary proper is subdivided into ten exhaustive categories: waste disposal, mining and industrial development, commercial and residential development, agriculture, commercial forestry, national defense, commercial fishing, sports fishing, tourism and recreation, and wildlife resources. Although preservation of natural areas may be considered as a separate human use of the system, evaluation of aesthetics under tourism and recreation, habitat changes under wildlife resources, and water quality maintenance/restoration under waste-related topics fully incorporate the major environmental aspects of preservation.

The uses described here are grouped according to their major relationships to the estuarine system. Societal uses of the estuarine complex can be separated into primarily affecting uses and primarily affected uses, recognizing that every use can, to a greater or lesser degree, be viewed in either way. Those that are considered primarily affecting uses are agriculture, commercial forestry, residential and commercial development, mining and industrial development, and national defense. Waste disposal, actually a specific aspect of the other uses identified, also falls in the category of affecting uses. Waste disposal as a unique category is important, however, because impacts may be generated much farther upstream than impacts generated from the other affecting uses. Uses categorized as primarily affected are wildlife resources, commercial and sport fishing, and tourism/recreation.

Each of these uses are discussed in this chapter. Each section contains a characterization of the use, presentation of baseline data which establishes use trends, examination of significant trends within the baseline data, discussion of expected outcomes of these use trends, and a critical issues section providing a link between this discussion of use trends and profiles and the examination in Chapter IV of existing and potential conflicts between these uses.

III. 2 Waste Disposal In The Albemarle-Pamlico Region

III.2.1 Introduction

A major use of the Albemarle-Pamlico estuarine system and its tributaries is the disposal of waste generated by domestic and industrial facilities or by other human activities on the surrounding land. Potential and realized impacts from the movement of anthropic materials into estuarine waters are considerable and careful management of waste disposal is essential to maintain the productivity of the estuarine waters and the domestic, industrial and recreational uses derived from them.

This section presents a general characterization of waste disposal patterns in the Albemarle-Pamlico estuarine system and its tributaries, and examines temporal trends in those patterns. For purposes of this report, "waste" is any material which enters waters of the State of North Carolina through human action (cf. G.S. 143-213(18)); therefore, not only must the more traditional point source pollutants from industrial and domestic point discharges be considered, but loadings of substances derived from nonpoint sources (e.g. agriculture, forestry, other land conversion activities, stormwater runoff and septic system leaching) must also be evaluated. As will be shown, these nonpoint contributions to total pollutant loads are significant in the Albemarle-Pamlico region, especially for nutrients and sediment, which are two constituents clearly implicated in existing water quality problems.

The study area is defined herein as the region drained by all major tributaries to the sounds, upstream as far as the seaward-most impoundment, or the boundaries of the State of North Carolina. In that regard, waste disposal patterns are evaluated for the entire Pasquotank River Basin (Currituck, Camden, Pasquotank, Dare, Tyrrell and Perquimans Counties and parts of Hyde, Washington and Gates Counties), the entire Chowan River Basin (the remainder of Chowan, and Gates Counties, all of Hertford and parts of Bertie and Northampton Counties), the Roanoke River Basin below the Roanoke Rapids Dam (the remainder of Northampton, and parts of Bertie, Halifax and Martin Counties), the entire Tar-Pamlico River Basin (Franklin, Nash, Edgecombe, Pitt, Beaufort and Hyde Counties and parts of Warren and Halifax Counties), the Neuse River Basin downstream of Falls of the Neuse Dam (part of Wake County and Carteret and all of Johnston, Wayne, Greene, Lenoir, Craven, Jones, and Pamlico Counties) and the small portion of the White Oak Basin east of the Newport River (Carteret County).

III.2.2 Point Source Contributions

The discharge of waste by domestic and industrial facilities is regulated in North Carolina by the Division of Environmental Management (DEM) of the North Carolina Department of Natural Resources and Community Development (NRCD) under the NPDES permit program. The number of NPDES permits which are currently valid in the study area is shown in Table III-1. Nearly half of all permits (48%) represent small domestic discharges such as schools, prisons and private residences. However, the vast majority of waste volume (97%) is discharged by municipal wastewater treatment plants and industries (Table III-1).

TABLE III-1

PERMITTED POINT SOURCE DISCHARGERS IN ALBEMARLE-PAMLICO STUDY REGION

River Basin	Domestics								Industrials						Total	
	Municipal		Schools		Other		Total		Minor		Major		Total			
	No.	MGD	No.	MGD	No.	MGD	No.	MGD	No.	MGD	No.	MGD	No.	MGD	No.	MGD
Chowan	7	1.87	13	0.09	8	0.04	28	2.00	-	0.04	-	1.93	16	1.97	44	3.97
Pasquotank	9	4.61	9	0.07	16	0.09	34	4.77	-	0.03	-	0.39	26	0.42	60	5.19
Roanoke	9	11.10	9	0.06	12	0.13	30	11.29	-	0.02	-	83.00	9	83.02	39	94.31
Tar-Pamlico	25	40.70	35	0.26	21	0.12	81	41.08	-	0.33	-	61.75	52	62.08	133	103.16
Neuse	38	102.72	49	0.44	87	1.69	174	104.84	-	6.51	-	47.40	87	53.91	261	158.75
White Oak	0	0	2	0.03	3	0.01	5	0.04	-	0	-	3.00	11	3.00	16	3.04
Total	88	161.00	117	0.95	147	2.08	352	164.02	-	6.93	-	177.46	201	204.40	553	368.42

Notes: No. = Number of permitted dischargers
MGD = wasteflow in million gallons per day
Major industrials are those with a design flow greater than or equal to 0.1 MGD

Waste discharge information is available in the DEM Compliance System from self-monitoring records subsequent to 1983. The relationships between permitted flow and measured flow for dischargers having design flows greater than or equal to one million gallons per day (MGD) and for each year since 1983 is shown in Table III-2. Permitted discharges equalling or exceeding 1MGD represent 93% of the total permitted inputs. Generally, measured waste volumes amount to just over 60% of permitted waste flows in the entire region.

The amount of dilution of point-source waste inputs varies from stream to stream, especially during periods of low flow (Table III-3). Releases from impoundments and point source discharges have significantly affected flow regimes in some of these streams, particularly the Roanoke (Roanoke Rapids Dam) and the Chowan (Union Camp pulp mill near Franklin, Virginia). At mean flow, relatively low percentages of the total flow are discharged waste (0.1 % in the Chowan to 4.9% in the Neuse at New Bern). However at low flow, waste contributions may exceed 85% of the total flow in the Neuse, and more than 50% of the total flow in the Tar-Pamlico at Washington. Careful control of wastewater constituents is clearly required.

Although the discharge of toxicants from industrial and municipal sources has not generally been perceived to be a major problem in the Albemarle-Pamlico region, many discharges do contain potentially toxic components. Additional future discharges of toxicants are likely. Many NPDES permits have limits for oil and grease (Table III-4), but permitted discharge volumes are usually very small. The Neuse River system contains the greatest number of discharges of toxic pollutants (Table III-4), although the relatively large volumes of the discharges in the Roanoke and Tar-Pamlico make the potential impacts of toxic inputs significant.

The influence on water quality of point source discharges upstream of the study region can be great. For example, pulp mill effluent from Union Camp approached 50% of total flow in the Chowan River in 1981 (DEM, 1983). In addition, there were 145 other point-source discharges in the Virginia portion of the Chowan River Basin in 1985 whose waste contributions must be added to those located in North Carolina (Virginia Water Control Board, 1985). The Roanoke River has a very large watershed upstream of the Roanoke Rapids Dam (7840 mi^2) which contains 203 NPDES discharges in North Carolina and many in Virginia. Upstream influences in the Neuse River basin are also significant, with major municipal discharges from Durham, Hillsborough and Creedmoor.

III.2.3 Nonpoint Source Contributions

Nonpoint sources contribute significant amounts of sediment, nutrients and other runoff-associated pollutants into the estuarine receiving waters. Evaluations of the relative contributions of nutrients from point and nonpoint sources have been conducted for several major tributaries to the Albemarle-Pamlico system (Figure III-1). The major tributaries differ in the relative importance of point and nonpoint sources. The Chowan River waste load is dominated by nonpoint source contributions for both phosphorus (76%) and nitrogen (79%) (DEM, 1982a).

TABLE III-2

Mean Monthly Wastewater Inflows (in MGD) in Albemarle-Pamlico Study Region for Facilities with Design Flows Equal or Exceeding 1 MGD

BASIN	PERMITTED	1983	1984	1985	1986	MEAN
CHOWAN	1.50	0.86	0.76	0.42	0.29	0.55
PASQUOTANK	3.50	2.57	3.41	2.62	2.01	2.79
ROANOKE	92.15	80.93	68.60	65.99	71.46	69.03
TAR-PAMLICO	98.82	53.75	51.93	73.17	45.27	55.82
NEUSE	147.29	74.18	85.97	84.54	90.38	86.78
WHITE OAK	3.00	1.07	0.34	0.61	0	0.43
TOTAL	346.26	213.34	211.00	227.34	209.41	215.40
PERCENT OF PERMITTED FLOW		61.6	60.9	65.7	60.5	62.2

TABLE III-3

Permitted Waste Inputs as a Percentage of Flow for the Albemarle-Pamlico Study Region

BASIN	AVERAGE FLOW (cfs)	ESTIMATED LOW FLOW (7Q10) (cfs)	PERMITTED WASTE CONTRIBUTION AVERAGE FLOW	LOW FLOW
CHOWAN				
MOUTH	4600[1]	68[1]	0.1%	9%
ROANOKE				
ROANOKE RAPIDS	8119[2]	1443[3]	1.7%	10%
MOUTH	8900[4]	----	1.6%	--
TAR-PAMLICO				
WASHINGTON	3150[3]	130[3]	2.1%	51%
MOUTH	5400[4]	----	3.0%	--
NEUSE				
NEW BERN	4800[4]	264[4]	4.9%	90%
MOUTH	6090[4]	290[4]	4.0%	85%

SOURCES:

1. Giese et al., 1985
2. Hill et al., 1984
3. Personal Communication, Trevor Clements Technical Services Branch, DEM
4. DEM, 1986b

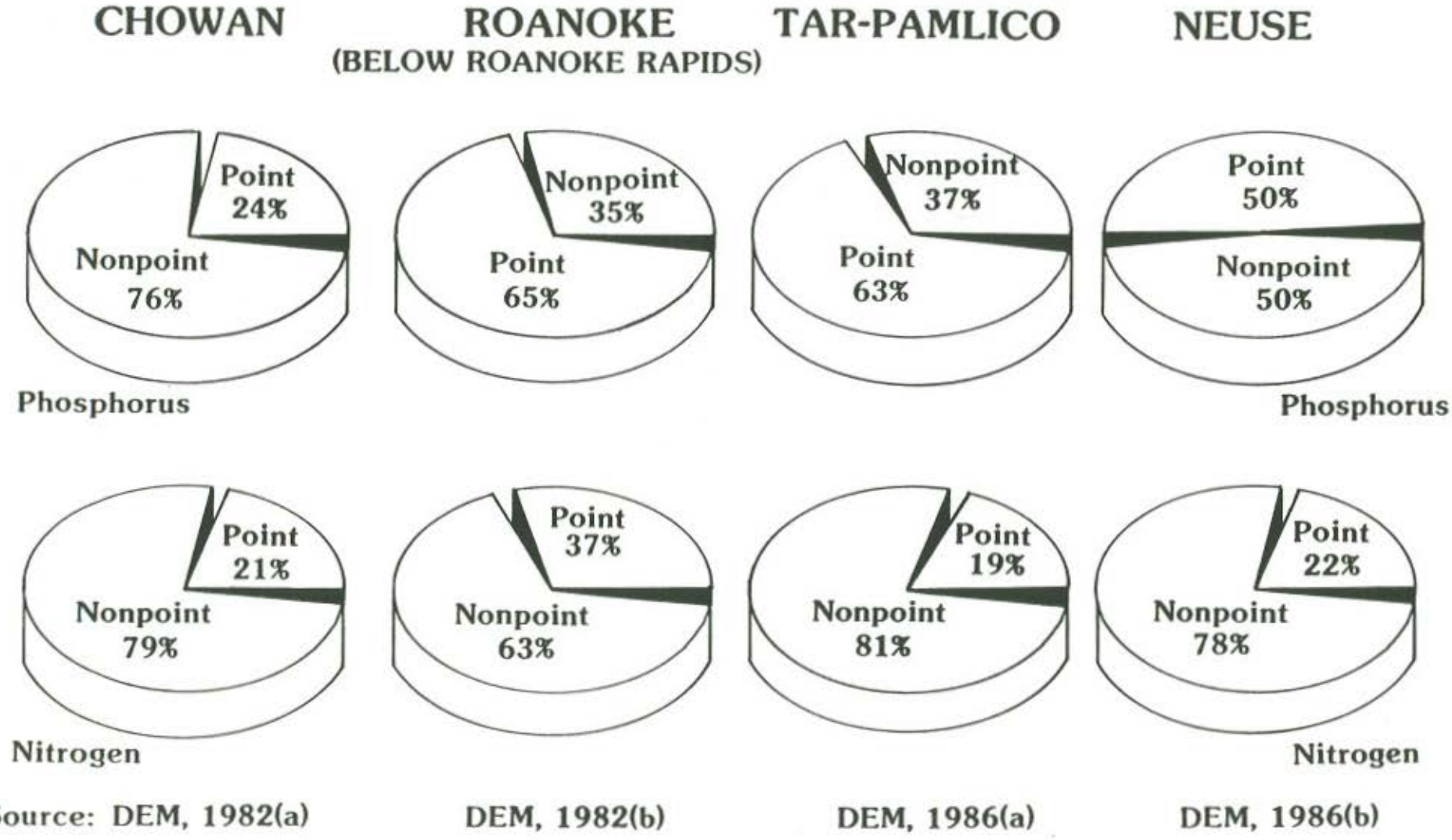
Notes: Contributions from sources upstream of impoundments are not included
Downstream sources are omitted for intermediate points
1 MGD = 1.547 CFS
7Q10 = low flow which occurs for seven consecutive days and has a ten year recurrence interval

TABLE III-4

Number of NPDES Permits with Limits for Toxic Constituents in the Albemarle-Pamlico Study Area

	POLLUTANTS				
BASIN	OIL & GREASE	OTHER ORGANICS	METALS	OTHER SUBSTANCES	TOTAL PERMITS W/TOXICS
CHOWAN	1	1	5	1	6
PASQUOTANK	7	1	2	0	8
ROANOKE	3	2	3	2	8
TAR-PAMLICO	20	6	8	4	31
NEUSE	39	12	19	12	45
WHITE OAK	4	0	0	0	4
TOTAL	74	22	37	19	102

Figure III-1. Nutrient inputs for major tributaries to the Albemarle-Pamlico estuarine complex.



Source: DEM, 1982(a) DEM, 1982(b) DEM, 1986(a) DEM, 1986(b)

The Roanoke River Basin downstream from the Roanoke Rapids impoundment shows the same domination by nonpoint sources for nitrogen (63%), but phosphorus inputs originate from mainly point source (64%) (DEM 1982b). The Tar-Pamlico and Neuse Rivers receive similar nutrient inputs from nonpoint sources: 81% and 84%, respectively, for nitrogen, and 37% and 50%, respectively, for phosphorus. The relatively large point source contribution in the Tar-Pamlico comes mostly from Texasgulf Chemicals' phosphate mine near Aurora (up to 60% of the basinwide phosphorus loading). The Neuse Basin phosphorus load comes mainly from wastewater treatment plants (up to 45%). Although nutrient budgets for the Albemarle Sound have been compiled by DEM, no comprehensive budget for the Albemarle-Pamlico Sound complex exists.

III.2.4 Trends in Waste Disposal

The reconstruction of temporal trends in waste disposal in the Albemarle-Pamlico region is difficult because the available information is not organized to facilitate the extraction of time series. Since late 1983, most self-monitoring records have been computerized in the DEM Compliance System, which will allow time series analysis in the future; reconstructing pre-1983 trends, however, is exceedingly time consuming, if possible at all. For that reason, much of the following discussion is based on indirect evidence.

The growth in the total number of NPDES permits in the Albemarle-Pamlico region can be estimated using the original dates of issuance of existing and expired permits (Figure III-2 and Figure III-3). Large increases in total numbers of permits between 1977 and 1982 represent a combination of new facility construction and an expansion of the NPDES program to include different elements of the discharging community, e.g. many school permits date from 1978, and many wastewater treatment plants permits date from 1981-1982. Population growth trends demonstrate the increasing demand on sewage treatment facilities for both the immediate watershed area of the sound complex and for the broader area upstream to the seaward-most impoundments (Figure III-4). The piedmont areas are growing at a faster rate than the coastal areas, as indicated by the steeper slope of the plot.

Industrial growth, as reconstructed from date of NPDES permit issuance, proceeded steadily from 1977 to 1984 (Figure III-2). Dollars spent on new and expanded industrial growth since 1970 reflect the constantly increasing number of permitted industrial discharges and the increasing pressure on the assimilative capacities of coastal streams (Figure III-5). Interestingly, the measured waste volumes, presented earlier (Table III-2), do not show clear increases since 1983. This may be due to the relatively short time involved, or to real decreases in discharges attributable to, among other things, loss of industry and/or capital improvements in treatment plants.

Temporal changes in nonpoint source pollution are more difficult to estimate, especially because current land-use data are sparse. Large amounts of land clearing took place on the Albemarle-Pamlico Peninsula between 1963-1981 (Richardson, 1982; McMullan, 1984), but the depressed

Figure III-2. Temporal trends in point-source waste disposal, I.

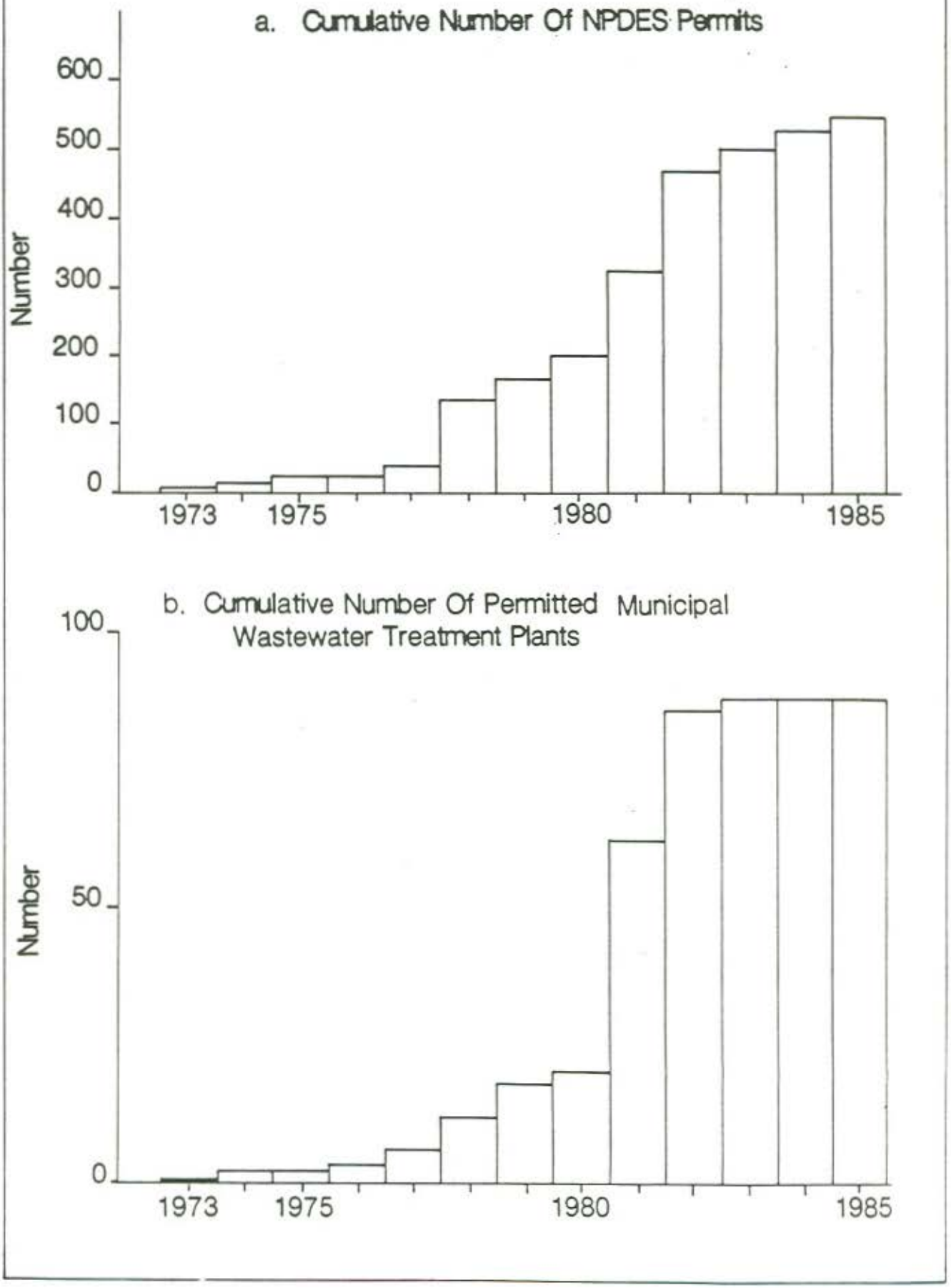


Figure III-3. Temporal trends in point-source waste disposal, II.

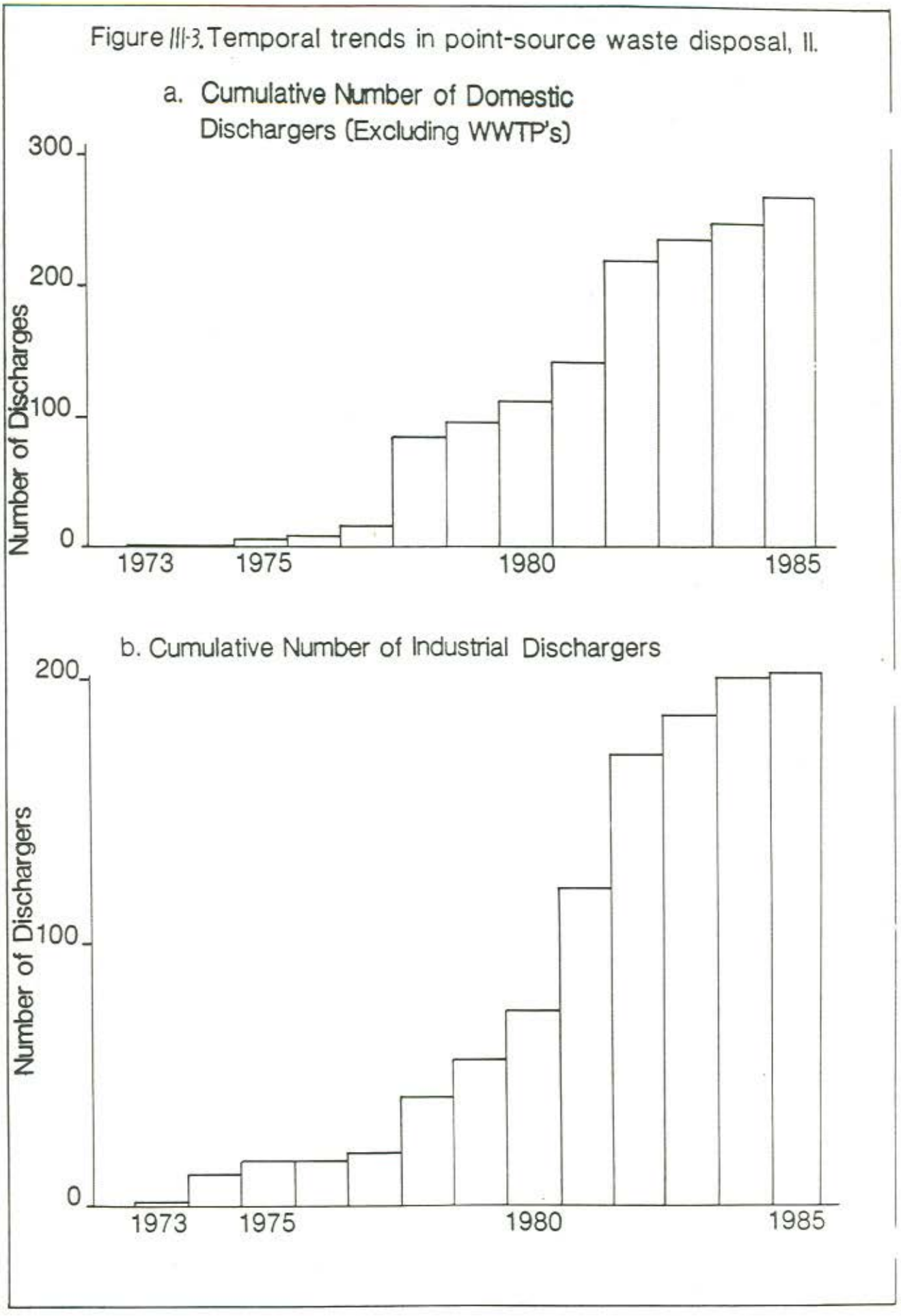
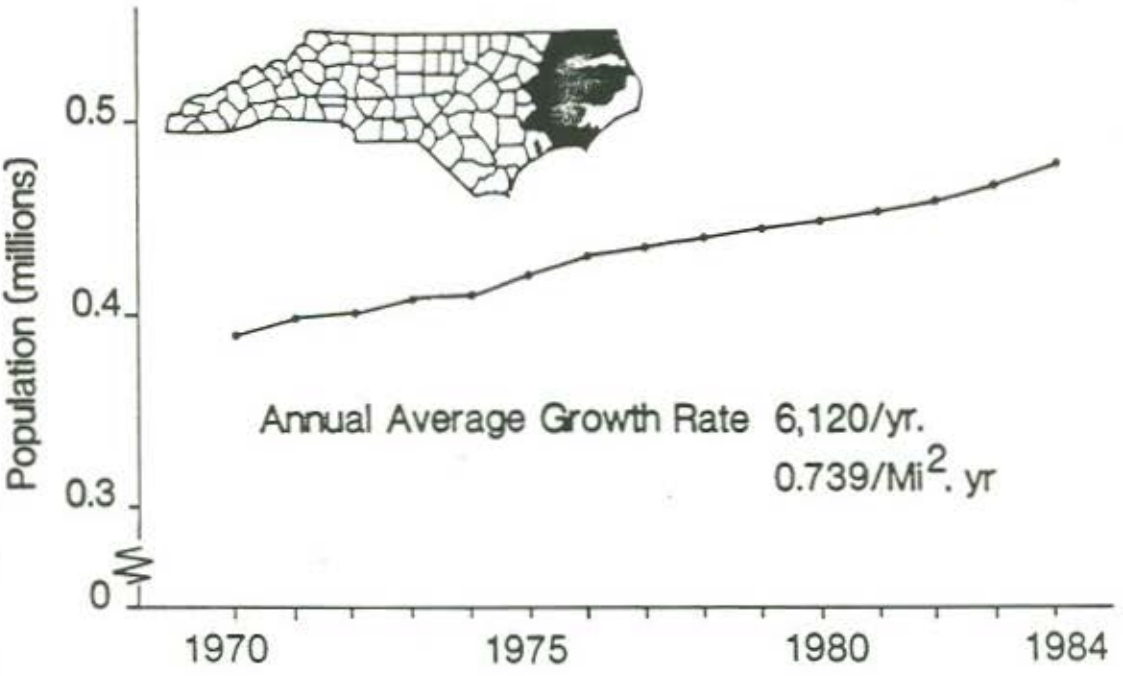
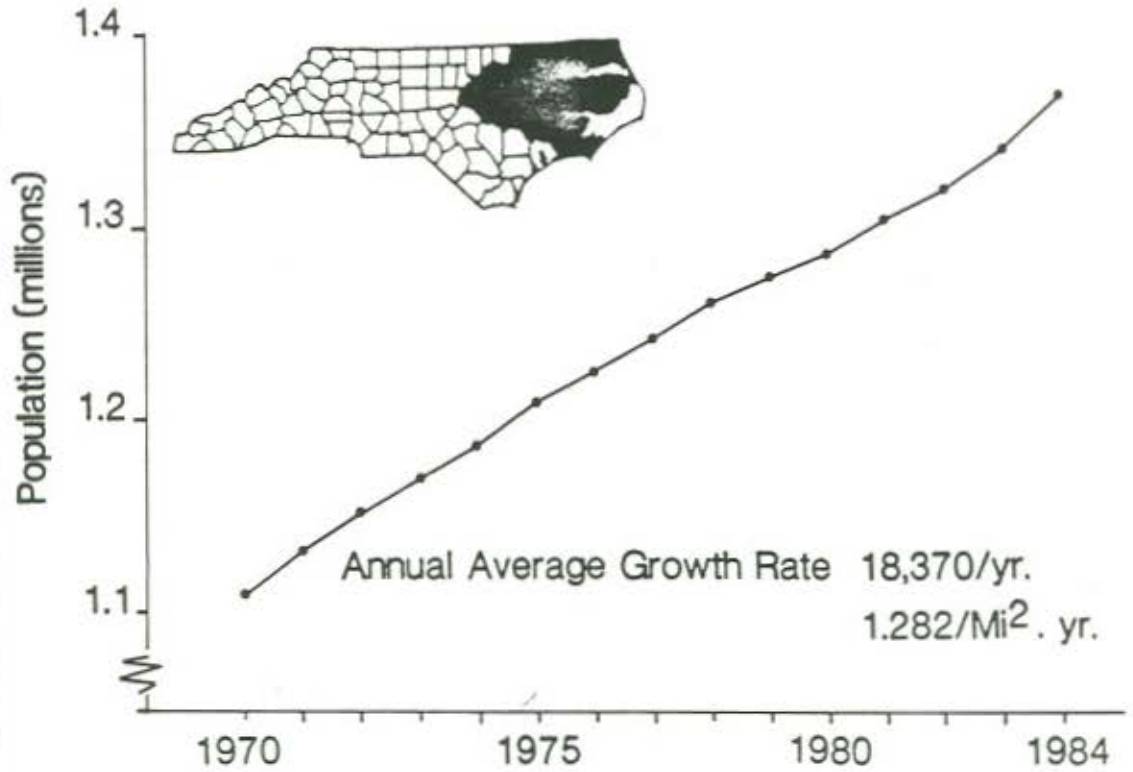


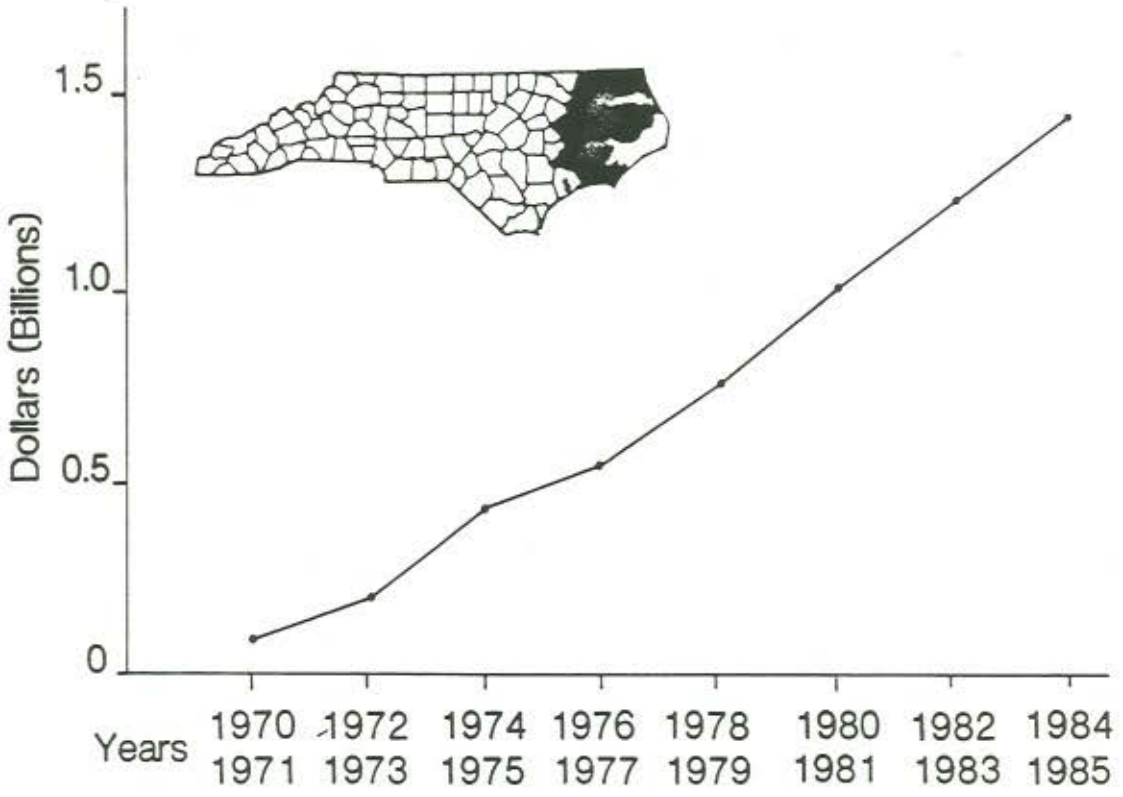
Figure III-4 Population Growth Trends

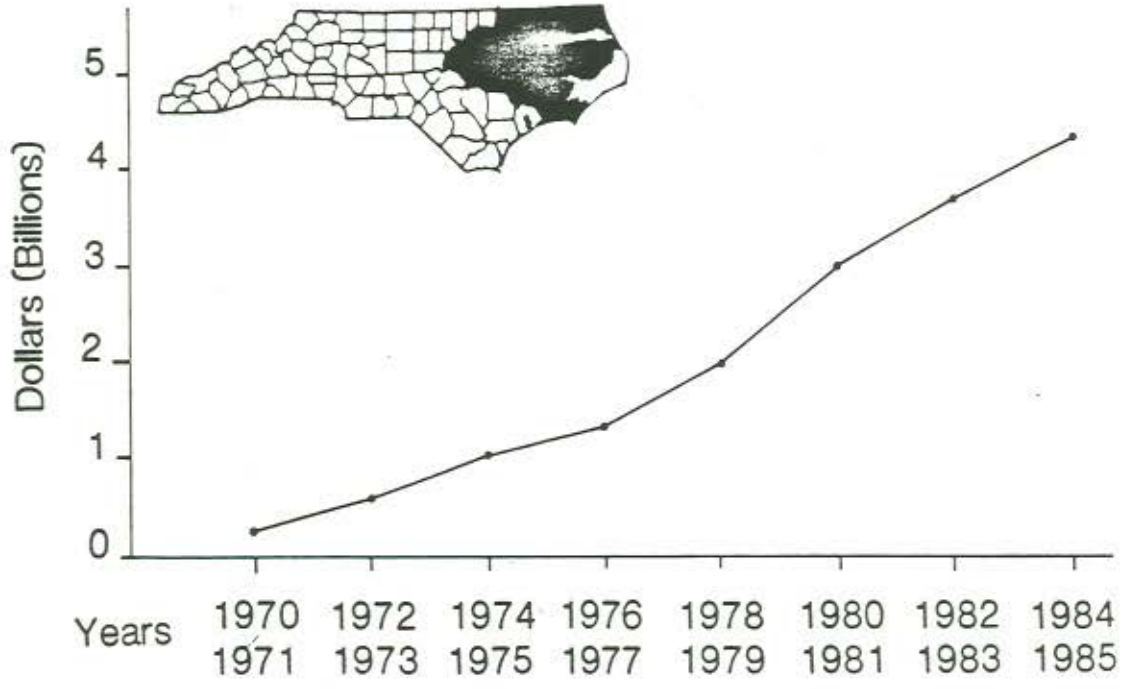




Data Source: Profile-North Carolina Counties, OSBM (1986)

Figure III-5. Cumulative Industrial Growth Since 1970





Data Source: Profile-North Carolina Counties, OSBM (1986)

economics of agriculture and silviculture on saturated soils has reduced the rate of land conversion in recent years. Peat mining will probably continue to be important in the land-conversion process in the region.

Indirect evidence of temporal trends in nonpoint source pollutant loadings can be estimated from records of harvested acres (Figure III-6). These figures do not incorporate the success of best management practices at controlling loss rates of pollutants from farms, but serve as an approximate indicator of temporal change in total nonpoint pollutant loadings in the region. It should also be noted that cleared land continues to contribute pollutants for some time after abandonment.

The best available evidence suggests that waste disposal pressure will continue to increase, both from domestic and industrial sources, as the population in the region grows. Relatively little additional agricultural land clearing is presently occurring, but significant forestry activities on the Albemarle-Pamlico Peninsula and in the Roanoke River bottomlands may continue to exacerbate nonpoint source pollutant loadings.

Impacts of disposal of waste are evident in the Albemarle-Pamlico estuarine system, although the exact causal mechanisms and the magnitudes of the effects are not well documented. The most obvious result of anthropic augmentation of nutrient fluxes into the estuaries has been eutrophication. Noxious growths of microplanktonic and filamentous algae have occurred periodically in the Chowan, Neuse and Pamlico Rivers during the past 15 years (Davis and Brinson, 1976; Christian et al., 1986; DEM, 1986a; DEM, 1986b). The Neuse River continues to experience high levels of algal density, with concomitant violations of the water quality standard for chlorophyll a. Periodic outbreaks of noxious blue-greens still occur in tributaries to the Albemarle Sound (J. Overton, per. com.), despite extensive nutrient control plans enacted in the region. Major shifts in algal populations due to nutrient inputs have greatly modified food chains in the region and probably have contributed to marked declines in certain fisheries. The Pamlico River commonly experiences early spring and late summer blooms of dinoflagellates, which undoubtedly contribute significantly to severe summer anoxia problems and associated fish and macroinvertebrate kills. Without careful management, increased nutrient loadings will result in even more severe degradation of water quality, which has ramifications for water-dependent uses such as fisheries. The relationship between waste loading and ulcerative sore disease of fishes is not well understood, but the causal connection is plausible (DEM, 1982a). Furthermore, major shifts in distribution and abundance patterns of estuarine organisms (macrophytes, sessile invertebrates and fishes) have resulted at least in part from increasing waste loadings.

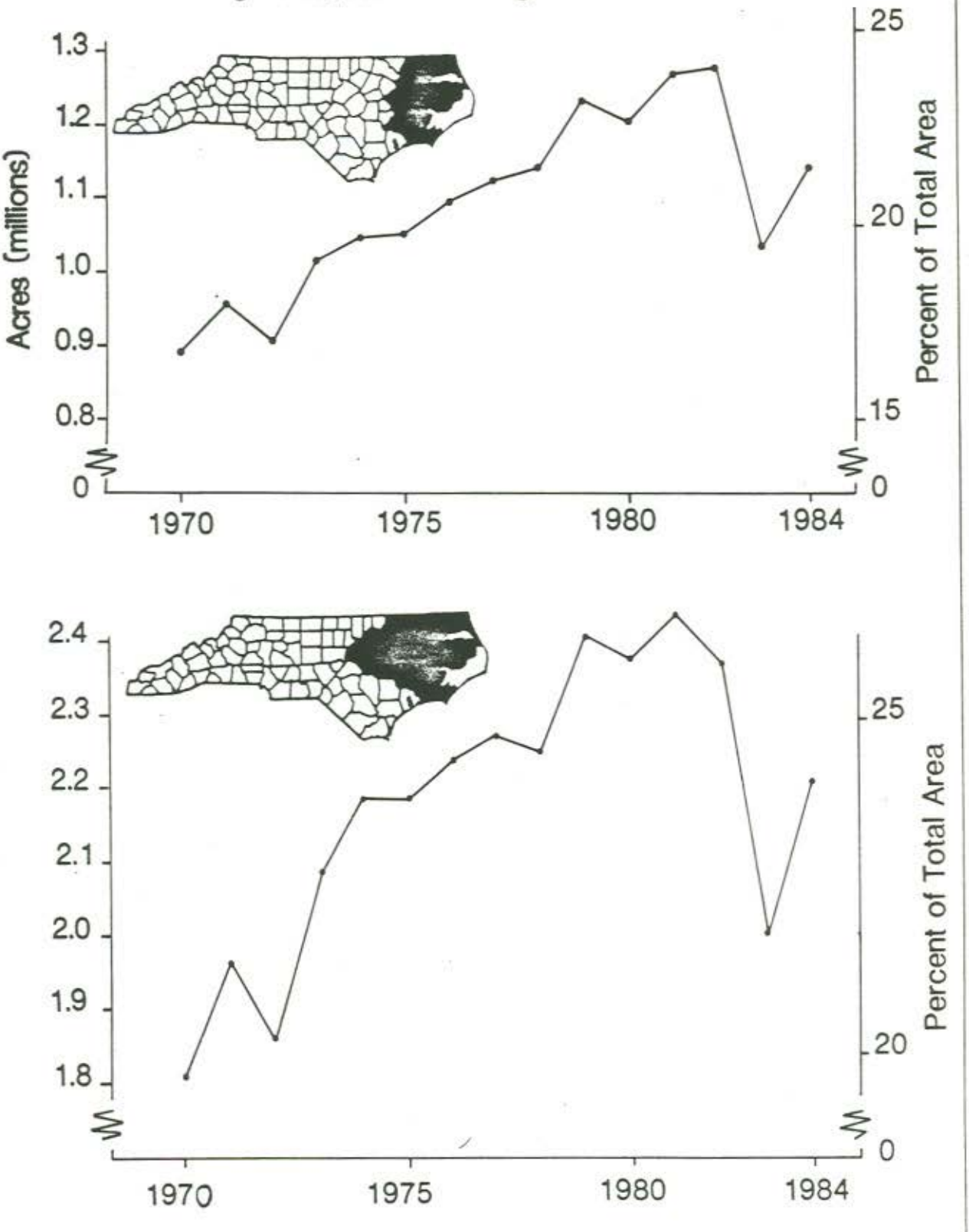
III.2.5 Critical Issues

There is a need to clarify the relationship between waste disposal and environmental effects. Particularly important issues include:

1. Document historical trends and update information on land-use conversion.

2. Reconstruct historical trends in point source waste loading.

Figure III-6. Harvested Agricultural Land



Data Source: Profile-North Carolina Counties, OSBM (1986)

3. Construct overall nutrient budgets for the entire estuarine complex and update existing budgets.

4. Clarify hydrologic and ecological interactions between wetlands and surrounding water bodies.

5. Construct mass loading and transfer models for pollutants in critical areas of sounds (critical habitats or use-intensive regions).

6. Clarify relations between changed waste loads (nutrients, sediment, trace constituents), changes in water quality parameters (dissolved oxygen levels, nutrient and chlorophyll a concentrations, etc.) and effects on distribution patterns and health of estuarine organisms, e.g. macrophytes in the Pamlico River, striped bass in the Roanoke River, oysters in the Neuse and Pamlico River, primary nursery area-dependent species, and ulcerative sore diseases.

7. Evaluate effects of upstream inputs on estuarine nutrient budgets and water quality.

8. Evaluate costs of adequate treatment and controls to reach appropriate loading goals.

9. Evaluate alternative management strategies available, e.g. uniform treatment and zoned treatment.

III.3 Mining and Industrial Development In The Albemarle-Pamlico Region

III.3.1 Introduction

This section focuses on mining and industrial development in the counties contiguous with Albemarle and Pamlico Sounds. Mining in this area may be grouped into three categories: 1) construction materials (consisting of sand and limestone), 2) phosphate, and 3) peat. Mining for construction materials is highly dependent on local markets in residential, commercial, industrial, and highway construction, and its trends are closely related to trends in population growth. North Carolina's extensive phosphate reserves are a relatively rare resource for international agrichemical (fertilizer) markets. Florida's phosphate reserves (the only other significant deposits in the Eastern U.S.) are being rapidly depleted and this practically guarantees long-term growth of North Carolina's phosphate mining industry. Peat reserves in the "Pamlimarle Peninsula" are well documented to cover tens of thousands of acres and may be developed for firing steam-electric plants. The economic viability of peat mining is still unproven and the environmental restrictions to be placed on peat mining have not been completely established. Minerals resources underlie the sounds themselves. The exploitation of these resources may become economically viable within coming decades.

Many aspects of industrial development are covered in other sections of this chapter, including waste disposal, forestry, agriculture, seafood processing, and tourism. This section, therefore, explores uses and trends in manufacturing industries in the Albemarle-Pamlico study area by examining data on establishments by employment size class. The data indicate that in the 20-county area examined, the number of manufacturing establishments of all employment size classes has remained relatively constant over the period 1974-1984.

III.3.2 Characterization of Uses

Mining for construction materials consists mostly of sand pits scattered throughout the area. These are typically shallow excavations (10 to 20 feet deep) covering a few thousand square feet to a few acres each. Drainage is typically internal, and, with few exceptions, impacts on surface or ground water quality and/or quantity are insignificant. Construction materials mining is a high volume/low unit cost industry, with markets being determined by transportation costs and the demand imposed by population growth. The material from sand mines is used primarily as fill material and for fine aggregate for Portland cement and asphaltic concretes. The reserves of sand deposits for construction are practically limitless within the region, and extend beneath the sounds. On the Outer Banks, exploitable reserves are restricted by conflicting land uses, but some possibility exists of using spoil from navigation channel dredging for future construction.

The only coarse aggregate in the immediate area is from limestone quarries near New Bern. It is unlikely that minable limestone exists north of New Bern.

About 30 million cubic yards of submerged oyster shell deposits have been documented to be in eastern Albemarle Sound. These deposits are a possible mining resource for aggregate, chemical grade lime, Portland cement manufacture, poultry grit, or oyster clutch material. Extensive dredging of clam shells in Lake Ponchatrain, Louisiana, is an example of this type of mining.

Phosphate mining in Beaufort County is by far the largest single mining industry in the state, and greatly overshadows construction materials mining in the Albemarle-Pamlico region in terms of land disturbance, production tonnage, market value, and employment. Nearly half of the product is shipped overseas. The primary use is for enriched phosphate (superphosphates and phosphoric acid) to be used in agricultural fertilizers.

Phosphate mining and beneficiation produces large quantities of colloidal clay and gypsum, which are currently considered waste products. These wastes may become resources in coming decades. About 2000 acres of land in Beaufort County are diked for disposal of these clay wastes from phosphate mining, and approximately 800 acres are devoted to gypsum wastes. Conversion (reclamation) of these waste areas to lands having productive uses is an area of continuing research.

The phosphate industry in North Carolina is characterized by very large withdrawals of fresh ground water -- presently about 60 million gallons per day. Most of this water is cycled through processing operations and then discharged to the Pamlico River.

Texasgulf Chemicals, Inc., the only current phosphate producer in the region, owns or controls some 80,000 to 90,000 acres of phosphate reserves in the Beaufort County area. Some of these holdings include leases of State-owned submerged lands beneath the Pamlico River. Some of the reserves in the area are too deep to be mined under present economic conditions and with present technology. The successful development of borehole mining or other technological improvements, however, may open new reserve areas. In any case, existing available reserves are sufficient for several decades of production at current rates.

Exploration of offshore phosphate deposits is currently underway. Information presently available indicates the existence of large reserves of phosphate rock in submerged lands. These deposits should draw increasing interest as world supplies of this essential plant food diminish.

Large scale peat mining in the Albemarle-Pamlico region is still in speculative stages. Although several tens of thousands of acres and tens of millions of tons of peat reserves are proven and roughly 26,000 acres have been (tentatively) permitted for mining, the

economic viability of peat mining has not been established. It now appears that the most likely use of peat will be to fire boilers for electric generation plants. Should large scale peat mining become a reality, it will be subject to strict controls on water discharges to the estuaries, and reclamation will be mostly into timber and pulpwood land. Extensive research on the possible environmental effects of large scale peat mining has been done by NRCD and others, and needs for additional research have been identified. One significant area of uncertainty is the environmental acceptability of mining peat below sea level, and reclaiming these areas into wetlands.

Because many important industrial categories are discussed elsewhere in this chapter, this analysis focuses on manufacturing industries as classified by the federal Standard Industrial Classification (SIC) manual. Manufacturing establishments in the following counties are examined: Beaufort, Bertie, Camden, Carteret, Chowan, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Lenoir, Martin, Pamlico, Pasquotank, Perquimans, Pitt, Tyrrell, and Washington.

In general, the study area is not highly industrialized. However, there are several large manufacturing operations having a significant or potentially significant impact on water quality, salinity, and temperature in the Albemarle-Pamlico system. Individual facilities within the Albemarle-Pamlico region that have been identified by the N.C. Division of Environmental Management, Washington Regional Office, as having a direct discharge to tributaries of the estuary include a phosphate mining and processing facility on the Pamlico River, pulp and paper mills on the Neuse and Roanoke Rivers, a metal plating operation on the Neuse River, and textile and synthetic fiber manufacturers on the Pamlico, Roanoke, Chowan, and Neuse Rivers.

Many smaller industrial operations may have a localized effect or add to the cumulative impact of industrial operations on estuarine resources. Examples include hog and poultry processing operations, printing, chemical manufacturing, and boat building and repair. Industrial operations upstream of the immediate study area also affect the estuary, as discussed in the section on waste disposal.

III.3.3 Baseline Data

III.3.3.1 Mining

III.3.3.1.1 Construction Materials

The following tabulation indicates the number of permitted (greater than 1 acre) construction materials mines in 1985 in the counties contiguous with the Albemarle-Pamlico Sound area. The area of land disturbed and reclaimed varies annually, but the net disturbed area in any one year is on the order of 600 to 1200 acres. These data do not include borrow pits developed exclusively for highway construction. Specific data showing trends is not readily available,

but it is thought that construction materials production in the subject area has approximately doubled in the past 10 to 15 years.

County	Permitted Mines (1985)	Net Acres (1985)
Currituck	11	81
Dare	4	28
Camden	3	14
Pasquotank	4	13
Perquimans	2	4
Chowan	5	15
Gates	--	--
Hertford	5	94
Bertie	6	42
Washington	1	3
Tyrrell	--	--
Hyde	--	--
Beaufort	10	59
Pamlico	--	--
Craven	11 sand	109 sand
	2 limestone	512 limestone
Carteret	9	41
	73	1011

Future development of construction materials mining in the region should parallel population trends in the immediate area. An exception is limestone production in the New Bern area, since limestone has a wide market throughout the Coastal Plain.

III.3.3.1.2 Phosphate

Mining of phosphate rock and production of phosphate chemicals is presently limited to Texasgulf Chemical, Inc.'s operations in Beaufort County, which has been in production since 1965. Some of the salient baseline data for this operation are:

- Area disturbed by mining since 1965 = 2300 acres
- Area not mined but dedicated to slime ponds = 2000 acres
- Area mined and reserved for gypsum disposal = 840 acres
- Rate of mining = 150 to 200 acres per year
- Ground water withdrawal approximately 60-75,000 acre feet/year

Phosphate production has approximately doubled in the past twenty years. Considering North Carolina's phosphate reserves, the depleting Florida reserves, and the long-term international market for agricultural chemicals, it is expected that phosphate mining will continue to increase in North Carolina for many decades.

III.3.3.1.3 Peat

An interest in peat mining has developed over the last 6 to 8 years. Five mines have been permitted in the region:

Mine	Area Permitted
First Colony Farms(*)	15,000 acres
White Tail Farms(*)	7,142 acres
Peatco	3,600 acres
Peat Fuels	708 acres
American Peat	98 acres
Total	26,458 acres

*Mining permits undergoing review and revision.

Mining of peat to date has been limited to a 200 acre experimental mine at First Colony, a small experimental plot at Peat Fuels, and a few acres of horticultural peat extraction at American Peat. However First Colony Farms and White Tail Farms indicate intentions of large scale mining for electrical generation plant fuels, which could lead to peatlands disturbance of 2000 to 4000 acres per year by these two companies. First Colony Farms plans to utilize the peat fuel on-site, and White Tail Farms plan to barge the peat from its mine near Lake Mattamuskeet to a steam-electric plant near New Bern.

Sufficient exploration of peat reserves has been done to document that there are 175,000 acres of peat deposits over 4 feet thick containing 196 million tons of peat in the "Pamlimarle Peninsula". All of these reserves may not be available because of environmental restrictions, but it is clear that there is the potential for tens of thousands of acres of peat mining over several decades.

III.3.3.2 Industrial Development

Industrial development of the Albemarle-Pamlico study area has not been the subject of much detailed analysis or region-specific data gathering. For this report, county-level data collected and published annually by the U.S. Bureau of the Census in County Business Patterns (CBP) is the main source used to examine trends in manufacturing industry development in the 20-county area defined above.

Most measures of industrial activities collected by the Census Bureau are subject to suppression for reasons of confidentiality. This suppression is significant for many industrial categories in the counties of the study area, so that much of the Census Bureau information is of little value in establishing uses or trends. However, data presented in CBP on numbers of establishments by employment size class are fully disclosed since this information is not considered confidential. Therefore, these data have been chosen for use in this examination of industrial development in the area.

Information on establishments published in CBP is obtained from Internal Revenue Service records, the Bureau of Census Annual Company Organization Survey, and Economic Census reports. An establishment is defined as "a single physical location where business is conducted or where services or industrial operations are performed". The number of employees per establishment is determined from mid-March pay period employment in each year.

III.3.4 Significant Trends

III.3.4.1 Mining

The following is a summarization of significant trends pertinent to mining:

1) Construction materials mining is directly linked with the general economy of the area and can be expected to parallel general population growth; the resource is practically unlimited.

2) Phosphate mining is independent of local markets; the resource is relatively rare; North Carolina's reserves are extensive; and long-term continued growth is expected.

3) Peat mining is presently speculative; if peat fueled electric power plants are economically successful, tens of thousands of acres of peatlands could be mined in coming decades in the Pamlimarle Peninsula. In long-term, additional exploration for oil and gas, heavy minerals (sources of titanium and rare earths) and other mineral resources may be expected in the region, including resources beneath the sounds and beyond the Outer Banks.

III.3.4.2 Industrial Development

Figure III-7 presents numbers of manufacturing establishments by employment size class in the 20-county area for the period 1974-1984. As the figure shows, the total number of manufacturing establishments did not changed significantly during the period. The picture is rather different, however, for some individual industries. Figures III-8 through III-12 show the number of establishments by employment size class lumber and wood products (SIC 24), paper and allied products (SIC 26), chemicals and allied products (SIC 28), textile mill products (SIC 22), and printing and publishing (SIC 27) industries. These industries were identified by the Division of Environmental Management as having an existing impact on the estuaries and/or there has been a significant increase in the number of establishments in these industries between 1974 and 1984.

A clear decline in the total number of lumber and wood products manufacturing establishments between 1974 and 1984 is evident in Figure III-8. Most of the total decline has been in the number of small establishments (less than 50 employees). The number of establishments of all other employment size classes remained more or less constant over the period.

Paper and allied products establishments with fewer than 50 employees also showed a definite decline (Figure III-9) over the period. Other employment size classes remain relatively constant. In 1984, there was an addition of two firms with 50-249 employees, and the loss of one firm with more than 1,000 employees.

FIGURE III-7

FIGURE III-9

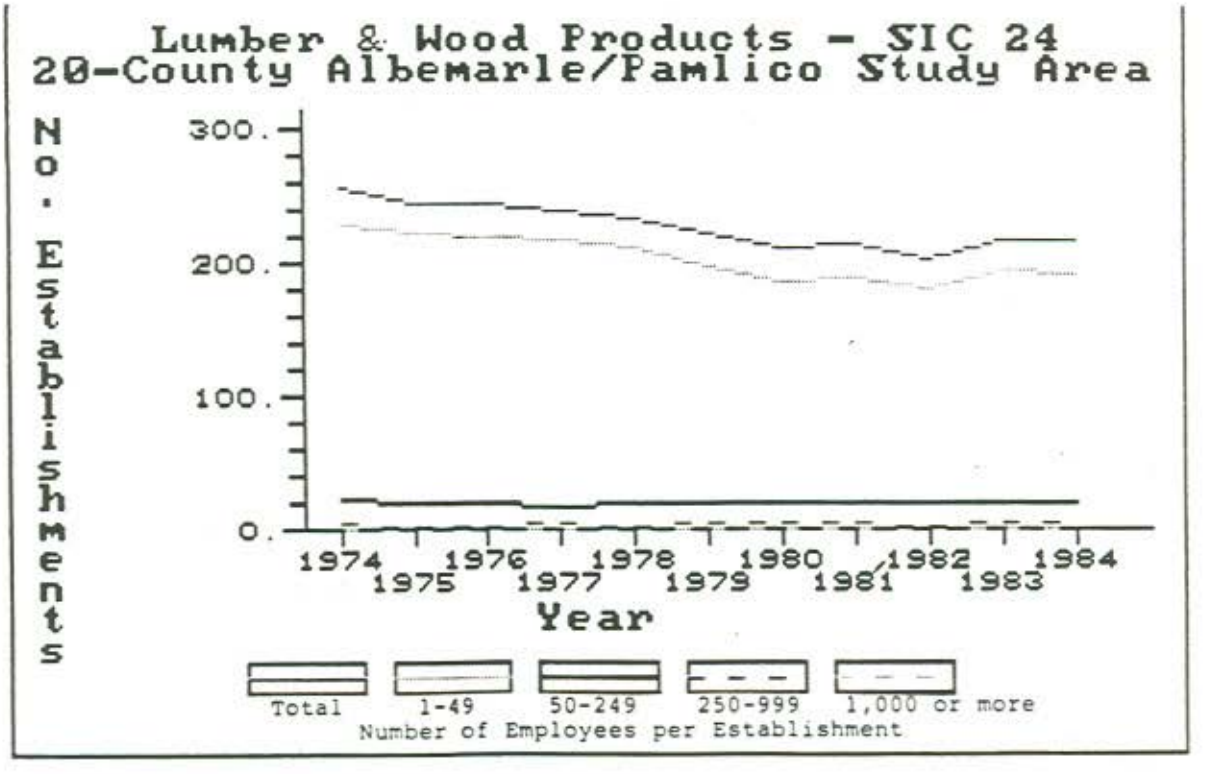


FIGURE III-9

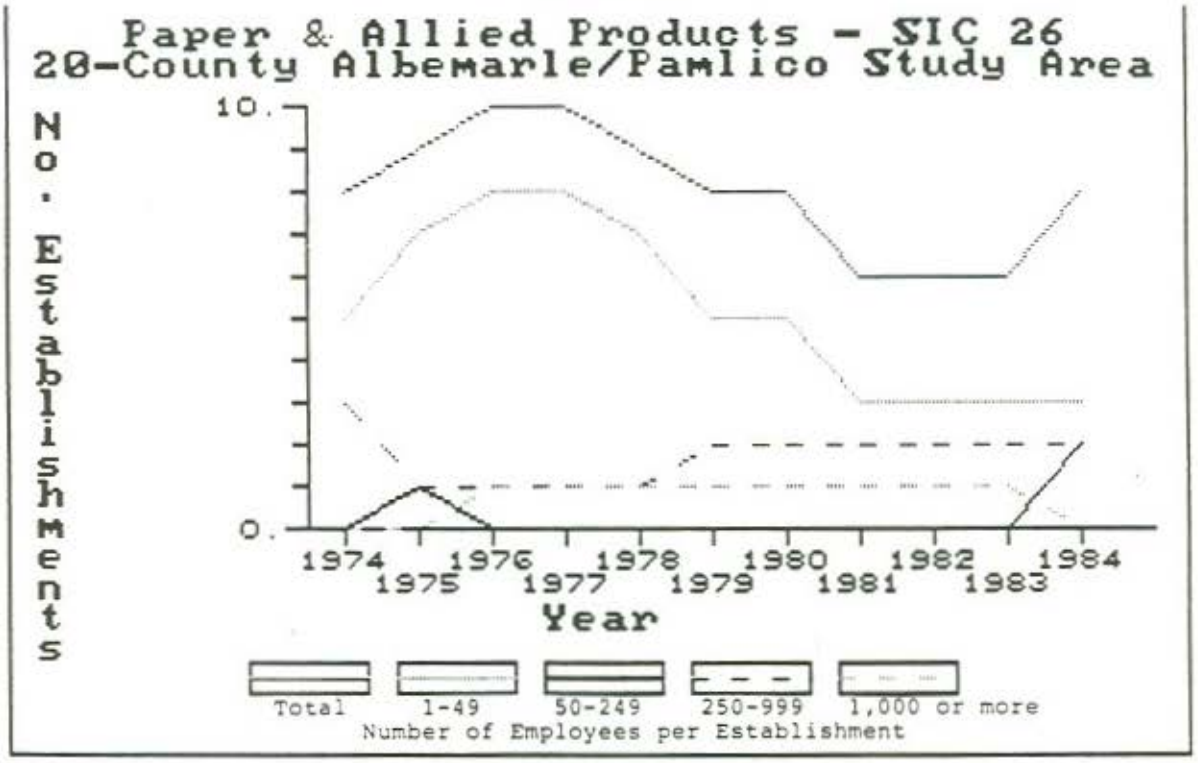


FIGURE III-10

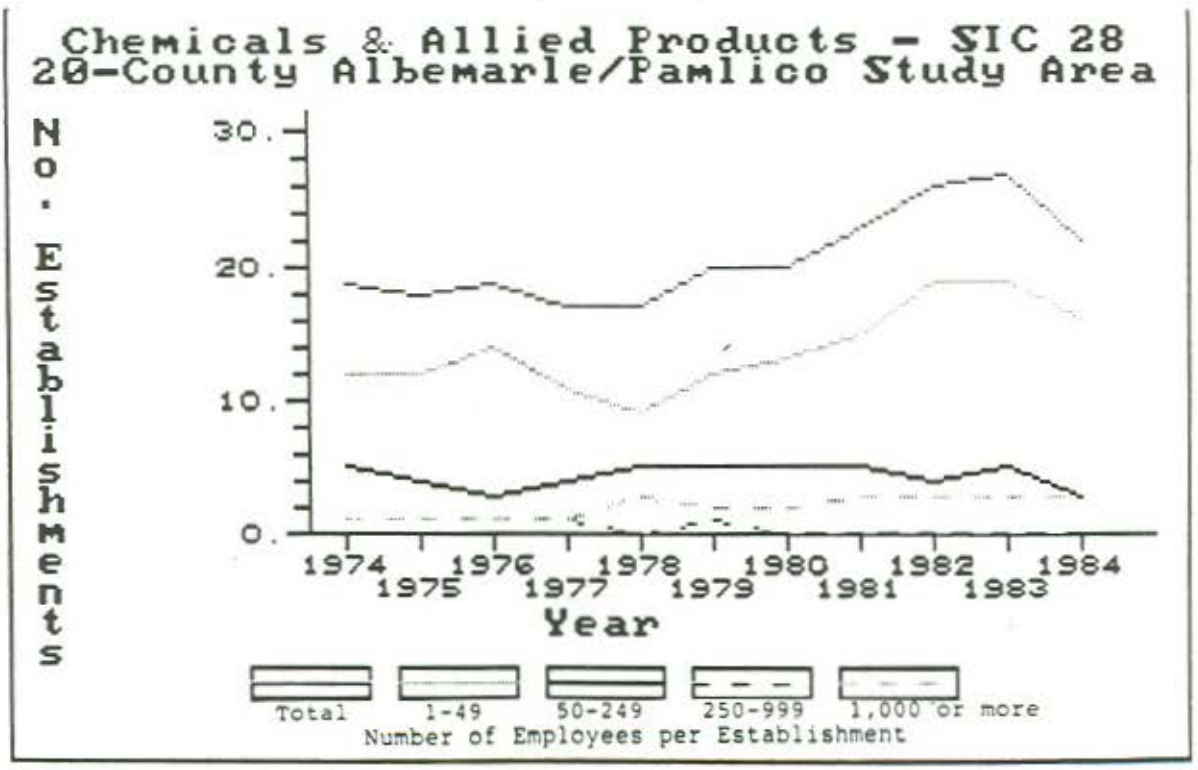


FIGURE III-11

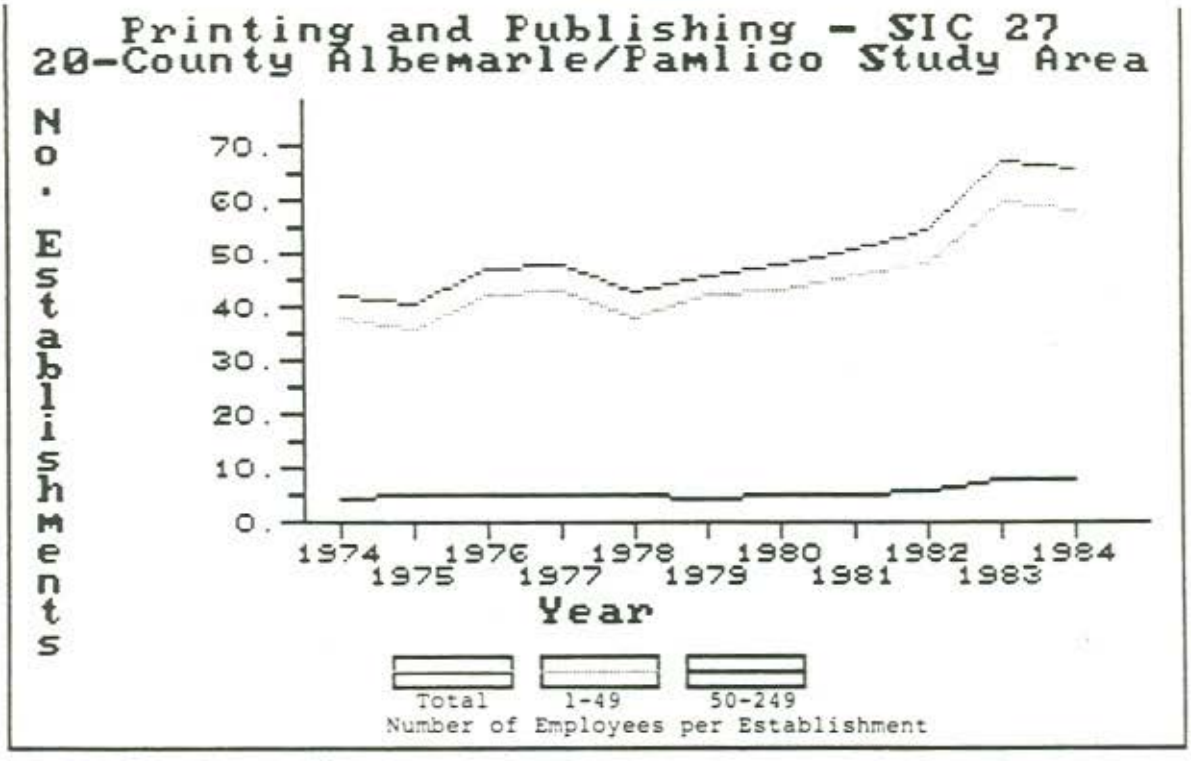
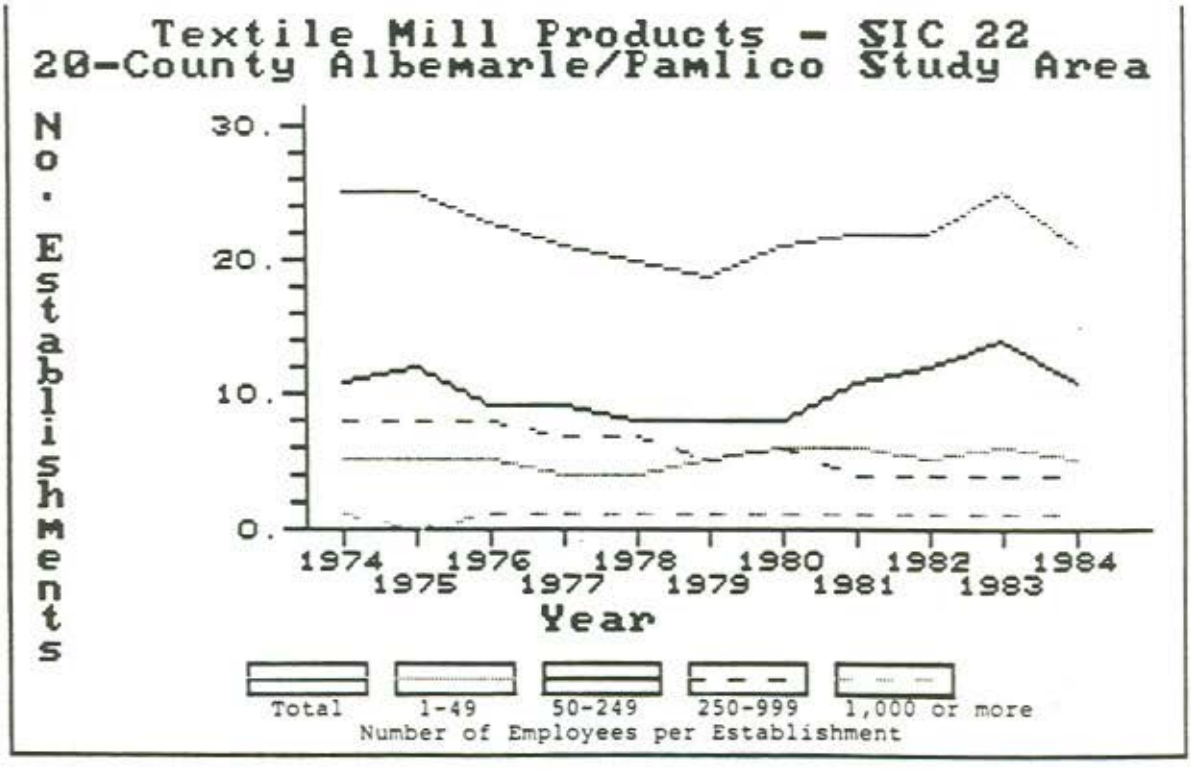


FIGURE III-12



The trends for chemicals and allied products are mixed (Figure III-10). Total number of firms increased between 1974 and 1983. The increase in total establishments was primarily due to an increase in the number of small firms (1-49 employees). Little change occurred in the number of establishments in the other employment size categories There was, however, in decrease in the number of small establishments (1-49 and 50-249 employees) in 1984.

Figure III-11 indicates that the printing and publishing industry, which typically consists of small firms, increased between 1974 and 1984, with particularly large increases during the latter part of the period. The growth in the number of smallest employment size class establishments during this period is likely related to the growth in population of the area at the same time.

A steady decrease in the number of textile firms occurred during the late 1970's (Figure III-12). An increase in the number of textile establishments, particularly of mid-sized firms, occurred between 1980 and 1983. Technological change as well as market change has been an important influence on this industry. Because of this, numbers of establishments by employment size class are probably less useful for establishing textile industry trends for any of the other industries examined in this section.

In summary, the number of manufacturing establishments of all employment size classes remained relatively constant during the period 1974-1984. The printing and publishing industry, largely composed of small operations, increased during the period, particularly in the early 1980's. Small lumber and wood products operations steadily declined in number, while the number of larger establishments remained relatively constant. Numbers of small establishments manufacturing paper and allied products also decreased, as did the total number of paper industrial firms. The number of small chemical firms increased during the period, while the number of firms of larger size remained constant or decreased slightly. Finally, numbers of textile firms showed no clear trend in any employment size class.

III.3.5 Expected Outcomes

Growth of mining for construction materials is not expected to produce significant environmental or social conflicts in the next few years, except perhaps in isolated instances. Public objections to sand and limestone mining may be expected to increase as the population grows; at the same time, such mining will be required for growth. The present regulatory framework provides adequate environmental and public safety protection from these types of mines. Agencies must, however, provide adequate inspection and enforcement resources.

Public concern over phosphate mining may be expected as the industry grows. A proposal to mine phosphate reserves beneath the Pamlico River will raise considerable public objection, will require extensive study on mining methods and environmental effects, and will

require difficult policy decisions. Continued growth of this industry will also increase the risks of accidental spills that could be environmentally damaging. On the other hand, the growth of this industry is important to the economy of the state and the nation.

The expected outcomes from peat mining are discussed extensively in the Cumulative Impacts of Peat Mining Report prepared under the guidance of the Coastal Management Division and the Peat Mining Task Force. One of the conclusions of the report is the need for additional research, especially the need for extensive hydrodynamic and water quality modeling of the sounds. Another area of needed research is the feasibility of reclaiming of low-lying peat mine areas into wetlands.

Finally, a stronger national policy toward lessening our dependence on critical foreign minerals could result in extensive minerals exploration beneath and beyond the sounds, particularly for heavy minerals, oil and gas, and manganese. Phosphate reserves in Onslow Bay, though outside the subject area, are an example of North Carolina's submerged resources. Development of mineral resources beneath the Albemarle-Pamlico sounds or beyond the Outer Banks could have dramatic economic, social, and environmental implications.

Total numbers of manufacturing industry establishments in the 20-county Albemarle-Pamlico study area do not show a significantly increasing or decreasing trend in any employment size class. Individual industries, however, may experience increases. For example, the number of printing and publishing firms has steadily increased in recent years.

Shifts within an industry to larger or smaller firms (in terms of employment size class) may have an impact on the estuary. Fewer, but larger firms will have different impacts on the estuary in terms of point source loadings and nonpoint source inputs than will a relatively larger number of smaller, dispersed establishments. The waste load and other impacts of larger plants may be more easily monitored and controlled through existing permitting and other regulatory procedures than those of smaller plants.

III.3.6 Critical Issues

Continued growth of the region is critical to the construction materials mining industry, and vice versa. Growth and materials for growth are interdependent.

Continued dewatering of the Castle Hayne artesian aquifer is critical for continued phosphate mining. It is environmentally critical that no phosphate dam-breaks occur. An important future question will be whether mining of phosphate beneath the Pamlico River is acceptable to the state.

Critical issues regarding peat mining are a) unresolved questions raised by the Cumulative Impacts of Peat Mining Study, particularly the need to develop data and refine methodology for hydrodynamic and

water quality modeling of the sounds and b) lack of information concerning the acceptability of reclaiming low-lying peat mines into wetlands. Reasonable environmental controls and public acceptance will be critical to the peat mining industry.

The State presently has no clear policy on leasing of state-owned submerged lands for oil and gas exploration and mineral development. This issue should be resolved now, rather than in a crisis atmosphere.

Overall, it is critical that the State provide adequate staff and legal support for enforcing the Mining Act.

Industrial effluents can have a major impact on the area's fisheries, leading to a potential conflict with both commercial and sport fishing uses of the resource. Pulp mills are a particularly significant source of effluents in several of the estuary's major tributaries.

Nonpoint sources of pollutants associated with industrial plant sites and the associated potentially negative effects on the fisheries are another critical issue related to industrial development. Stormwater runoff from industrial sites may have an adverse impact on fishery nursery areas, feeding grounds, and shellfish beds.

Wildlife activities and habitats are also negatively affected by industrial development and operations. Conversion of wetlands, through drainage and filling, causes complete loss of habitat for many species. Land clearing for industrial development may lead to increases in some wildlife populations, such as deer, but many already endangered species requiring a more undisturbed habitat will be further threatened.

Tourism and recreation may be adversely affected by industrial development in many ways. Impacts of industry on recreational fishing have already been noted. Aesthetics are a vital component of recreational activities in the area, which means that most industrial operations will not have a positive effect on recreation and tourism. Industry and tourism also compete directly for the waste disposal capacity of the water.

III.4 Residential and Commercial Development In The Albemarle-Pamlico Region

III.4.1 Introduction

This section describes residential and commercial development within the Albemarle-Pamlico system. Residential and commerical uses on the Albemarle-Pamlico system, even within the context of the other use categories in this chapter, are extremely varied. Residential uses include trailer parks, neighborhood housing developments, and condominiums. Commercial uses range from marinas to central business districts.

While the initial rush to develop the coast was on the oceanfront, the diminishing availability of oceanfront land and soaring oceanfront prices has placed new development pressure on the sounds and rivers. These developments are often outside the areas classified in land use plans (LUP's) as developed or transitional (to development), and require amendment to the LUP.

III.4.2 Baseline Data

Data on development trends are available only for some time periods and are often relatively inaccessible. Available information includes population data from 1950 and projections to 2000, population density maps, data on Sediment and Erosion Control (SEC) plans, numbers of mannas, shoreline development, and land use classification schemes used in the region.

III.4.3 Significant Trend

Population in the Albemarle-Pamlico study region is fairly low (Figure III-13). Very little change in total population occurred between 1950 and 1970, although population in the four counties which are now experiencing the greatest development, i.e., Carteret, Beaufort, Craven, and Dare Counties, did increase during the period. Based on present projections, population in the region may double over 1970 levels by the year 2000. Much of that increase may again occur in Carteret, Beaufort, Craven, and Dare Counties, where population densities are already high relative to most of the rest of the region (Figure III-14). As an example of development pressures, less than ten percent of the non-wetland shores of the Pamlico River in Beaufort County were undeveloped in 1984 (Phillips, 1985). The amount of developed shoreline along the Pamlico River in Beaufort County increased from 45 percent of the total shoreline (including wetlands) to 61 percent of the shoreline between 1976 and 1984 (Phillips, 1985).

Land classifications schemes of coastal counties indicate where growing populations, and the structures needed to house and serve them, will be located. Growing communities appear to be focusing their expansion

FIGURE III-13

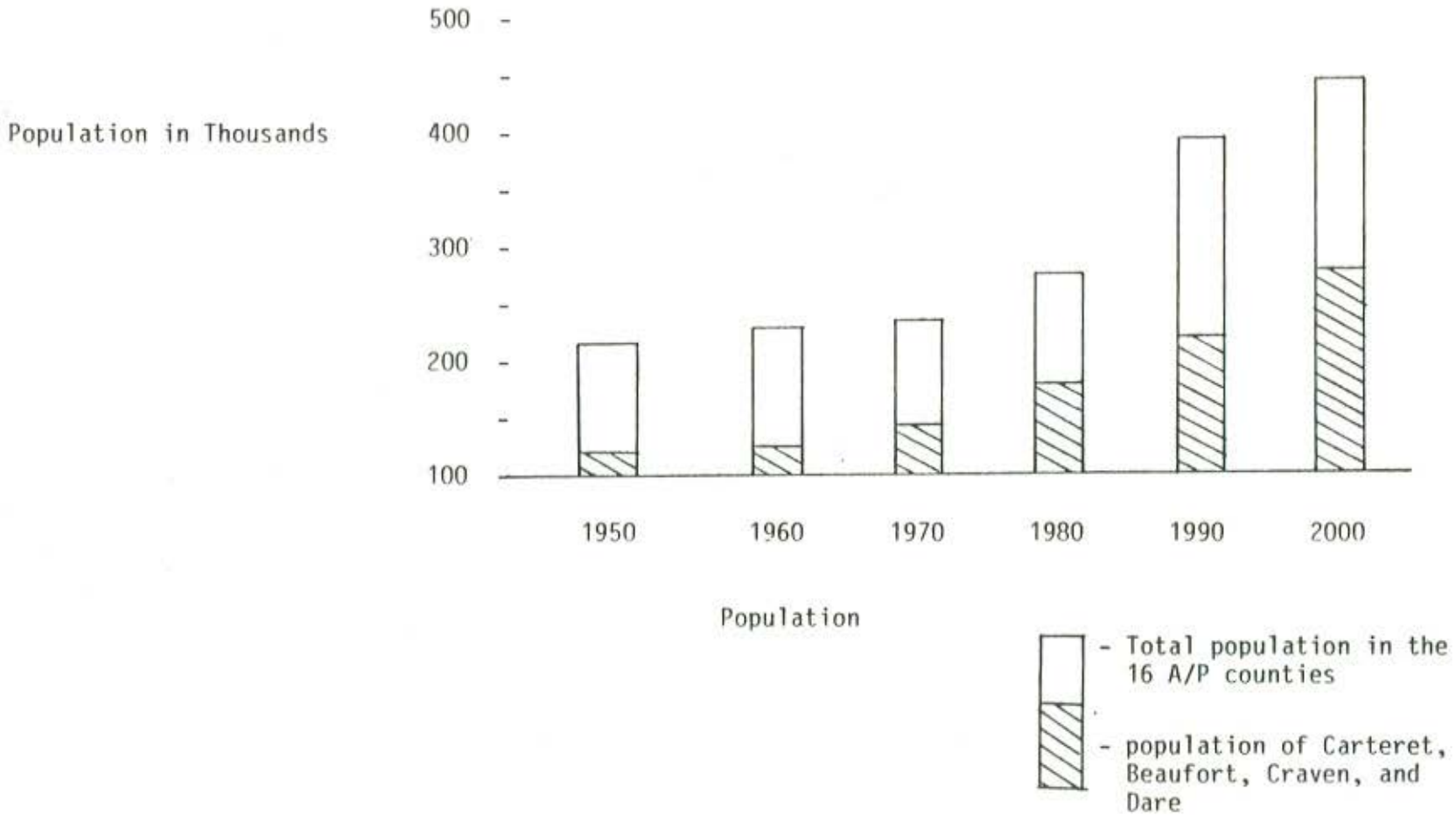
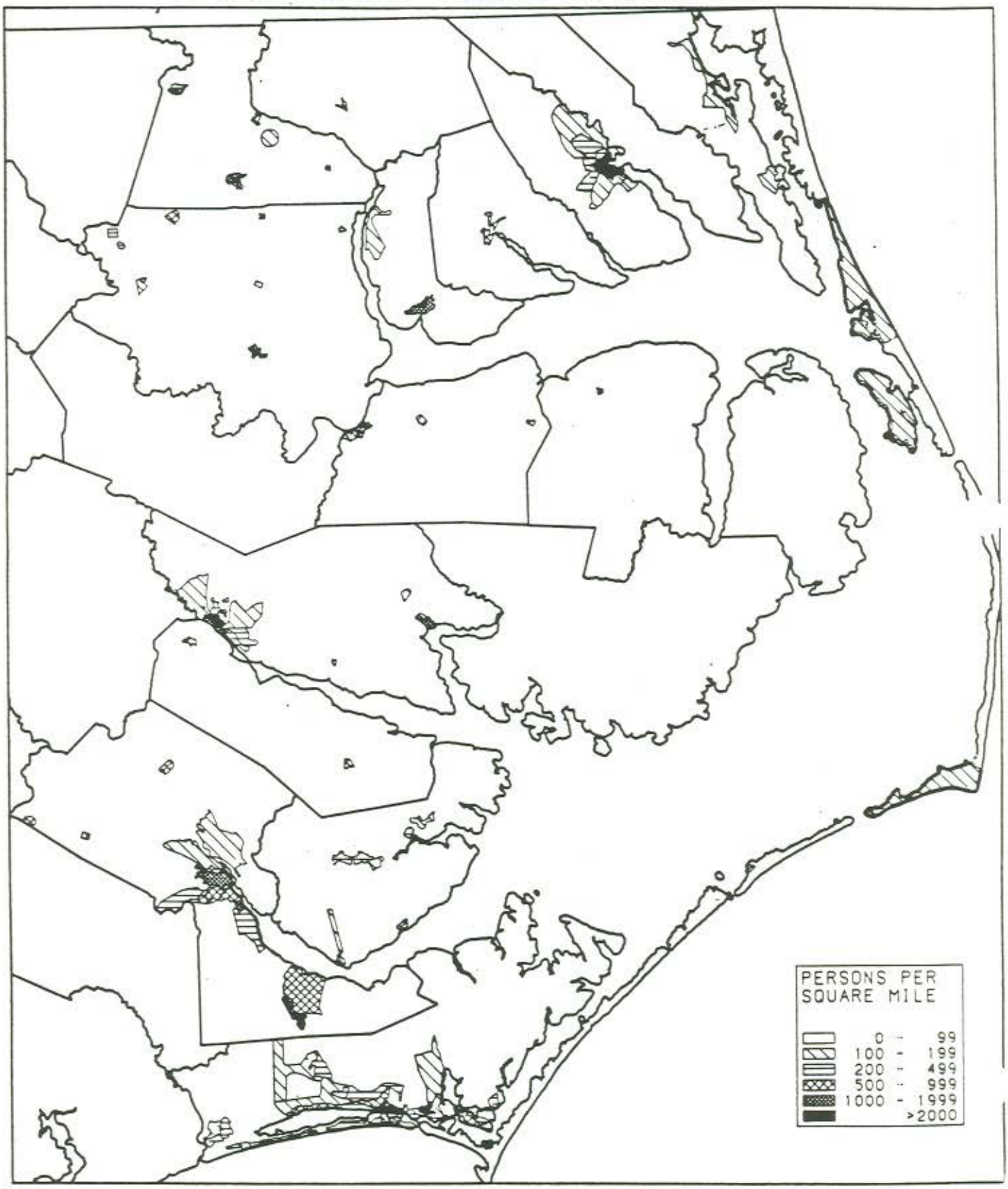


Figure III-14. ALBEMARLE-PAMLICO SOUND ESTUARINE PROJECT AREA
POPULATION DENSITY (PERSONS PER SQUARE MILE)



PLOTTED BY LAND RESOURCES INFORMATION SERVICE

along the waterways (Table III-5) where the property is more attractive and serves as a more valuable tax base. This is also a general pattern coastwide in land use plan updates since 1980. In the previous set of plans, shorelines and the adjacent areas were primarily classified as "rural". The new updates are recognizing that the State regulates the estuarine shoreline area of environmental concern and that the Corps of Engineers regulates wetlands. However, there is little local government activity to control or protect shore area beyond what is required by State and Federal law. In general, those counties exhibiting any growth are targeting that growth for the shoreline. It would be expected that, with the ever-increasing popularity of the North Carolina coast, those shoreline areas selected for transition to intense development will surely, and quickly, be used for that purpose.

III.4.4 Critical Issues

In the past, and in the present water quality initiative, the Coastal Resources Commission and the Division of Coastal Management have recognized a number of development land uses and issues of importance to the quality of North Carolina estuaries. These are listed below:

1) Septic tanks -- Tanks which fail or which are in inadequate locations contribute to eutrophication and bacterial problems.

2 Marinas -- Marinas contribute to bacterial and nutrient pollution, as well as toxics -- with antifouling paints and petroleum hydrocarbons.

3) "Urban" runoff -- Pollutants off developed impervious (be it paved or cleared and packed) areas include bacteria, nutrients, sediment, heavy metals, pesticides, and petroleum hydrocarbons.

4) Landfills -- The needs for solid waste disposal increases with population, but soils/water table conditions are often unsuitable for landfills. Leachate contaminants include bacteria, methane, and household toxics.

5) Development density/carrying capacity -- At what density does development begin to have an impact, what is the significant impairment threshold?

6) Cumulative impacts -- Similarly, when do incremental development insults, such as wetland losses, impact the resource?

7) Basinwide management -- Many coastal water quality problems are created or exacerbated with upstream contributions. Addressing coastal contributors alone will not solve water problems.

8) Groundwater -- Often forgotten, and pollution ignored, if not used for a drinking water source, groundwater can carry pollutants to the estuary. Also, any aquifer may be needed in the future as water sources, yet many are sacrified to septic tanks or runoff infiltration systems if the waters are not now used.

TABLE III-5

TRANSITION AND CONSERVATION LAND CLASSIFICATIONS OF ALBEMARLE/PAMLICO COUNTIES

COUNTY	PLAN DATE		
Beaufort	1981	--	About 1/4 of the shoreline is in transition class, very little of shoreline in conservation.
Bertie	1986	--	Transition areas are adjacent to present urbanized areas, with only one of these areas being adjacent to the shoreline of the Chowan. Conservation areas include poor draining areas on waterways and pocosins.
Camden	1986	--	A small transition area near Elizabeth City, with conservation areas along the shores of the Pasquotank and North Rivers.
Carteret	1986	--	A large portion of shoreline is in transition approximately 1/7 along the Newport River; 1/3 along the North River; 1/4 along the mainland side of Core Sound, and all of Harkers Island and the opposite shore.
Chowan	1986	--	The only shoreline transition is alongside Edenton and a length south of the Edenton Airport.
Craven	1982	--	Almost the entire shoreline along the Neuse and Trent Rivers is classified transition (land is now a combination of forest and development). Development is targeted to fill between New Bern and Cherry Point along the Neuse, across the Neuse from New Bern and along the Trent south of New Bern.
Currituck	1985	--	Very little transition, all located on the oceanfront.
Dare	1982	--	Nearly all the sound side of the island that is not already developed is classified transition, from Kitty Hawk to Cape Hatteras, as well as the Manteo and Wanchese areas of Roanoke Island.
Gates	1980	--	No transition, conservation along the Chowan River.
Hertford	1986	--	Virtually no transition, a conservation zone, varying in width, lines the waterway.
Hyde	1986	--	Most of the shoreline is in conservation, though there is some transition around Swan Quarter, Ocracoke, Englehard, and Fairfield.
Pamlico	1986	--	Some transition in shore towns about a third of the shoreline in conservation.
Pasquotank	1981	--	No transition area. About 3/4 of shoreline is in conservation.
Perquimans	1986	--	Small amount of transition along the shore in Hertford and at Harveys Neck, with conservation along the Perquimans River from Hertford upstream and along the tributaries.
Tyrell	1985	--	Small inland transition area with a 1/4 mile wide conservation buffer on all waterways/shorelines.
Washington	1980	--	Virtually no transition shorelines classified as rural/natural areas.

III.5 Agriculture In The Albemarle and Pamlico Sound Basins

III.5.1 Introduction

This section provides a general description of agricultural activities and soil and water conservation issues of the study region. Agriculture is very significant to the economy of the central and northern coastal plain. In this region, farming accounts for over $1,500,000,000 in annual gross receipts from field crops and livestock. Although the environmental impacts of agriculture on the sounds are not well understood, concerns about water quality problems associated with cropland runoff and animal waste do exist. Improving the control of agricultural nonpoint source pollution depends upon stronger efforts to support implementation of Best Management Practices (BMPs) for controlling soil erosion and animal wastes and for improving water management.

III.5.2 Characterization

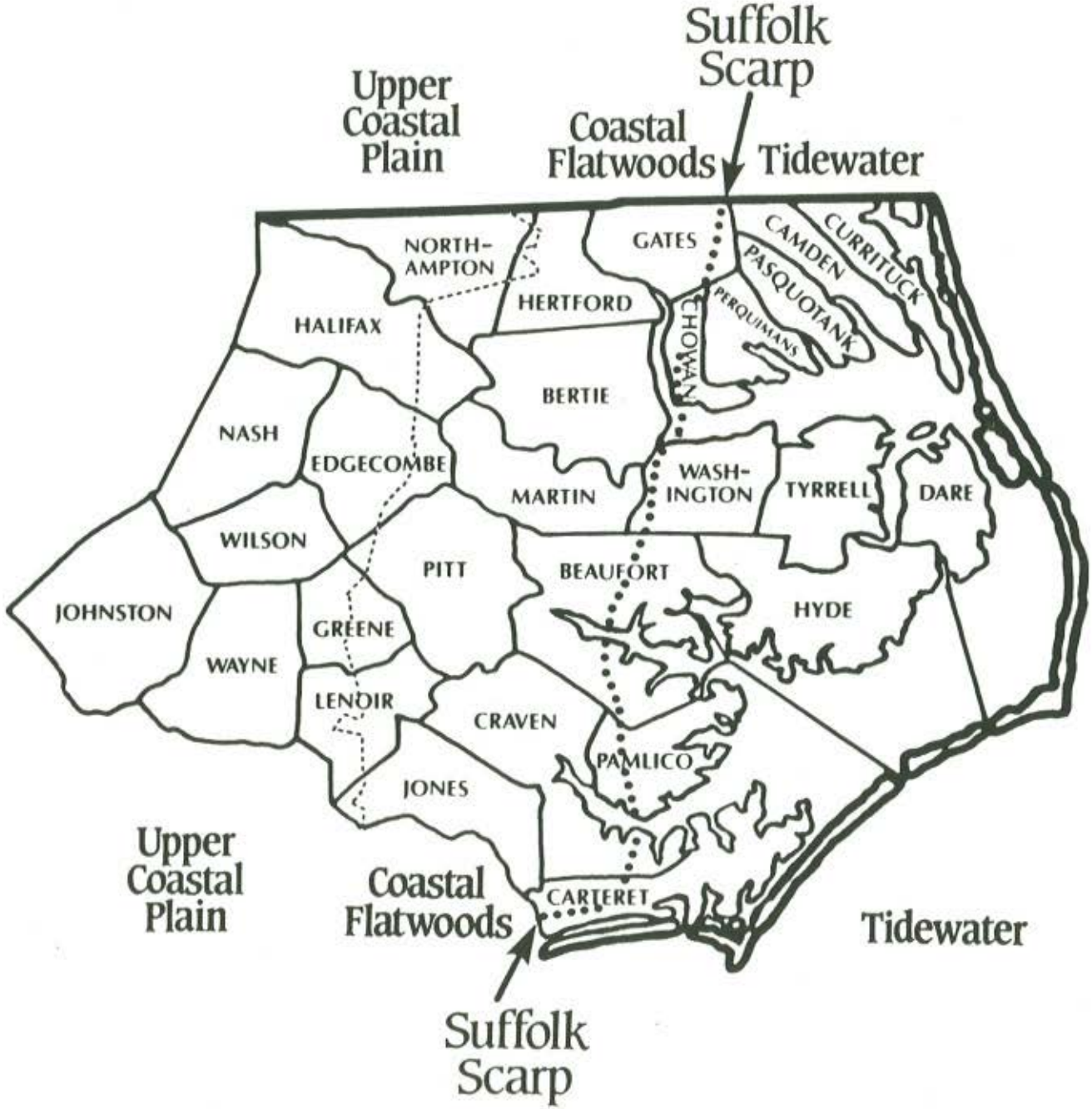
Agriculture is the largest industry in the 28 counties of the central and northern Coastal Plain and it accounts for over 40% of North Carolina's gross farm receipts. These counties contain 45% of the State's cropland and 50% of the hogs as well as 25% of the chickens. Predominate field crops are corn, soybeans, tobacco, potatoes, wheat and peanuts. This success in agricultural development stems from highly productive soils and a relatively flat landscape well suited for farming.

Agriculture has evolved across the study region in different ways due to the varying topographic features of the Coastal Plain. The Coastal Plain is divided into two main geographic sections by the Suffolk Scarp as shown on Figure III.15. The region west of the Scarp is older, has a higher elevation and the soils generally have a sandier texture. For these reasons, natural soil drainage is generally better west of the Scarp. The high value crops of tobacco and peanuts are grown mostly west of the Scarp and on the ridges and better drained soils eastof the Scarp. These crops are very sensitive to even short periods of excessive soil moisture and require very low levels of soil organic matter.

East of the Scarp, row crop agriculture is characterized by larger operations with the main crops being corn, wheat and soybeans. Production of such crops is highly mechanized and relative net income per acre is low.

Artificial drainage is necessary throughout the Coastal Plain except for the upper portions of the local topography. East of the Scarp, requirements for artificial drainage are universal. Elevations are less than 22 feet above sea level, topography is flat and the soils are generally medium- to fine-textured. With an average annual rainfall of approximately 50 inches and incidences of high intensity, extensive artificial drainage systems are necessary to prevent damage from excessive soil moisture in the root zone and periodic field flooding. Crops require a water removal system capable of

FIGURE III-15 STUDY REGION OF THE ALBEMARLE~PAMLICO AREA



handling about 2 inches of surface runoff within a 24-hour period. This water removal is usually accomplished through gravity flow, although some pumping is done on the peninsula. A typical surface drainage scheme begins with field ditches on a 330-foot spacing. These drain into collector canals which lead to main canals. The main canals ultimately connect with an outlet which is usually a major canal. These major outlet canals are fairly old, with some dating back to the 1700s.

Despite the success of agricultural drainage, the amount of cropland in the region appears to have reached its peak. Landclearing activities begun between 1950/the late 1970's are complete, and no new large-scale operations have been started. In 1975, the Corps of Engineers 404 dredge and fill permit became a major constraint to clearing land. The jurisdiction for the permit was drastically broadened from navigable waters to include wetlands. The inability of First Colony Farms to obtain a 404 permit decision for land clearing after an extensive Environmental Impact Statement process has set a precedent against future land development under the new law. Regardless of acreage, all land development comes under the purview of this permit.

The current economics of farming has eliminated any financial motivation to develop new cropland. The agricultural economy has undergone a drastic reduction since the early 70's when land clearing was widespread. The current real[1] price for corn and soybeans has dropped to about one half of 1973 levels. Real net farm real estate income is down by 44% and the farm debt has risen by over 60%. As a result, bankruptcies are occurring at an alarming rate. The immediate future is not promising because the worldwide surplus of grain commodities is expected to keep prices very low for several years.

An additional deterrent to clearing land for agriculture was included in the 1985 Food and Security Act. Under its Swampbuster provision, if a farmer plants annual crops on wetlands cleared after December 23, 1985, the farmer loses benefits from all federal agricultural programs such as price support, commodity loans, FmHA loan availability and crop insurance.

Major concerns about agricultural nonpoint source pollution of the sounds are: (1) nutrient loading of freshwater, particularly nitrogen and phosphorus; (2) increased freshwater peak flows into saline primary nursery areas; (3) general degradation of water bodies by sedimentation; and (4) coliform bacteria contamination of shellfish areas. The degree of agriculture's impact on these problems remains uncertain and depends upon many factors, including the weather, specific crops grown and the application of Best Management Practices (BMP's). Research has shown that BMP's are very successful in reducing pollution from agriculture.

BMP's for the Coastal Plain address soil erosion and sediment delivery, animal waste disposal and water management. Methods for controlling erosion on cropland include land treatment techniques such as no-till planting, field borders, grass waterways, terraces and sod-based rotations. The suitability of a specific practice varies according to topography, cropping rotations and other factors. Confined livestock facilities require animal waste management systems for either dry or wet manure. Adequate systems provide for proper waste storage or treatment and correct land application methods. In agricultural water management, the water table elevation is maintained in

cropland by using water control structures placed in existing drainage canals. This relatively new technology of controlled drainage reduces both runoff rates and the offsite delivery of nutrients and sediment.

The ongoing soil and water conservation program in each county is a joint effort among several agencies. The primary responsibility lies with the local soil and water conservation districts. Districts promote conservation by providing assistance to landowners in planning and implementing BMPs. In this 28-county region, Districts' staff are composed of 41 USDA/Soil Conservation Service (SCS) employees and nearly 40 county employees, some of which are part time. Federal financial assistance is made available to landowners for installing BMPs by the USDA/Agricultural Stabilization and Conservation Service (ASCS). Funding for the ASCS program is very limited to county allotments ranging from $5,000 to $40,000 annually, depending on requests and needs. In general, all federal programs for conservation have recently been reduced.

Further reductions in conservation program budgets are anticipated due to the current federal budget deficit reduction efforts. The N.C. Agriculture Cost Share Program for nonpoint source pollution control is currently under way in 18 of the counties in the study region. This program is very successful and is anticipated to greatly accelerate the ongoing conservation efforts within these counties. $1,425,000 was allocated to the counties of this region for fiscal year 1986-87 to provide a 75% cost share to landowners for installing BMPs. This represents about half of the total funds of the state cost share program.

Expansion of the N.C. Agriculture Cost Share Program in the coastal counties is a milestone in the state's conservation effort. In 1937, the first Soil and Water Conservation District in the nation was formed in Anson County. Since then, 93 additional Districts have been established to cover the entire State. Erosion control in the piedmont historically received greatest attention from in conservation programs. However, offsite water quality impacts in the coastal area have more recently gained more attention.

In the late 1970s, the Soil and Water Conservation Commission and the N.C. Agricultural Task Force responded to Section 208 of P.L. 92-500, the Clean Water Act, by evaluating the impacts of agriculture on water quality. This was a major step by the agricultural community to become more involved in nonpoint source pollution control and to develop an awareness of water quality concerns.

The reemphasis of agriculture's conservation needs along the cost was furthered by work of the Governor's Coastal Water Management Task Force in 1982. This group made ten recommendations in their final report addressing the best use of coastal resources for agriculture, forestry, the fishing industry and environmental concerns. Continuing research and a state cost share for conservation were given high priority.

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[1]Adjusted for price level changes.

The first realization of the conservation community's effort came in 1984. The General Assembly appropriated funds for agricultural nonpoint source pollution control in the newly established Nutrient-Sensitive Watershed Program. Continuing support by the legislature was evidenced in 1986 by the designation of the N.C. Agriculture Cost Share Program along with its additional funding.

III.5.3 Baseline Data

A general picture of agriculture for the study region by county is given in Table III-6. Farm income is significant to almost all the counties of the region. Harvested cropland accounts for about 28% of the land area (2,353,000 acres). The Upper Coastal Plain has a slightly higher percentage (34%) of cropland than does the Coastal Flatwoods and Tidewater areas (27% each). Hog numbers are fairly evenly distributed throughout the study region. Chicken production is lowest in the tidewater area accounting for only 10% of the total in the region.

Major crops ranked by average are corn, soybeans, small grain, peanuts, tobacco, cotton, sweet potatoes, irish potatoes, grain sorghum and various truck crops. Corn, soybeans and small grain are grown throughout the study region. Tobacco is concentrated in the mid to western counties with Pitt and Johnston counties the largest tobacco producers in the state. Peanuts are found in the northern half of the area with Northampton County ranked as the top producer statewide. Nine of the top ten peanut producing counties are found in the study region. Cotton is also located in the north with Halifax, Northampton and Edgecombe counties being the top three producers in the state.

Sweet potatoes are concentrated in the Upper Coastal Plain with Johnston and Nash counties at the lead. Irish potatoes are predominately found around the Albemarle Sound with eight of the to 10 leading counties located in the study region. Small acreages of truck groups (cucumbers, melons, squash, etc.) can be found through much of the mid to western area with heavier concentrations toward the south.

The 1982 National Resource Inventory conducted by Soil Conservation Service (SCS) provides the best available data on agricultural land use. Cropland erosion rates were found generally to be low and were lowest near the coast, as shown below.

Region	Percent Adequately Protected	Percent Needing Erosion Control	Tons/Acre Average Erosion Rate
Tidewater	95%	5%	1.8
Coastal Flatwoods	74%	26%	3.4
Upper Coastal Plain	69%	31%	4.0
Statewide	55%	45%	7.1

Table III-6
Agriculture Statistics

County	Land Area (In Thousand Acres)	Harvested Cropland 1/ (In Thousand Acres)	Hogs # 2/ (In Thousands)	Chickens # 3/ (In Thousands)	Farm Income 4/ (In Millions)
Tidewater					
Beaufort	526	148	64	35	$60
Camden	154	56	8	0	14
Carteret	336	32	1	40	10
Chowan	116	42	16	203	25
Currituck	163	55	20	33	18
Dare	250	2	0	0	1
Hyde	399	84	12	0	23
Pamlico	218	42	1	50	15
Pasquotank	146	76	9	0	28
Perquimans	158	75	33	492	31
Tyrrell	260	53	31	0	21
Washington	212	97	114	936	53
Total	2,940	762	309	1,743	301
Coastal Flatwoods					
Bertie	449	94	60	1,039	$67
Craven	449	63	30	245	46
Gates	217	49	22	703	30
Greene	170	74	111	187	72
Hertford	228	55	8	400	38
Jones	301	50	10	10	24
Lenoir	258	105	42	1,385	94
Martin	295	86	40	735	61
Pitt	420	145	101	1,450	124
Total	2,785	721	433	6,154	556
Upper Coastal Plain					
Edgecombe	324	128	48	611	$78
Halifax	463	131	68	881	83
Johnston	509	156	80	339	121
Nash	345	99	55	2,477	116
Northampton	345	111	58	1,307	72
Wayne	351	148	69	3,271	170
Wilson	239	97	42	531	77
Total	2,576	870	420	9,414	717

1/ Highest number within past 5 years (N. C. State Government Statistical Abstract 1984)
2/ Numbers on Farm December 1, 1984 (N. C. Ag Statistics 1985)
3/ Numbers on Farm December 1, 1982 (N. C. Ag Statistics 1982 and 1982 Census of Agricultur Volume 1, part 33)
4/ For 1984 (N. C. State Government Statistical Abstract 1984)

The use of agricultural water management is rapidly expanding in the study region. Presently, about 30,000 acres of cropland in this region have controlled drainage compared to less than 5000 acres in 1983. Pilot projects by SCS and research by N. C. State University are directing farmers to this practice which reduces pollution and also increases crop yields. Water management is also promoted through the N.C. Agriculture Cost Share Program. Water management is applicable to naturally poorly-drained soils with slopes of less than 2%. Up to 1,000,000 acres of cropland in the study region including most of the Tidewater area, meet these conditions.

The future impact and the direction of the N.C. Agriculture Cost Share Program in the 18 coastal counties may be anticipated from examining the results of the program in the last two years in the Chowan Basin. Over 500 landowners signed agreements to install BMPs on more than 42,000 acres of cropland in portions of Bertie, Chowan, Gates, Hertford and Northampton Counties. More than 92,000 tons of soil will be saved in these counties each year for 10 years on 23,000 acres of cropland. Thirteen animal waste management systems will store over 11 million gallons of nutrient laden liquid. In addition, large quantities of liquid and solid animal wastes will be applied to crop and pasture lands in an environmentally safe manner. Through the implementation of these BMPs, a significant amount of nitrogen, phosphorus and sediment will no longer be washed into the stream systems.

Expanding the N.C. Agriculture Cost Share Program to the remainder of the study region would cost an average of $100,000 to $150,000 per county each year for financial assistance. Technical assistance necessary to support the Program would take about $15,000 per county each year.

III.5.4 Trends

Agriculture in the study region is anticipated to remain a fairly steady industry. Cropland acreages are not expected to increase due to economic and legal restrictions on clearing certain lands. The acreage of planted cropland will, however, vary from year to year. Hog and chicken production should continue to grow with a large increase possible if a major processing plant locates within or near the region. The potential for agricultural nonpoint source pollution in the study region will remain fairly constant. Pollution increases, if any, will be attributable to growth in livestock production.

Conservation work is progressing. The N.C. Agriculture Cost Share Program is greatly accelerating BMP implementation in the 18 counties participating in the program. Water management is proving to be very attractive to farmers and its use should increase dramatically. A trend which is having a negative impact on BMP implementation is the decline of federal staff numbers and programs which historically have been the mainstay of the conservation effort. Increases in state and local involvement will be required.

III.5.5 Critical Issues

In terms of the Albemarle-Pamlico study region, the basic objective for agriculture is to be productive without significantly impairing the water quality of the sounds. Three critical issues which affect the success of meeting this objective are:

(1) Adoption of on-farm BMPs is of highest priority. Acceleration of basin-wide BMPs implementation will require expansion of the N.C. Agriculture Cost Share Program, along with support of other conservation efforts.

(2) Conservation programs capable of dealing with agriculture-related water quality impairments need continuing direction. Understanding the degree, cause and location of water quality problems is necessary before conservation program priorities can be established that can best correct the water quality problems.

(3) Larger scale innovations in water management, such as re-routing drainage and temporary storage of excess water, may be a practical alternative in some coastal watersheds. If these innovations are to occur, additional research is needed as well as a reassessment of the present position of some environmental agencies regarding wetland preservation.

III.6 Forestry In The Albemarle-Pamlico Region

III.6.1 Introduction

This section addresses the current status of the forests of this study area and makes tentative projections of their future status based upon discernible trends and upon reasonable assumptions. The information is presented, in so far as possible, in tabular format. Data are drawn primarily from the Forest Survey of North Carolina, information maintained at the Division of Forest Resources district offices in the area under study, and interviews with knowledgeable professionals, both public and private.

III.6.2 Characterization of Use

The current major economic use of the forestland of the study area is as a base for the production of raw material for the diverse forest products industry. The present stumpage value of the annual harvest is 72 to 78 million dollars. These forests also serve as extensive wildlife habitats. This use will not be considered in this section, but is evaluated elsewhere in this chapter. Recreational use of the area's forests is ongoing, but lags far behind use of the waters and beaches of the area in intensity. Except for hunting, most of the forest recreation occurs on public lands. A less often recognized function of this vast woodland is to act as a filter and surge control mechanism for fresh waters entering the sounds. The utility of a vigorous, multi-leveled forest as a CO2 sink is a passive role about which little is known.

III.6.3 Baseline Data

The Southeastern Forest Experiment Station of the U. S. Forest Service makes an intensive inventory of the woodlands of North Carolina. The database used in this section was specific to the counties involved and was obtained from the three most recent inventories. These data are extremely reliable (sampling errors for the 17 county area, depending upon the type of data, range from less than 1% to less than 6%). Data from the survey are readily available from the Asheville headquarters of the Southeastern Forest Experiment Station. Information on conditions and trends not addressed by the survey has been obtained from records maintained by the Division of Forest Resources district offices. These data are in much less convenient form than those of the survey. Some data were supplied by several of the managers of large forest ownerships. In addition, some data pertaining to trends were obtained from a prepublication manuscript of "The Southern Study."

III.6.4 Significant Trends

The following trends, which may be of significance to the study, are as follows:

1. There appears to have been an average annual reduction in total forest area of 20,000 acres (Table III-7).

2. The extent of the pond pine, the oak-gum-cypress (both typical of poorly drained sites), and the natural pine types decreased between 1964 and 1984. Other hardwood types and pine plantations have increased over the same period (Tables III-7, III-9, III-10, and III-11).

3. There has been a shift in the land ownership pattern. Acres owned by private individuals has decreased while acres owned by corporations not associated with the manufacture of forest products has increased (Table III-12 and III-13).

4. There are a number of trends in silviculture (Table III-14).

   a. The degree of disturbance centered upon pine plantation establishment has decreased.

   b. The annual rate of pine plantation establishment has also decreased.

   c. The use of herbicides and prescribed fire has increased.

   d. The rate at which drainage systems for woodlands are being installed has declined. It is estimated that between 75 and 80 percent of the land owned by forest industry for which drainage is a feasible option has already been drained. Future activity for the forest industry is likely to center about the conversion of passive drainage systems to water management systems. Only about one percent of private, nonindustrial woodlands is estimated to be artificially drained. An unknown percentage of this class of woodland receives incidental drainage associated with adjacent agricultural land and road construction. The current trend toward less intensive management of private land portends that an increase in drainage from private forest lands will not occur. The growing ownership of large blocks of woodlands by non-forest industry corporations may, however, result in an increase in the extent of acres drained.

   e. Fertilizer is currently used only on pine plantations. It is a common practice for forest industry to apply phosphorus during the establishment of a plantation on poorly drained sites. Post establishment application of nitrogen is much less widely practiced. It is estimated that about 10,000 acres per year receive phosphorus fertilizers. This may increase slowly. Currently, about 2,000 acres of plantation per year have the potential for nitrogen application. The exact rate of application is not known.

TABLE III-7

FOREST ACRES BY TIMBER TYPE

(1000 acres)

TYPE	PAST			PROJECTED 1/	
	1964	1974	1984	1994	2004
Loblolly Pine	775	754	803	834	849
Pond Pine	658	515	279	240	220
Other Pines	27	36	39	40	38
Oak-Pine	464	424	354	320	300
Oak-Hickory	140	383	394	406	416
Oak-Gum-Cypress	1009	832	759	740	745
Elm-Ash-Maple	39	38	40	40	40
Total	3112	2982	2668	2620	2608

TABLE III-8

CURRENT

PHYSIOGRAPHIC FOREST CONDITIONS

PERCENT BY OWNERSHIP CLASS

	% TOTAL	FOREST INDUSTRY	PUBLIC	PRIVATE	TOTAL
Deep Swamps	5.45	20.15	15.75	64.11	100.00
Stream Margins	7.94	25.07	0.14	74.79	100.00
Flatwoods & Dry Pocosins	63.09	39.27	4.32	54.61	100.00
Bays & Wet Pococins	18.63	13.73	24.51	61.76	100.00
Rolling Uplands	3.01	18.63	11.12	70.25	100.00
Sandhills	0.17	--	--	100.00	100.00
Miscellaneous	1.67	17.19	14.19	68.62	100.00
Total	100.00				

TABLE III-9

STAND ORIGIN BY TIMBER TYPE
% OF TOTAL FOREST ACREAGE

TYPE	For The Year 1964	1974	1984	1994 1/	2004 1/
Planted Pine	0.88%	7.47%	16.10%	20.4%	27.0%
Planted Oak-Pine	0.18	1.28	0.93	2.6	3.0
Planted Hardwood	0.18	0.27	0.17	.1	.1
Natural Pine	45.63	36.29	25.93	17.1	8.0
Natural Oak Pine	14.81	12.98	12.33	12.4	11.1
Natural Hardwood	38.32	41.71	44.54	47.4	50.8
Total	100.00				

1/ Simple linear extrapolation of three base years

TABLE III-10

COMMERCIAL GROWING STOCK

PAST AND PROJECTED

MILLION CUBIC FEET

TYPE	1964	1974	1984	1994 2/	2004 2/
Pine	1763	1823	1798	1830	1847
Other Softwoods	177	177	194	199	208
Hardwoods	1797	2005	2338	2588	2858
Total	3737	4004	4330	4617	4913

TABLE III-11

ANNUAL GROWTH & DRAIN
MILLION CUBIC FEET

	1964		1974		1984		1994 2/		2004 2/	
TYPE	Growth	Drain	Growth	Drain	Growth	Drain	Growth	Drain	Growth	Drai
Pine	61.3	41.7	76.7	93.3	87.4	90.4	101.2	123.8	148.2	150.
Softwoods	3.3	5.4	5.7	5.4	6.0	5.9	7.7	6.1	9.0	6.
Hardwoods	56.3	43.8	72.6	65.4	90.0	47.2	106.7	55.5	123.5	57.
Total	120.9	90.9	155.0	164.1	183.4	143.5	215.6	185.4	246.8	21

TABLE III-12

PERCENT OF TOTAL FORESTLAND OWNERSHIP

	1964	1974	1984	1994 1/	2004 1/
PUBLIC					
National Forests	3.5	3.6	4.2	4.5	4.8
Other Federal	0.0	1.3	3.3	4.8	6.5
State	2.0	0.9	1.2	0.6	0.2
City/County	0.0	0.1	0.1	0.1	0.1
Total	5.5	5.9	8.7	9.9	11.5
PRIVATE, NON-INDUSTRIAL					
Farmer	37.7	31.3	23.6	16.7	9.7
Non-Farmer	25.0	27.6	20.2	19.4	17.1
Corporate	0.0	8.0	16.2	24.3	32.4
Total	62.7	66.9	60.0	60.5	59.1
FOREST INDUSTRY					
Owned	31.7	26.9	30.4	28.4	27.7
Leased	0.0	0.4	0.9	1.4	1.9
Total	31.7	27.3	31.3	29.7	29.5

1/ Simple linear extrapolation of three base years

2/ Extrapolation guided by trends developed for "The Southern Study"

TABLE III-13

PERCENT OF TIMBER TYPE

BY OWNERSHIP CLASS

1984

FOREST COVER TYPE	OWNERSHIP CLASS					
	PUBLIC		PRIVATE		FOREST INDUSTRY	
	% TOTAL	%TYPE	%TOTAL	%TYPE	%TOTAL	%TYPE
Pine	4.1	9.6	18.6	44.4	19.3	46.0
Oak-Pine	1.3	11.8	9.6	72.0	2.1	16.1
Oak-Hickory	0.6	3.6	12.0	81.6	2.2	14.8
Oak-Gum-Cypress	2.6	8.8	19.0	66.8	6.9	24.4
Elm-Ash-Cottonwood	0.2	4.3	0.7	49.8	0.7	45.9

TABLE III-14

ANNUAL PERCENT OF TOTAL FOREST

AREA BY DISTURBANCE CLASS

DISTURBANCE CLASS	1974	1984	1994 3/	2004 3/
Harvest	1.72%	1.64%	1.70%	1.75%
Selective Cutting	0.14	0.31	0.25	0.15
Thinning	0.54	0.13	0.40	0.55
Timber Stand Improvement	0.62	0.18	0.40	0.40
Site Preparation	0.75	1.04	1.00	1.02
Planting	0.73	0.73	0.75	0.77
Other	0.04	0.18	0.57	0.24
Natural Regeneration	0.41	0.55	0.60	0.65
Natural, Non-man	0.75	0.75	0.75	0.75
Total	5.70	5.51	6.42	6.28

3/ Projection based upon reasonable assumption

III.6.4 Expected Outcomes

From these trends it appears that, at least for the short-term, the forest condition will remain relatively stable. Drainage activity will probably not change. Fertilization activity will likely increase (until energy costs climb). Conversion of forest land to other uses will continue at its present rate until, and if, agriculture becomes much more profitable. The rate of harvest will change little unless climbing energy costs create markets for "energy wood".

III.6.5 Critical Issues

The critical issues or trends pertaining to the forestlands of the study area are defined as those which impact jointly the commercial forestry and the waters of the estuarine system. Paramount among these is the rate at which forestland is being converted to other states and uses. A second critical issue centers upon the strongly positive benefits of land drainage to commercial forestry and the possible negative benefits of this to water quality and salinity. Less serious but worthy of study are the relationships between the infrequent application at long intervals of fertilizer to pine plantations. The same can be said of the use of herbicides and heavy equipment in site preparation practices. The long-range impact of the rapid rate of replacement of natural pine and oak-pine stands by pine plantations is also an issue which might have joint impact.

III.7 Department of Defense Activities and the Albemarle-Pamlico

III.7.1 Introduction

Department of Defense activities have a profound affect upon the Albemarle-Pamlico estuarine system. Defense activities include the construction, continued use and maintenance of the Atlantic Intracoastal Waterway, the Cherry Point Marine Air Station, and the numerous and dispersed bombing ranges and target areas. Comprehensive knowledge of the environmental impacts from these activities is disjointed at best and nonexistent at worst. A systematic assessment of the effects of Department of Defense activities on this estuarine system is not feasible at this time and is certainly beyond the capacity of this estuarine study. There should, however, be opportunities to evaluate impacts from some defense activities in the broader considerations of the estuarine study.

III.7.2 Characterization of Uses

Department of Defense facilities in the Albemarle-Pamlico estuarine system can be grouped into four categories.

A. Atlantic Intracoastal Waterway - The impacts from this facility are use-related (petroleum by-products and wastes from the ships head and galley). Maintenance dredging also generates significant, intermittent impacts.

B. Cherry Point Marine Air Station - The Air Station is a potential source of known and unknown hazardous waste pollutants to both surface and ground water from historical and ongoing activities. Thirty-two hazardous waste facilities/sites have been identified at the Air Station.

C. Bombing Ranges And Target Areas - Site-specific physical effects occur in these areas. Broader and more significant impacts may prove to be the use-conflicts (exclusion and noise) with commercial fishing, recreation, wildlife, and the Intracoastal Waterway.

D. Other Facilities - Present impacts from these facilities are minor, although the potential exists for significant future impacts.

Table III-15 contains information on the defense facilities in the region. The Coast Guard is a Department of Transportation agency; Coast Guard installations were not included in this review of Department of Defense facilities.

III.7.3 Baseline Data

The Corps of Engineers has numerous flood control, aquatic plant control, and ports and harbors projects, either planned or ongoing, in the region. The environmental impacts from those projects

TABLE III-15

National Defense Facilities
in the Albemarle-Pamlico Study Region

Category	Facility	Agency	Acreage	County
Atlantic Intra-coastal Waterway (AIWW)	Atlantic Intra-coastal Waterway	Corps of Engineers	23,200	Carteret, Craven Pamlico, Beaufort, Hyde, Tyrrell, Dare, Currituck
AIWW	Dismal Swamp Canal	Corps of Engineers	260	Camden
Cherry Point Marine Air Station	Cherry Point Marine Air Station	Navy	11,550	Craven
Bombing Range	Dare Co. Range	Air Force	46,650	Dare
Target Area	Piney Island	Navy	12,460	Carteret
Target Area	Palmetto Point	Navy	1.9	Chowan
Target Area	Stumpy Point Area	Navy	?	Dare
Target Area	Air Combat Management Range Tracking Station	Navy	?	Dare
Target Area	?	?	?	Pamlico
Target Area	Harvey Point	Navy	1,270	Perquimans
Target	Abandoned	?	?	Tyrrell
Other	Naval Research Training Center	Navy	2	Beaufor

TABLE III-15

National Defense Facilities
in the Albemarle-Pamlico Study Region

Category	Facility	Agency	Acreage	County
Other	Atlantic Outlying Field	Navy	1,470	Carteret
Other	Army Reserve Center	Army	6	Carteret
Other	Cape Lookout	Corps of Engineers	5	Carteret
Other	LST Landing Ramp, Radio Island	Navy	21.2	Carteret
Other	Radar Facilities, Nags Head	Air Force	9.6	Dare
Other	Naval Facility, Cape Hatteras	Navy	?	Dare
Other	National Guard Facility, Elizabeth City	Army	2	Pasquotank

could be significant, both individually and cumulatively. Environmental consequences from these projects are, however, presumably delineated in an Environmental Impact Statement completed prior to the initiation of the project.

III.7.4.1 Atlantic Intracoastal Waterway (AIWW)

The best and most complete data on the use of the AIWW was secured from the Norfork District, U.S. Army Corps of Engineers. Table III-16 shows twenty-five years of vessel usage and eleven years of waterborne tonnage data for the two branches (Dismal Swamp Canal, and Albemarle and Chesapeake Canal) of the AIWW at the North Carolina-Virginia state line. The total usage is divided into recreational and other craft in Figures III-16 and III-17.

There is no single source of data on AIWW usage for the study area. The data in Table III-16 can be used as an indicator of AIWW system use, but the information does not indicate the influence of local traffic within the study area. An estimate could be made of AIWW use within the study area from waterborne commerce tonnage figures, drawbridge data from the DOT, and information from the Wilmington District of the U.S. Army Corps of Engineers. Such estimates would be susceptible to significant error, however, because of the very poor data on localized AIWW usage by small recreational vessels, which do not require drawbridges to be opened. These small craft routinely account for the majority of traffic.

Use data might be an indicator of the potential for pollution from petroleum by-products and wastes from the heads and galleys of vessels. Ship's heads are regulated by the Coast Guard, although there is some question about the diligence of enforcement and sufficiency of protection provided. No direct data found to either provide direct figures on such use-related pollution, or to allow for meaningful estimates.

There is an abundance of data for AIWW maintenance dredging and spoil disposal activities. Table III-17 presents dredging information for 1987 on the AIWW and related channels within the study area. Since maintenance dredging is a continuous activity, historical data can be used to assess potential impacts and long-term management plans (Table III-18).

III.7.4.2 Cherry Point Marine Air Station (CPMAS)

Environmental data gathering on activities at the CPMAS has only begun in the past few years. Recently completed and ongoing studies are beginning to characterize the magnitude and nature of identified hazardous waste contamination problems. Thirty-two potentially contaminated sites on CPMAS were idenitified in a 1983 study; fourteen of those sites were recommended for further study. The fourteen sites are currently being evaluated to verify or deny suspected problems, to characterize the extent of the contamination,

TABLE III - 16

AIWW Use Between

North Carolina & Virginia

YEAR	A & P CANAL	DISMAL SWAMP CANAL	TOTAL
1960	9,240	2,518	11,758
1961	8,629	2,943	11,572
1962	8,885	2,143	11,028
1963	9,039	1,887	10,926
1964	10,087	2,044	12,131
1965	10,286	2,147	12,383
1966	9,633	2,259	11,892
1967	11,137	2,004	13,141
1968	11,664	2,308	13,972
1969	11,925	2,300	14,225
1970	12,317	2,253	14,570
1971	13,009	2,279	15,288
1972	13,827	2,731	16,558
1973	14,085	2,875	16,960
1974	12,533	2,874	15,407
1975	12,660	3,162	15,822
1976	13,701	1,405	15,106
1977	13,229	847	14,076
1978	14,111	1,212	15,323
1979	13,831	1,397	15,228
1980	13,390	639	14,029
1981	13,020	1,234	14,254
1982	12,516	1,125	13,641
1983	13,092	996	14,088
1984	12,342	1,007	13,349
1985	15,515	745	16,260

Figure III-16. AIWW Use By Type Between North Carolina & Virginia

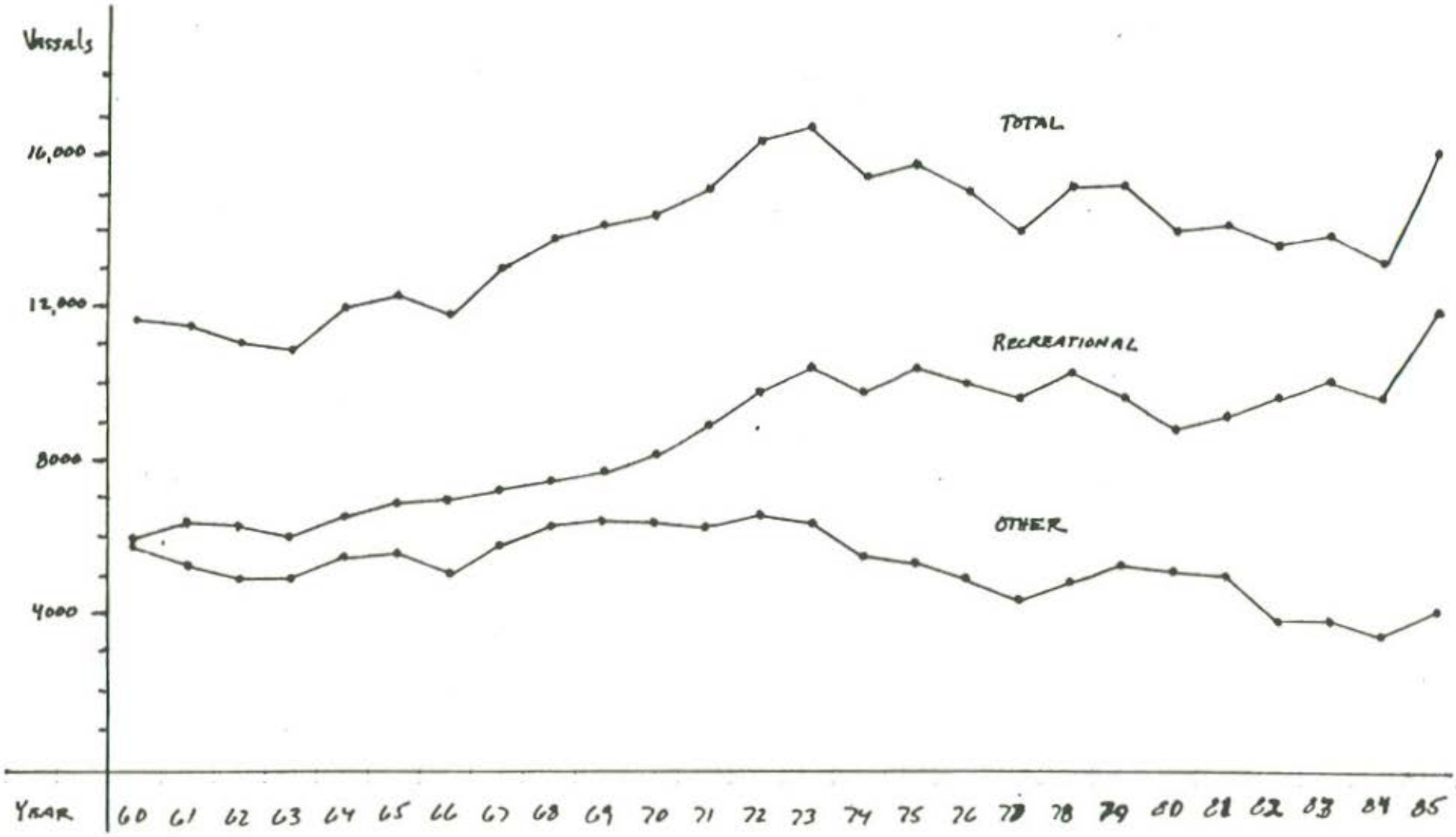


Figure III-17. Dismal Swamp Canal Use By Type Between North Carolina & Virginia

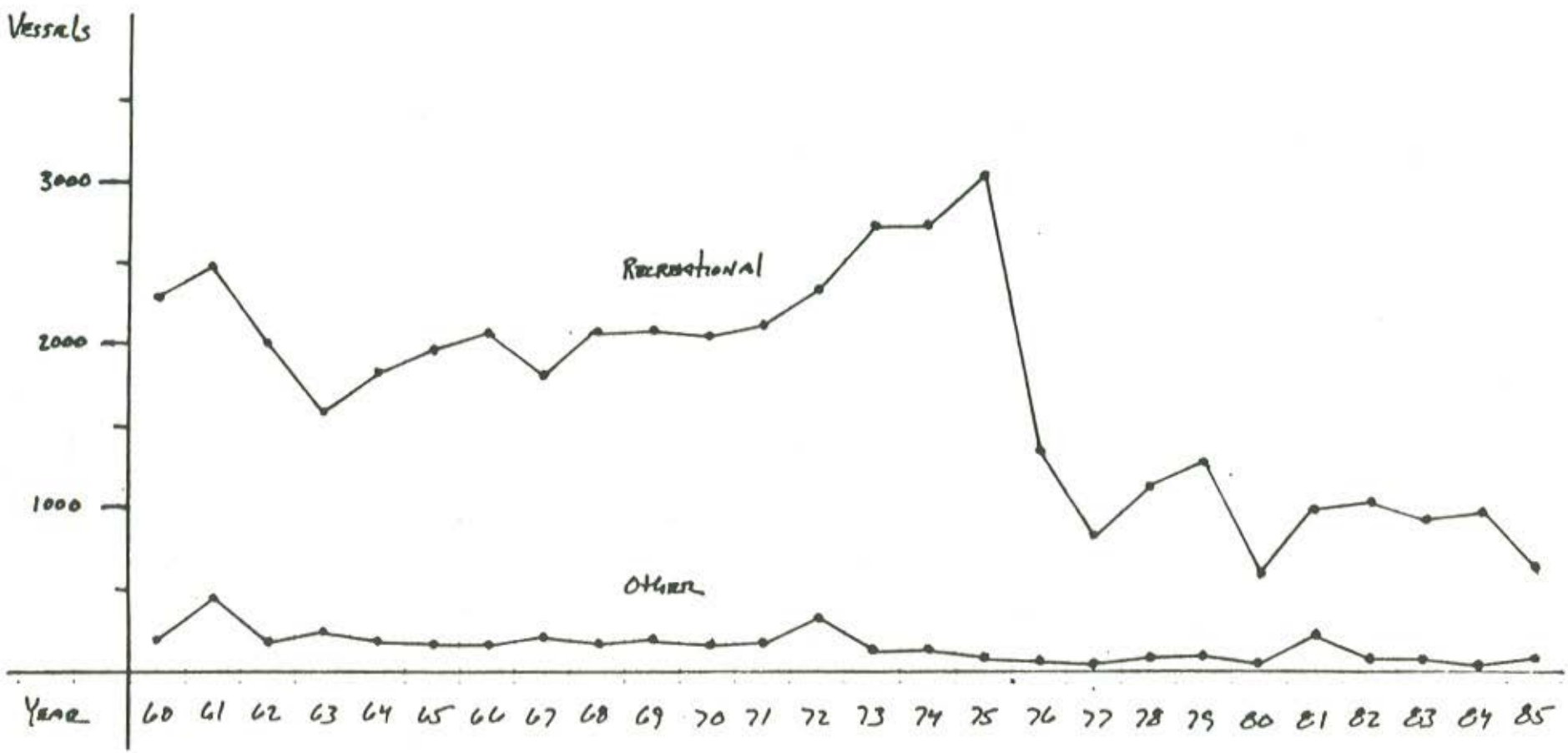


TABLE III - 17

FY 87 Dredging Projects

Project	Estimated Cubic Yards	Dredging Method	Disposal Method
Silver Lake Harbor (Big Foot Slough, Teaches Hole)	192,000	Pipeline	Sand Bag Area & Beach
Beaufort Harbor	257,000	Pipeline	Upland
Manteo (Channels to Wanchese)	300,000	Pipeline	Upland
AIWW, Alligator-Pungo	50,000	Pipeline	Toe of Bank
Morehead City Harbor (Ocean Bar)	700,000	Hopper	Open Water
Manteo (Oregon Inlet)	450,000	Hopper	Open Water

TABLE III 18

Historical Dredging of AIWW

	Alligator Rv.- Alligator Pungo	Adams Ck.- Core Ck.	North Rv. Landing	Peltier Ck. Bogue Inlet	Totals
1960	380,803	723,174			1,103,977
1961		382,602			382,602
1962	67,661	648,761			716,422
1963	77,638	272,364			350,002
1964	42,037	728,788	249,892		1,020,717
1965		554,464	879,168		1,433,632
1966			998,408	28,445	1,006,853
1967		95,689		14,784	110,473
1968		165,140		63,896	229,036
1969		111,892			111,892
1970					
1971	247,286	171,604		107,178	526,068
1972					
1973		170,268			170,268
1974	197,077	137,807		21,253	356,137
1975				68,807	68,807
1976		191,995		34,992	226,987
1977		871,070			871,070
1978		87,414		78,618	166,032
1979	247,677			96,550	344,227
1980					
1981				13,622	13,622
1982					
1983		42,414		25,277	67,691
1984		225,543			225,543
1985	176,224				176,224
25 Year Total					

and to assess the feasibility of corrective measures. This study is to be completed in late 1986 or early 1987. Other sites and continuing operations beyond the study's fourteen continue to suffer from incomplete data for decision-making.

III.7.4.3 Bombing Ranges & Target Areas

With the exception of location and total use figures (Table III-15), there is very little available information on bombing ranges and target areas within the study region. Estimates of pollution or impacts associated with target utilization apparently have not been made. The likelihood of securing specific data on the direct physical effects of live ordnance on these ranges and targets is very small. The targets in estuarine waters do have low utilization, high unused capacity, and major potential for user conflicts from overflights.

The Dare County Bombing Range includes a buffer area of 19,000 acres (approximately 40% of total site) which has been registered as a Protected Natural Heritage Area. This buffer isolates the bombing range impacts from surrounding areas, except for occasional fires and use conflicts from overflights.

III.7.4.4 Other Facilities

There is little data available on any of these facilities, although further investigation may uncover some information worthy of consideration as the sites are further characterized. For the most part, however, the facilities in this category appear to generate minimal impacts.

The sheer size of the Atlantic Outlying Field (1470 ac.) makes its future use a significant issue. The fact that the Field is abandoned means there is no readily available information on hazardous waste sites that may exist on this facility. The Coast Guard Station at Elizabeth City, which is a Department of Transportation facility and thus not specifically included in this review, does contribute to surface and ground water pollution and to problematic discharges to the town's sewage treatment plant.

III.7.5.1 Significant Trends

III.7.5.1 Atlantic Intracoastal Waterway (AIWW)

Total system use of the AIWW has gradually and sporadically increased about thirty percent over the past twenty-five years (Figure III-16). The fluctuation in total use between 1973 and 1985 is probably related to gasoline prices. Recreational craft use on the AIWW has more than doubled since 1960, while use by commercial vessels has dropped about thirty-five percent. Although recreational and other

uses of the waterway were about equal in 1960, recreational usage was about three times that of other uses in 1985. Commercial tonnage has also decreased fifty-one percent over the past thirteen years (Table III-19).

The Dismal Swamp Canal branch of the AIWW has had considerable fluctuation in usage over the past twenty-five years (Figure III-17). The fluctuation in use can be attributed directly to drought cycles. The Corps of Engineers has conducted recent studies on closing the canal to traffic. One alternative being considered to stimulate additional traffic on the canal, when water levels permit, is the development of a Welcome Center at Elizabeth City. Table III-20 shows the projected traffic increases based upon this study.

Maintenance dredging of the AIWW is a continuous process requiring periodic dredging of various segments of the system. The dredged material must be placed in spoil disposal areas that avoid unnecessarily negative environmental impacts. This is a particular problem because projections indicate a deficiency of existing capacity and locations for future spoil disposal. [Note: Based upon telephone comment from the Wilmington District, U.S. Army Corps of Engineers.] Over the next several years, the Wilmington District of the Corps of Engineers will be conducting a comprehensive study of the AIWW to project long-term disposal needs, quantify the remaining capacity of existing disposal areas, and identify new, environmentally-acceptable disposal sites to accommodate long-term needs.

III.7.5.2 Cherry Point Marine Air Station

Baseline data on this facility are so inaccessible or poor at this time that trends cannot be projected. Under the Naval Assessment & Control of Industrial Pollutents Program, which was begun in 1982 and is ongoing, several findings are beginning to immerge. Heavy metals contamination has been found in Slocum Creek, which is a tributary to the Neuse River. Shallow acquifer contamination has been documented in conjuction with hazardous waste site studies. Expansion of the facility has been proposed by the Marine Corps in a recent announcement of their desire to construct a training facility for 120 harrier jets within the Croatan National Forest.

III.7.5.3 Bombing Ranges and Target Areas

Baseline data are sparse but indicate a large unused capacity on existing bombing ranges and targets. There are, however, other trend indicators that may be considered. Based upon changes in technology aircraft, and weapon types, the military is in the process of requesting expanded airspace area and controls over a number of sites. The Navy hs requested Restricted Airspace at Harvey Point and Stumpy Point. The Marine Corps is also preparing a Restricted Airspace expansion request tentatively proposing increasing the use of the Piney Island Target Area within the Marine Corp's existing Restricted

TABLE III-19

Waterborne Commerce Tonnage

On The AIWW Between

North Carolina & Virginia

YEAR	ALBEMARLE AND CHESAPEAKE ROUTE (tons)	DISMAL SWAMP ROUTE (tons)
1973	1,756,424	10
1974	1,384,248	10
1975	1,400,446	00
1976	1,426,917	10
1977	1,211,880	00
1978	1,350,071	03
1979	1,515,608	00
1980	1,414,780	30
1981	1,348,985	5550
1982	926,876	1950
1983	920,470	265
1984	919,555	1212
1985	869,548	590

TABLE III-20

Projections For Dismal Swamp Canal Use

From Corps of Engineers Study

Year	Ratio (DSC/Total)* 10%	25%	Additional Use With Welcome Center**
1985	1000		1200
1990	1100	2700	1400
2000	1300	3300	1800
2020	2000	5000	3100
2030	2400	6000	4100
2035	2700	6700	4700

*The ratio of the Dismal Swamp Canal to total Intracoastal Water (total = Dismal Canal + Albemarle & Chesapeake Canal); has been estimated at 10% & 25% which is within the historical range of fluctuation.

**If a Welcome Center and other "attractions" planned in the Elizabeth City area come about, these additional trips will occur. Note that the Corps has used the 25% ratio in their study, so the total max. Dismal Swamp Canal use in 2035 would be: 6700 + 4700 = 11,400.

Airspace. If these proposals are approved then the cumulative effect will be a tremendous potential future for use-conflicts over virtually the entire Albemarle-Pamlico estuary system.

There appears to be a movement toward increased use of laser targeting devices and electronic warfare simulator devices. If this becomes a trend, then the physical impacts of the use of live ordnance will be reduced.

III.7.5.4 Other Facilities

Of the numerous facilities in this category, only one has a proposed change of use that might be considered a significant trend. The LST Landing Ramp on Radio Island is being studied by the Navy as the future site of an Agricultural Quarantine and Decontamination Facility (AQDF). The purpose of the AQDF would be to clean foreign matter (such as soil, plants, seeds, spores, animals, insects, snails, larva, and eggs) from vehicles and equipment returning from overseas use. This would be the first such facility located in the continental United States.

III.7.6 Expected Outcomes

National defense facilities have been very important to the development and economy of North Carolina's coast. As coastal communities continue to grow and the area's economy diversifies, there will be serious questions about the further integration of defense facilities and about the problems inherent in the expansion of these facilities. Conflict between defense activities and other coastal-resource users is guaranteed.

III.7.6.1 Atlantic Intracoastal Waterway

The AIWW maintenance dredging program will require the identification of new spoil disposal areas in the future. Options may include ocean dumping, the use of pipelines to beach nourishment sites, pipeline to upland disposal sites, creating new spoil islands, and side casting. Choices among these alternatives must be based upon the best possible resource and use data to avoid unnecessary conflicts.

Recreational craft are the dominant users of the Atlantic Intracoastal Waterway. If this trend continues and is reinforced by more year around use from resident and tourist populations in coastal counties, then increased pressure should be expected for marina and second home development along the waterway.

III.7.6.2 Cherry Point Marine Air Station

The CPMAS may be one of the largest polluters in the study area. Improved environmental laws over the past decade and a half have

begun to focus on the operating procedures that have caused past environmental problems at this facility. By incorporating CPMAS staff in the Albemarle-Pamlico Study and directing study resources to this area, the ongoing CPMAS studies could be broadened and more comprehensive results sought.

The ongoing investigations will determine over the next several years the extent of the problems. Cleanup may be required, but will not begin for about five years. Continuing operation should be carried out in an environmentally sound manner. The added weight of inclusion of CPMAS studies in the Albemarle-Pamlico Study could speed this trend and assure that the most complete environmental improvement is pursued.

III.7.6.3 Bombing Ranges And Target Area

The apparent trend for bombing ranges and target areas in the study area is toward expansion and more sophisticated weapons testing. Associated controlled airspace expansions will cause significant conflicts with commercial and private air traffic, recreational and commercial use of the surface waters including the Atlantic Intracoastal Waterway, and the development and use potential of underlying lands, including the National Seashores. A further result of these conflicts will be the curtailment of aircraft use within the study area for resource management overflights for research and enforcement. This trend will be particularly acute if the controlled airspace expansions are accompanied by increased use.

III.7.7 Critical Issues

There are numerous national defense activities that either are, or may become critical issues to the future of the Albemarle-Pamlico estuarine system.

III.7.7.1 Atlantic Intracoastal Waterway (AIWW)

1. Locating and developing new, environmentally sound disposal sites for the spoils from maintenance dredging.

2. Continued increases in recreational boating including its pressure for marine/second home development with concurrent water quality impacts, and competition for fisheries resources.

III.7.7.2 Cherry Point Marine Air Station (CPMAS)

1. May be the toxic "hot spot" in the study area, requiring extensive cleanup efforts.

2. There is no inventory of toxic/hazardous waste loading for the study area.

3. There is no plan for managing ongoing CPMAS activities involving toxic/hazardous wastes, beyond current RCRA studies, or the military command structure to carry out such a plan.

III.7.7.3 Bombing Ranges and Target Areas

1. Virtually the entire Albemarle-Pamlico estuary will be covered by controlled military airspace if current military proposals are approved. The use of nonmilitary aircraft over the study are for research management and enforcement could be severely curtailed.

2. There is no limit, based upon an environmental threshold, on the maximum utilization of target areas and bombing ranges.

3. Recreational and commercial boat usage could be curtailed in many areas where military airspace is proposed to control the water surface.

4. Noise from military aircraft may become a significant nuisance and determent to recreational use and development potential of the area.

5. There are no seasonal limits to avoid conflict between military aircraft and migrating waterfowl along the Atlantic Flyway.

III.8 Commercial Fisheries of the Albemarle-Pamlico Region

III.8.1 Introduction

This section discusses the commercial and recreational fisheries of the Albemarle-Pamlico system, including the major species, gears, seasons and areas. Very little information is available on the sport fisheries of the area, except for some limited data for Albemarle Sound. Thus, discussion will concentrate on the commercial fisheries, including commercial harvest data for 1972-1985. Approximately 95% of the total North Carolina commerciallandings are comprised of estuarine dependent species. Such fishes must spend at least a portion of their life in the estuaries. Thus, the Albemarle-Pamlico system provides the basis for North Carolina's commercial fishing industry.

III.8.2 Characterization of Uses

The Albemarle-Pamlico system includes a number of distinct habitats including typical Coastal Plain rivers with adjacent hardwood bottoms, shallow low-salinity marsh with meandering, mud-bottom creeks, wide estuarine rivers with mud/sand substrates, open water areas exceeding 20 feet in depth bordered by sand shoals, and the higher-salinity shoal areas with sea grass meadows adjacent to the barrier islands (Outer Banks). All of these habitats are linked within a complex system in which a wide variety of species utilize different areas of the system (spawning areas, nursery areas, feeding areas, and migration routes) during different seasons, according to the stages of their life cycle.

The commercial fishing gears utilized by local fishermen are adapted to the specific habitat, season and life history stage of the various target species. Some gears are very specific in what they catch. Channel nets take little other than migrating shrimp moving on ebb tides. Clam and oyster tongs and rakes are used to harvest sessile shellfish. Crab pots catch very few finfish. On the other hand, gears such as trawls, pound nets and long haul seines capture a wide variety of seafood. Fishermen can, however, target desirable species with these gears by utilizing certain mesh sizes in selected areas during limited time periods.

Utilization of fisheries resources has steadily increased over the years with more and more fishermen taking part in the fisheries. In North Carolina, only commercial fishing boats and vessels are licensed, not fishermen or gear. The numbers of licensed boats and vessels in the counties comprising the Albemarle-Pamlico area has gone from 6,600 in 1972 to 9,500 in 1985, an increase of 44%.

An important factor to consider is that very few, if any, commercial fishermen in North Carolina rely on only one fishery for their living. Virtually all of the fishermen have an annual round of seasonal fisheries including several different species and gears, and sometimes a non-fishing job during part of the year, as well. This situation is due to the wide variety of fisheries resources which vary in availability during the year,

as well as among years. For example, pink shrimp are available during spring and fall, brown shrimp in the summer and fall, and white shrimp only in the fall. American shad and river herring enter the estuaries during February and are gone by mid-June. Blue crabs enter pots during April through November or December in western Pamlico Sound, but can be taken during winter warm spells by pots in the Ocracoke Island area. Thus, North Carolina's commercial fishermen must be versatile in order to be successful.

Sport fishermen take large quantities of finfish, crustaceans and shellfish in coastal North Carolina, using principally rod-and-reel. Many, however, use gill nets, trawls, crab pots and rakes recreationally. The rod-and-reel catches are estimated annually for the entire State as a whole by the federal government (National Marine Fisheries Service), but data are not calculated for smaller units (water bodies or counties) as they are for the commercial fisheries. No data are collected on recreational catches of crustaceans or shellfish. Recreational catches of some species may equal or exceed commercial landings, but without recreational fishing data, evaluation of the status of these species is very difficult.

III.8.3 Baseline Data

Commercial harvest data are collected weekly for shrimp and monthly for other species. Data sources are dealer records and interviews, and interviews with fishermen. Data include pounds, value, fishing gear, water body, and county. This information is collected through a cooperative program by employees of the North Carolina Division of Marine Fisheries (DMF) and the National Marine Fisheries Service (NMFS). Data are easily available on computer back to 1972, with less availability for earlier data on the computer system.

The DMF entered the program in 1978, employing five field persons (Port Samplers) to collect data. Prior to that time one or two NMFS employees gathered data through a variety of means including interviews, telephone conversations, and voluntary submittals. Quality of data has improved greatly under the cooperative state-federal program. Earlier data are still valid, especially when the principal concern is trends rather than precise values. The nature of some fisheries and marketing practices make it difficult to collect complete information. For example, catches sold directly by fishermen to consumers generally go unrecorded. Virtually all the landings which go through established dealers are, however, reported. Landings data which could disclose the business dealings of an individual or a business must be treated confidentially by law (GS 113-163c) and can be released only in summary form, as in the tables included in this report.

III.8.3.1 Fishing Areas

Since 1976 Pamlico Sound landings have exceeded the combined landings from Albemarle and Core sounds (Table III-21). Pamlico Sound is

Table III-21. Total commercial fisheries landings, Albemarle Sound area, Core Sound area, North Carolina, 1972-1985 (in thousands of pounds). Data do not include menhaden landed by purse seine.

Year	Albemarle Sound area	Pamlico Sound area	Core Sound area	Total	% State total
1972	16,205	13,746	6,881	36,832	44.3
1973	12,734	14,350	8,845	35,929	56.6
1974	12,270	17,835	12,480	42,585	56.9
1975	11,326	20,611	10,700	42,637	54.7
1976	11,635	22,383	6,555	40,573	47.4
1977	13,385	25,678	6,612	45,675	49.0
1978	13,107	36,383	8,559	58,049	54.1
1979	12,906	45,651	10,869	69,426	51.0
1980	13,755	62,161	13,633	89,549	56.2
1981	12,506	50,227	8,579	71,312	58.2
1982	20,657	49,478	9,159	79,294	65.6
1983	16,633	41,542	9,507	67,682	61.7
1984	13,916	41,796	10,166	65,878	55.1
1985	22,005	42,319	11,392	75,716	64.6

much larger and has a wider variety of habitats, species and fisheries than either of the other two sounds. The principal fisheries of Pamlico Sound are for blue crabs, brown shrimp, flounder, croaker, spot, and weakfish. Juveniles of all these species utilize the extensive nursery areas surrounding the Sound for early growth. Major fisheries for crabs are in the bays and perimeter of the Sound, while finfish and shrimp are taken primarily at the mouths of the bays and near shoals out in Pamlico Sound. Salinity differences influence the Pamlico Sound fisheries. For example, most male blue crabs, which prefer low salinity, are taken in the western portions of the Sound, while females, which utilize the inlet areas for spawning, dominate the eastern area catches.

Albemarle Sound's largest volume fishery is concentrated in the Chowan River where millions of pounds of river herring are harvested during a brief spring fishery. Albemarle Sound provides habitat for freshwater catfishes, white perch, and striped bass which support significant commercial fisheries. Blue crabs are taken in eastern Albemarle Sound where the salinity is higher than in the western region.

The habitat of Core Sound differs from both Albemarle and Pamlico Sounds and thus provides different fisheries. The extensive high salinity sea grass beds and sand shoals support large stocks of hard clams. The grass beds also provide nursery areas for pink shrimp, while brown shrimp utilize the bays along the western shoreline for nurseries, as in Pamlico Sound. Blue crabs separate by sex in Core Sound as they do in Pamlico Sound. The most important species in Core Sound are hard clams, shrimp and blue crabs.

III.8.3.2 Fishing Gears

Five gears generally account for 85 to 90% of the annual commercial harvest from the Albemarle-Pamlico system. The gears are the long haul seine, pound net, gill net, crab pot and shrimp trawl. The long haul seine and shrimp trawl are movable fishing gears, towed through the water by one (trawl and small seine) or two boats (large seine). The other three gears are used in the areas in which they are placed and rely on fish and crabs to come to the gear for capture.

Table III-22 shows landings data for these five gears during 1972-85. Long haul seine catches are greatest for Pamlico Sound; catches peaked during 1979-80. This peak represents the years of greatest total catches (all gears and areas) of species such as croaker, weakfish, spot, and bluefish. These same species support the pound net and gill net fisheries in Pamlico Sound.

The situation in Albemarle Sound is quite different. Long haul seines are much less important there, while pound nets and gill nets are more productive. The spring pound-net fishery, directed principally at river herring, is the Albemarle Sound area's largest volume fishery. Peak catches usually occur during a three-week period in April, with weekly landings exceeding two million pounds. Few pound nets are used in the Albemarle area after May. Two fisheries in Pamlico Sound utilize pound

Table III-22. Commercial fisheries landings by principal fishing gears in the Albemarle Sound, Pamlico Sound, and Core Sound areas, North Carolina, 1972-1985 (in thousands of pounds).

	Long haul seine			Pound net			Gill nets			Crab pots			Shrimp trawl		
Year	Albemarle	Pamlico	Core	Albemarle	Pamlico	Core	Albemarle	Pamlico	Core	Albemarle	Pamlico	Core	Albemarle	Pamlico	Core
1972	107	682	2,832	11,912	444	262	826	712	323	1,361	7,120	2,093	0	2,545	1,105
1973	215	2,364	5,269	9,180	566	471	848	620	198	1,638	5,993	1,587	0	2,126	1,048
1974	553	3,370	5,844	7,119	845	696	1,388	837	391	1,812	6,833	2,239	44	3,871	2,949
1975	666	8,680	6,666	6,632	1,267	424	1,467	732	325	1,190	4,730	1,679	0	2,245	1,316
1976	603	6,421	2,422	7,219	3,412	419	1,697	644	80	813	5,036	1,854	0	3,792	1,448
1977	234	9,925	2,994	9,253	1,519	285	1,404	467	263	1,046	7,059	1,181	0	4,168	1,097
1978	175	14,159	2,204	6,493	2,463	298	3,983	1,544	649	2,798	11,274	2,757	4	1,954	1,315
1979	1,678	17,559	3,290	5,570	1,900	840	2,059	1,937	764	2,683	13,886	2,580	0	3,584	2,065
1980	1,359	16,227	4,800	7,265	6,501	586	2,188	1,525	1,349	1,888	22,730	2,629	49	7,010	2,454
1981	388	11,887	2,345	4,902	4,418	435	2,460	1,415	807	3,774	23,043	2,741	5	2,340	986
1982	1,576	11,277	2,497	9,197	4,545	353	3,047	1,134	512	6,076	21,884	2,335	15	4,947	1,867
1983	1,108	8,737	3,291	5,504	2,486	448	3,140	1,232	648	6,033	20,808	1,667	62	3,582	2,388
1984	1,035	8,470	2,171	5,616	3,216	713	3,855	1,584	935	2,620	21,760	2,098	73	1,241	1,881
1985	318	6,337	2,187	11,925	3,999	302	3,086	1,560	864	5,576	18,812	2,323	101	9,666	1,593

nets--a summer-fall fishery for croaker, weakfish, spot and others and, a fall fishery for migrating flounder. In Core Sound, pound nets are mainly used in the fall to take flounder as the fish leave the estuary for the ocean. Gill nets dominate the winter and early spring fisheries in the Albemarle Sound area and are primarily directed at white perch, striped bass, river herring and American shad. Gill nets are generally less important in the Pamlico Sound and Core Sound, although gill nets are quite important to specific local fisheries, such as the American shad fisheries in Neuse and Pamlico rivers.

Crab pots were introduced in the 1950's and are now quite prevalent in the region. More than 300,000 pots are fished annually in virtually all parts of the Albemarle-Pamlico system. Easy to use and inexpensive, crab pots are the means by which many persons initially enter commercial fishing or participate on a part-time basis to supplement their income.

The harvest by shrimp trawl varies greatly from year to year. The low salinity waters of the Albemarle Sound area produce few shrimp, so there is little use of this gear in that area. However, large numbers of shrimp trawls are utilized by boats from 16 ft to 85 ft long in Pamlico and Core Sounds. Shrimp are generally taken as they emigrate from the bays, which utilized as nursery areas, and move through the sounds toward the ocean.

III.8.3.3 Fishing Seasons

Except for sessile shellfish, all of the economically important species are migratory, at least to some degree. Blueback herring tagged in Minas Basin (Nova Scotia), Canada, have been caught in the Roanoke River. Flounder and croaker tagged in western Pamlico Sound have been recaptured as far south as Florida. After mating, female blue crabs move from low salinity nursery areas to the high salinity inlets.

Commercial and sport fishermen base their fishing strategies on the known seasonal movements of the various target species. For example, river herring enter North Carolina's estuaries from the ocean beginning in mid-winter. Gill net fishermen make small catches which bring high prices due to scarcity during this period. Pound nets are set as soon as the threat of ice is over, and catches steadily increase to the major runs during April. By mid-May spawning, which occurs in the rivers, creeks, and shorelines around the Albemarle Sound, is over and virtually all surviving fish have returned to the ocean by mid-June.

Pink shrimp first reach harvestable size in the estuaries during early fall and are caught until they burrow into the bottom for the winter. Those which survive the winter emerge in the spring to gradually migrate to the ocean for spawning, supporting a fishery as they move. Brown shrimp become available for harvest in early summer as pink shrimp leave from the estuaries.

Three species of commercially important flounders spawn in the ocean during the winter. The larvae enter the estuarine nursery areas and remain

for one to two years. As they emigrate, beginning about mid-September in Albemarle Sound and continuing until about Christmas in Core Sound, the flounder are harvested with trawls, gill nets, and pound nets set along the shoals adjacent to the western shore of the Outer Banks.

Many finfish, such as croaker, spot, weakfish, and bluefish, are usually abundant in Pamlico Sound during the spring and fall, when they support the long haul seine fishery. During the winter, these same species are taken in the ocean trawl fishery.

III.8.4 Individual Species

Commercial landings data are shown for 14 leading species for the Albemarle-Pamlico system in Table III-23, and separately for Pamlico Sound (Table III-24), Albemarle Sound (Table III-25), and Core Sound (Table III-26). Each species is briefly discussed below.

III.8.4.1 River Herring

Blueback herring and alewife, collectively known as river herring, ascend North Carolina's coastal rivers each spring to spawn in freshwater creeks and swamps. Tens of millions of individual fish, are harvested, mainly in the Chowan River, for processing to yield salted herring, specialty products, and roe. River herring are also highly valued as bait for striped bass sport fishing and for blue crabs in the south Atlantic area and the crayfish in Louisiana. Landings declined sharply during the 1970's as foreign fleets made large catches in the ocean. Ocean landings essentially ended when foreign fishing was controlled by enactment of the Fisheries Conservation and Management Act of 1976. Estuarine landings remained depressed into the early 1980's. The fisheries in Virginia and Maryland also declined and have remained severely depressed. Some recovery has been noted in the North Carolina landings during the last two or three years. It has been suggested that water quality problems in spawning and nursery areas have inhibited stock recovery from the overfishing which occurred in the ocean.

III.8.4.2 Bluefish

Bluefish are very important to both sport and commercial fishermen. Long haul seines, pound nets, and gill nets account for most of the commercial catch. Abundance has been high all along the Atlantic coast for about ten years, making bluefish one of the few species consistently available to all fishermen. Their wide distribution and abundance may indicate that bluefish can "co-exist" with civilization better than most other species. However, bluefish have been found to carry varying amounts of contaminants. A recent federal study of PCBs indicated that there is no general hazard to the public from PCBs in bluefish, although large bluefish from various Atlantic coast sites, including North Carolina, contained PCB concentrations exceeding the federal action level of 2 parts per million.

Table III-23. Landings of principal commercial species from the Albemarle Sound, Pamlico Sound, and Core Sound areas of North Carolina combined, 1972-1985 (in thousands of pounds).

	SPECIES													
	River Herring	Blue-fish	Catfish	Croaker	Flounder	Weakfish	American Shad	Spot	Striped Bass	White Perch	Shrimp	Blue Crab	Hard Clam	Oysters
1972	11,237	77	2,375	755	779	341	402	1,978	429	201	3,125	13,112	77	275
1973	7,926	477	1,888	2,608	898	767	289	3,723	642	145	2,827	11,659	134	380
1974	6,210	1,195	1,739	3,804	1,868	833	349	4,152	511	309	6,234	12,861	40	383
1975	5,949	936	1,654	6,775	1,696	1,639	218	6,767	716	289	2,988	10,783	13	302
1976	6,401	809	1,500	6,677	1,672	1,835	158	8,769	704	184	4,666	11,411	8	214
1977	8,523	813	2,068	8,207	672	4,781	106	2,790	480	268	4,494	11,903	533	266
1978	6,606	482	1,734	7,974	1,327	3,098	364	3,090	532	499	1,744	22,044	471	164
1979	5,031	739	1,512	11,006	1,822	3,261	201	5,570	366	361	2,596	25,154	688	433
1980	6,217	1,101	1,447	12,637	3,077	5,340	150	5,372	433	105	6,632	32,987	777	489
1981	4,611	765	1,716	8,080	2,102	3,290	192	2,729	358	395	1,646	36,202	652	315
1982	9,428	1,008	1,167	7,815	1,803	2,662	270	4,368	244	665	4,196	35,866	873	352
1983	5,868	622	1,050	5,587	2,377	2,178	377	2,373	306	498	3,754	33,042	723	497
1984	6,505	773	1,330	4,506	2,178	2,464	502	2,492	497	440	2,201	31,484	859	563
1985	11,548	977	1,279	4,166	1,841	1,922	309	2,775	280	701	9,601	28,562	886	393

Table III-29. Landings of principal commercial species from the Pamlico Sound area, North Carolina, 1972-1985 (in thousands of pounds).

	SPECIES													
	River Herring	Blue-fish	Catfish	Croaker	Flounder	Weakfish	American Shad	Spot	Striped Bass	White Perch	Shrimp	Blue Crab	Hard Clam	Oysters
1972	0	50	22	273	265	144	267	218	155	11	2,073	9,418	0	215
1973	<1	122	13	1,257	322	388	205	719	106	6	1,744	8,393	0	348
1974	5	325	16	2,324	715	510	226	648	62	28	3,162	8,682	0	328
1975	<1	553	21	5,489	992	1,349	131	1,724	80	17	1,558	7,597	0	248
1976	0	417	19	5,377	1,019	1,455	80	1,085	28	6	3,197	8,599	0	168
1977	3	645	21	6,788	393	2,481	23	1,458	10	10	3,442	9,634	0	199
1978	36	373	46	7,444	866	2,840	198	1,875	7	16	840	15,651	1	113
1979	0	0	16	9,612	824	2,847	112	3,108	39	40	920	19,365	2	261
1980	38	814	44	11,302	2,275	4,793	64	3,275	56	23	4,378	27,970	0	382
1981	51	590	44	7,570	1,453	2,934	123	1,676	25	47	847	29,230	2	245
1982	20	822	25	6,729	1,243	2,263	146	3,153	16	31	2,701	26,677	3	266
1983	9	401	36	4,951	1,527	1,670	158	957	17	46	1,934	24,571	7	409
1984	12	571	46	3,799	1,108	2,058	264	1,514	21	23	763	25,862	2	465
1985	11	762	41	3,655	1,282	1,707	150	1,444	10	22	8,168	20,307	38	334

Table III-25 Landings of principal commercial species from the Albemarle Sound area, North Carolina, 1972-1985 (in thousands of pounds)

	SPECIES													
	River Herring	Blue-fish	Catfish	Croaker	Flounder	Weakfish	American Shad	Spot	Striped Bass	White Perch	Shrimp	Blue Crab	Hard Clam	Oysters
1972	11,237	22	2,353	19	121	26	130	23	314	190	0	1,499	0	0
1973	7,925	6	1,875	29	73	10	81	19	535	139	0	1,647	0	4
1974	6,205	27	1,738	282	102	36	117	39	449	281	44	1,863	0	8
1975	5,949	26	1,633	293	232	51	87	18	636	272	0	1,439	0	1
1976	6,401	73	1,481	442	215	78	78	11	676	178	0	922	0	3
1977	8,520	15	2,047	246	11	41	80	19	470	258	0	1,051	0	18
1978	6,570	4	1,688	145	22	41	159	21	525	483	3	2,796	0	6
1979	5,031	89	1,496	1,062	43	246	85	143	327	321	0	2,708	0	44
1980	6,179	45	1,403	802	26	137	69	129	377	82	30	1,959	0	13
1981	4,560	37	1,672	165	59	40	67	33	333	348	5	3,905	0	14
1982	9,408	63	1,165	894	62	99	119	232	228	634	15	6,264	0	25
1983	5,859	38	1,014	380	201	74	216	48	289	452	10	6,375	16	32
1984	6,493	64	1,284	533	129	124	227	61	476	417	4	2,813	21	49
1985	11,537	40	1,238	353	121	52	149	39	270	679	98	5,446	12	10

Table III-24 Landings of principal commercial species from the Core Sound area, North Carolina, 1972-1985 (in thousands of pounds)

	SPECIES													
	River Herring	Blue-fish	Catfish	Croaker	Flounder	Weakfish	American Shad	Spot	Striped Bass	White Perch	Shrimp	Blue Crab	Hard Clam	Oysters
1972	0	333	0	463	393	171	5	1,737	<1	0	1,052	2,195	77	61
1973	0	349	0	1,322	503	369	3	2,985	1	0	1,083	1,619	134	27
1974	0	843	0	1,198	771	287	6	3,465	0	0	3,028	2,316	40	47
1975	0	357	0	993	472	239	0	5,025	0	0	1,430	1,747	13	53
1976	0	319	0	858	438	302	0	906	0	0	1,469	1,890	8	43
1977	0	153	0	1,173	268	424	3	1,313	0	0	1,052	1,218	533	49
1978	0	105	0	385	439	217	7	1,194	<1	0	901	3,597	470	45
1979	0	168	0	332	955	168	4	2,319	0	0	1,676	3,081	686	128
1980	0	242	0	533	776	410	17	1,968	0	0	2,224	3,058	777	94
1981	0	138	0	345	590	316	2	1,020	0	0	794	3,067	650	56
1982	0	123	0	192	498	300	5	983	0	0	1,480	2,925	870	61
1983	0	183	0	256	647	434	3	1,368	0	0	1,810	2,096	700	56
1984	0	138	0	174	941	282	11	917	0	0	1,434	2,661	774	49
1985	0	175	0	158	438	233	10	1,292	0	0	1,335	2,809	836	49

III.8.4.3 Catfish

Channel catfish and white catfish are primarily taken in western Albemarle Sound and the Chowan River in pound nets, gill nets, and catfish pots. Landings have varied, generally trending downward, since the mid 1970's. Catfish are quite tolerant of degraded water quality, especially low oxygen levels. They are, however, susceptible to red sore disease, a bacterial infection prevalent in the Albemarle Sound area during the 1970's. Little biological research has been conducted on catfish in the Albemarle area, and no cause can be stated for the apparent decline in landings.

III.8.4.4 Croaker

Atlantic croaker is one of North Carolina's most important finfish for both commercial and recreational fishermen. Some large year classes were produced during the mid-and late 1970's and provided record landings during 1976-1980. During this period, large numbers of three-and four-year-old fish were taken, especially in the ocean. Recent landings have generally come from the estuarine fisheries using long haul seines and pound nets, with few large fish being taken. Reasons for the increase and decline in croaker abundance are unknown, but are probably due to environmental conditions in ocean spawning areas and estuarine nursery areas. Extreme winter temperatures may cause mortality of eggs, larvae, or early juveniles.

III.8.4.5 Flounder

Three species of flounder support North Carolina's most important commercial finfish fisheries, as well as important sport fisheries. All three species spawn in the ocean during the winter, and the young utilize nursery areas of the Albemarle-Pamlico complex. Summer flounder is the most important species and accounts for almost all of the oceanic catch. The harvest of southern flounder and Gulf flounder is restricted almost entirely to estuarine waters because of these two species appear to be restricted to the estuaries and very near-shore ocean area, and thus are not available to the ocean trawl fisheries. Landings of summer flounder have declined along the Atlantic coast from North Carolina to southern New England. Because of market demand, fishing pressure is very heavy which may be a cause for the decline. The Albemarle-Pamlico system may be the major summer flounder nursery area for the entire Atlantic coast.

III.8.4.6 Weakfish

Generally called "grey trout" in North Carolina, weakfish utilize estuarine waters for spawning and nursery areas. Commercial catches reached their peak during 1978-84, with most of the increased catch coming from the ocean. Most of the estuarine harvest is taken with long

haul seines and pound nets. Commercial landings have fluctuated widely all along the coast. Peak landings in New England have reflected increased landings further south, while weakfish virtually disappeared from New England during periods of reduced abundance further south. The historic centers of abundance appear to be Pamlico Sound and Chesapeake Bay. Reasons for the wide variations in abundance over time are unknown. Weakfish appear to be fairly delicate fish and are quite susceptible to disease. They have exhibited ulcerative mycosis infections in the Pamlico River during recent years.

III.8.4.7 American Shad

During the early 1900's, American shad was the most important commercial species in North Carolina. Landings declined from more than 8 million pounds in 1896 and 1897 to the million pound range and below in the 1930's. The lowest landings on record occurred during the mid-1970's, with some improvements in landings occurring in recent years. Like river herring, American shad enter coastal streams in the spring to spawn. Shad stocks all along the Atlantic coast have been affected by loss of spawning areas due to construction of dams on coastal rivers, as well as by industrial and municipal pollution of rivers, and over-fishing of some stocks. Changed eating habits have resulted in reduced market demand for shad, although seasonal demand remains high in some areas. Intensively managed shad stocks in New England are increasing with habitat improvement and control of the fisheries. Such management has not been attempted in North Carolina, where the major fisheries are in Pamlico and Albemarle sounds rather than in the coastal rivers.

III.8.4.8 Spot

Spot are similar to croaker in spawning, nursery areas, distribution and fisheries. Long haul seines in Pamlico and Core Sounds constitute the principal harvest gear. Spot is usually one of the most abundant estuarine fishes of North Carolina, and is very important to sport fishermen. Landings of spot vary widely from year to year, generally indicating population changes. Reasons for the wide fluctuations are unknown, but are probably related to environmental conditions.

III.8.4.9 Striped Bass

Striped bass populations are found in all of North Carolina's major coastal streams. (Cape Fear River, Neuse River, Pamlico-Tar River, Roanoke River-Albemarle Sound). The Roanoke-Albemarle population is the largest and supports the most important commercial and recreational striped bass fisheries. During periods of high abundance, this stock probably contributes to the Atlantic migratory population which migrates along the coast from North Carolina to New England. Reproductive failure for the last 10 years in Chesapeake Bay has resulted in extreme restrictions on striped bass fishing from Chesapeake Bay northward. A similar situation exists with the Albemarle-Roanoke stock, although fishing

restrictions are less severe in North Carolina. Reproductive success, as measured by relative abundance of juveniles, has been below average since 1977. Reasons for poor reproduction are not known for certain, but appear related to poor water quality. The commercial and sport fisheries have been supported, to some degree, by stocking of young fish in 1981 and each winter since 1983. The natural stock, which spawns mostly in the Fall Line area of Roanoke River, is extremely depressed. Data for 1985 and 1986 indicate further decline in the spawning stock, with fewer mature females available each year. Because of coastwide restrictions, market demand is greatly reduced, and prices are lower then they were a few years ago. Landings have declined due to a combination of reduced abundance and restriction of the fishing season by regulation.

III.8.4.10 White Perch

A slow-growing fish related to striped bass, white perch has replaced striped bass as a target species for many Albemarle Sound fishermen. White perch and striped bass are sought by gill net fishermen in Albemarle Sound, leading to problems in taking striped bass as bycatch in the white perch fishery. White perch spawn in the lower Roanoke and Chowan Rivers and utilize most of the Albemarle Sound area as a nursery. They are especially susceptible to red sore disease, which may be responsible for the extremely low landings of 1980.

III.8.4.11 Shrimp

Brown, white and pink shrimp all contribute to North Carolina's shrimp harvest, with brown shrimp supporting the major summer fishery, especially in Pamlico Sound. As an annual crop, shrimp abundance depends entirely on annual climatological conditions, which influence salinity and temperature in nursery areas. Thus, landings fluctuate widely from year to year. Especially critical for brown shrimp are nursery conditions during April and May each year. Warm, dry weather during the spring of 1985 resulted in the largest shrimp harvest in North Carolina in 30 years. In contrast, wet conditions in the spring of 1984 produced a poor crop of brown shrimp. The contrasting situations in 1984 and 1985 demonstrate the importance of climatological conditions for commercial fishing.

III.8.4.12 Blue Crabs

In terms of total harvest, value, numbers of fishermen, gear, processing plants, and employment, blue crabs support North Carolina's most important commercial fishery. Effort and landings increased steadily since the mid-1970's, and reaching all time peaks during the early 1980's, before starting a decline which continues to the present time. Pamlico Sound is the center of the fishery, although contributions from Albemarle and Core Sounds have increased. Blue crabs may not have been fully exploited prior to the rapid increase in fishing effort during the 1970's, but they probably are today. Blue crabs are essentially an annual crop like shrimp, so annual environmental variations probably dictate population size. Controlling factors, however, are not known.

III.8.4.13 Hard Clam

Hard clams supported a minor fishery located mainly in the southern coastal area. Abundant stocks in Core Sound are harvested by kicking (using propeller wash to dislodge clams from the bottom so that they can be captured in a small trawl towed behind the boat) in the winter. Harvest during warm weather with hand gears also developed rapidly to supply northern markets. The same pattern continues today. Landings during the last four years have been fairly stable, suggesting that clams are fully exploited under current fishing and management conditions. Demand from northern markets has driven the price steadily upward, resulting in significant management problems. Control of clam harvest in areas polluted by sewage, in grass beds, and oyster rocks which are productive habitats for other species (crabs, shrimp, bay scallops, oysters) has been difficult.

III.8.4.14 Oysters

North Carolina possesses thousands of acres of potentially productive oyster bottoms. Much of this habitat is around the perimeter of Pamlico Sound. Oysters can tolerate the wide variety of conditions found in the area as long as the oysters have the proper substrate. The Division of Marine Fisheries annually plants about 300,000 bushels of shells in the Pamlico Sound area to serve as substrate for oysters. Oyster landings from the Pamlico Sound have generally increased in recent years which is probably due largely to this management program. Some environmental problems are becoming more important however, such as (possibly) decreasing general salinity--some oyster rocks in western areas are no longer productive--and oxygen depletion episodes. In 1985, several hundred square miles of Neuse River, Pamlico Sound and Pamlico River bottoms were virtually devoid of oxygen for several days, resulting in reported oyster mortalities in some areas. Further development of processing facilities and the state management program, combined with improvements in water quality, should lead to long-term increases in oyster landings.

III.8.4.15 Seafood Processing

Processing of seafood is becoming more important every year, especially in coastal areas where job opportunities are limited. About 25 blue crab processing facilities in the Pamlico Sound area make North Carolina a center for this industry. Increased finfish catches resulted in small fish processing facilities being added to existing operations during the early 1980's. Improved oyster stocks have led to a return of small oyster shucking houses in some communities of the Pamlico Sound area. Table III-27 shows the number of seafood processing plants and value of processed products for the counties surrounding Albemarle and Pamlico sounds during 1975-1985.

Table III-27 Seafood processing plants and processed product value for the Albemarle-Pamlico area, North Carolina, 1975-1985.

Year	No. plants	Processed products value
1975	75	$21,351,000
1976	69	21,558,000
1977	67	22,835,000
1978	68	21,065,000
1979	80	35,115,000
1980	83	32,481,000
1981	86	43,756,000
1982	90	41,360,000
1983	93	50,107,000
1984	98	54,663,000
1985	97	59,197,000

III.8.5 Significant Trends

A number of trends in the commercial fisheries are apparent from examination of landings data.

1. Landings of the major finfishes, all of which have fairly similar life histories and are taken by the same fishing gears, reached historic peaks in the late 1970's-early 1980's and have since declined. Reasons for the the decline have not been defined.

2. Landings of anadromous fishes (fish which spawn in freshwater but spend most of their life in saltwater--striped bass, American shad, river herring) have declined since at least the early 1970's. The American shad decline may be due to habitat degradation. River herring initially declined because of excessive catches by foreign vessels in the ocean, but recovery has probably been impacted by poor water quality in the Albemarle Sound spawning and nursery areas. Reproduction of striped bass in Roanoke River has apparently been unsuccessful since 1977. This problem may also be due to water quality problems.

3. Landings of blue crabs, North Carolina's most important commercial fisheries species, reached peak levels in the early 1980's and have declined since for unknown reasons.

4. The hard clam fisheries of Core Sound are probably producing near their maximum potential, given the existing regulatory controls and mix of harvest methods used.

5. Oyster landings are highly dependent on state management efforts, and landings appear to respond gradually to such efforts.

III.8.6 Expected Outcomes

1. Continuation of downward trends in commercial landings at current levels of fishing intensity probably indicates declining stocks. Current or increasing levels of fishing pressure on such stocks will lead to increased social conflicts among all fishermen (commercial and sport) for access to the available resources, with resultant calls for the state to "solve" such problems.

2. Continuing stock declines, initially attributable to pollution, environmental conditions, or natural variations in abundance, will likely be magnified by fishing mortality from commercial and recreational fishermen. Such a situation will result in the need for restrictions on fishing to attempt to "solve" problems originally created by pollution or natural conditions, not by the fishermen.

3. Continued failure of Roanoke River striped bass to reproduce successfully could necessitate drastic fisheries restrictions affecting other Albemarle Sound fisheries which take striped bass only incidentally to other target species.

4. Lack of recreational fisheries data comparable to available commercial data will continue to hamper analysis and management of North Carolina's estuarine and marine fisheries.

5. The eventual abundance of harvestable adults of virtually all seafood species is probably determined early in life, most likely during egg, larval or early juvenile stages. The eventual survivors of a given year's offspring are called a "year class." The vast majority of North Carolina's important fish species occupy estuarine areas during their larval and juvenile periods. Thus, these areas serve as nursery areas. With few exceptions, the role of various environmental factors on the size of a year class and function of nursery areas is unknown. These factors must be identified and their influence delineated.

6. The factors influencing year class formation may or may not be affected by man's activity. Some factors, such as freshwater inflow, sedimentation, organic loading, nutrient input, and habitat alteration are most definitely influenced by man. The degree of man's influence on such factors must be determined, and where negative effects are found, efforts to minimize man's impacts should be implemented. Positive effects should similarly be utilized to improve productivity.

7. Like agriculture, commercial fishing is a basic food producer and provides products for consumers and employment for thousands of North Carolinans. Again, like agriculture, commercial fishermen are being severely impacted by environmental degradation, loss of productive areas, and economic factors. Specific policies have been developed at the state and federal levels addressing protection and maintenance of the "family farm." Similar policies may be needed for North Carolina's commercial fishermen, especially those who rely so heavily on the estuarine resources.

III.9 Sport Fishing and Recreational Boating in the Albemarle-Pamlico Region

III.9.1 Introduction

Sport fishing and recreational boating in the Albemarle-Pamlico estuarine system are discussed in this section. Specific data on the number of boats registered in the area and the availability of boating access areas or launching ramps are presented. This section also addresses the major types of sport fishing habitat available and utilized in the area, and estimates of sport fishing effort and harvest in specific locations of the study area are presented and discussed.

Boat registrations are based on the total number of vessels registered in the counties that border on the waters included in the study area. However, boaters and anglers who are residents of areas beyond the study region also utilize the study area to a great extent.

III.9.2 Characterization of Uses

III.9.2.1 Boating

Boating in the Albemarle-Pamlico system is primarily for the purpose of recreational sport fishing. However, boating for the purposes of commercial fishing, sailing, skiing, and other recreation is also common in the study area.

III.9.2.2 Sport Fishing

The upstream areas of the major tributary rivers of the system are freshwater and are characterized by rocky or sandy bottoms, fast flows, usually turbid waters, and a well defined streambed. This is particularly true of the streams in the southern portion of the system such as the Roanoke, Tar-Pamlico, and Neuse Rivers which originate in the Piedmont regions of North Carolina and Virginia. Other tributary streams which originate in the Coastal Plain are shorter in length, have sand or mud bottoms, relatively slow flows, and poorly defined streambeds. Sport fishing catches consist primarily of largemouth bass, crappie, other sunfish, various catfishes, pickerel, and yellow perch.

Extent of the upstream intrusion of brackish water (salinity of 1 to 12 ppt.) depends on seasonal rainfall amounts. Thus, fish species with very broad salinity tolerances comprise the fish community in the brackish water zone. Striped bass and white perch are major components of the sport fishery catch.

The eastern portion of Albemarle Sound, most of Pamlico Sound, and Croatan, Roanoke, and Core sounds constitute the saltwater portion of the study area. Salinities range from 12 to 35 ppt. The sport fishing catch in this region is primarily made up of marine species including croaker, spot, trout, flounder, channel bass, bluefish, and whiting.

A significant seasonal hook-and-line fishery also occurs for anadromous fish species throughout the Albemarle-Pamlico system. Striped bass, American shad, hickory shad, alewife, and blueback herring are eagerly sought by recreational anglers during the spring spawning runs. In addition to the hook-and-line fisheries, a substantial recreational special-device fishery for nongame fish species occurs primarily in the tributary streams. Special devices include nets, traps, and spears. Only fish species that are not specifically defined as game fish may be taken by these gears.

III.9.3 Baseline Data

III.9.3.1 Boating

Over 49,000 boats are registered in the 25 counties that border the study area (Table III-28). This is approximately 23% of the 218,000 total boats registered in North Carolina. Sixty-four publicly owned boating access areas (launching ramps) are located withing the study area. These are supplemented by at least 117 privately owned or commercial access areas that are available for public use in the study area.

III.9.3.2 Sport Fishing

In a creel survey conducted on Albemarle Sound and its tributaries from February 1977 through January 1980, hook-and-line sport fishermen exerted an annual average of 447,242 party-hours of fishing effort on this portion of the study area (Table III-29). Fishing parties averaged about 2.4 anglers in size. Thus, in excess of 1 million hours of angling effort were exerted annually (Mullis and Guier 1981). From 433,000 to over 1.3 million fish per year were caught by sport anglers on Albemarle Sound during that period (Table III-30). White perch and sunfish were the more important species in the harvest (Mullis and Guier 1981).

A total of almost 88,000 angler-hours of hook-and-line sport fishing effort were exerted on the middle reach of the Neuse River from US 17 bridge to the mouth of Pitch Kettle Creek and on tributaries to the river in 1981 (Table III-31). Over 70% of this effort was exerted by anglers fishing from boats. A major portion of the effort was expended in the tributaries to the river. Almost 66,000 fish were harvested from this portion of the study area by sport fishermen in 1981 (Table III-32). Sunfish were also the dominant fish species in the harvest from this location (Borawa 1983).

Specific estimates of sport fishing effort and harvest on the remainder of the Albemarle-Pamlico system are not available. However, the National Marine Fisheries Service has estimated the total number of sport fishing trips and harvest for all inland areas of North Carolina from the inlets to the freshwater-saltwater interface. The Albemarle-Pamlico estuarine system comprises the vast majority of the surface water area encompassed by the NMFS study, and it is expected that the system accounts for the bulk of the effort and harvest estimates as well.

Table III-29. Number of boats registered and boating access areas available for public use in the Albemarle-Pamlico system.

County	Number of Boat Registrations (1985)	Number of Publicly Owned Boating Access Areas	Number of Privately Owned Boating Access Areas Available for Public Use*
Beaufort	3,640	6	36
Bertie	1,198	0	3
Camden	410	1	8
Carteret	6,169	1	18
Chowan	1,002	2	4
Craven	5,073	10	8
Currituck	1,856	2	5
Dare	2,494	6	9
Edgecombe	1,365	3	0
Gates	548	1	0
Greene	639	3	0
Halifax	2,251	2	0
Hertford	1,073	2	3
Hyde	580	1	7
Lenoir	2,750	1	0
Martin	1,319	3	1
Nash	3,464	1	0
Northhampton	951	1	0
Pamlico	1,263	3	10
Pasquotank	1,486	4	0
Perquimans	863	2	2
Pitt	4,324	4	1
Tyrrell	338	3	1
Washington	1,069	2	1
Wayne	2,978	2	0
Totals	49,103	64	117

*Approximate

Table III-29. Total of estimated annual sport fishing effort (party-hours) on Albemarle Sound during the period 1 February 1977 through 31 January 1980[1].

February 1977-January 1978	February 1978-January 1979	February 1979-January 1980	Mean
473,039	455,731	412,958	447,242

[1]Mullis and Guier 1981

Table III-30. Estimated total harvest of nine major fish species and all other species from Albemarle Sound during the period 1 February, 1977 through 31 January, 1980. The top figures are kilograms and the bottom figures are numbers of fish each set[1].

Species	Harvest			
	Feb. '77-Jan. '78	Feb. '78-Jan. '79	Feb. '79-Jan. '80	Mean
Largemouth bass	31,286 39,519	27,193 39,547	62,893 88,705	40,457 55,924
Striped bass	32,600 33,202	14,023 16,599	5,694 5,235	17,439 18,345
Sunfish	25,241 162,023	35,116 168,393	15,229 133,955	25,195 154,790
Channel catfish	50,527 86,653	34,479 45,008	31,479 61,690	38,828 64,450
Crappie	26,793 109,481	3,891 14,546	8,219 27,340	12,968 50,456
White perch	70,652 398,693	18,955 128,182	7,182 69,837	32,263 198,904
White catfish	935 1,251	1,758 1,598	746 2,058	1,146 1,636
Weak fish	15,897 58,379	3,084 7,802	349 1,162	6,443 22,448
Spotted sea trout	10,458 17,055	1,653 2,335	9 30	4,040 6,473
Other species	135,177 440,972	15,831 63,172	10,629 43,352	53,879 182,499
Total	399,566 1,347,228	155,983 487,172	142,429 433,364	232,658 755,925

[1] Mullis and Guier 1981

Table III-31. Total estimated sport fishing effort (angler-hours) on the middle Neuse River during 1981[1].

Location	Type of fishing	Effort (hours)
US 17 to Streets Ferry Bridge	Boat	19,948
	Bank	15,874
Streets Ferry Bridge to Pitch Kettle Creek	Boat	4,153
	Bank	6,160
Tributaries	Boat	38,087
	Bank	3,532
Total	Boat	62,188
	Bank	25,566

[1]Borawa 1983

Table III-32. Estimated total harvest of nine major fish species and all other species from middle Neuse River during 1981. The top figures are kilograms and the bottom figures are numbers of fish in each set[1].

Species	Total Harvest
Striped bass	29 29
Largemouth bass	2,869 3,884
White perch	60 231
Sunfish	6,817 49,461
Crappie	984 3,754
Catfish	2,439 3,743
Yellow perch	298 1,322
Shad (hickory and American)	51 103
Channel bass	193 2,353
Others	979 887
Total	14,719 65,737

[1]Borawa 1983

NMFS estimated that over 1.8 million recreational fishing trips were made in North Carolina's inland areas in 1985. Over 8 million fish were caught by sport fishermen of which 5.5 million were harvested (Table III-33). Spot, pigfish, flounders, and croakers were the major species in the harvest (personal communication, Ronald J. Essig, National Marine Fisheries Service).

Hassler, Hill, and Brown (1981) estimated the sport fishing effort and harvest of striped bass from Albemarle Sound and Roanoke River in the late 1960's and 1970's. From 1970 through 1980, the number of fishing units (bow nets and rod and reels) used in the Roanoke River ranged from 4,189 to 10,209 per year. From 15,239 to 65,399 striped bass were estimated to have been harvested from the Roanoke River each year during this period. From 1967 to 1973, 6,005 to 12,360 boat-days of sport fishing effort were estimated to have been exerted annually on Albemarle Sound for striped bass. It was further estimated that 30,783 to 96,170 striped bass were harvested annually.

III.9.4 Significant Trends and Expected Outcomes

III.9.4.1 Boating

Boating pressure on eastern North Carolina waters, particularly the Albemarle-Pamlico estuarine system, is increasing at a rapid rate. The increase in number of marinas that support boating activity (gas docks, sewage pumpout stations, etc.) is evidenced by high numbers of Coastal Area Management Act permit review requests for these businesses. A number of new, publicly-owned boating access areas are constructed each year and existing areas are renovated and upgraded to meet the demands for adequate boat launching facilities. The N.C. Wildlife Resources Commission is also in the process of implementing a Development Program to be funded with newly authorized federal aid monies which will improve boating access to small streams.

An increasing amount of the boating pressure that is being exerted on Albemarle-Pamlico system is not related to sport or commercial fishing. Sailboating, regattas, speed boat races, and other water oriented events are becoming common on Albemarle and Pamlico Sounds and their major tributaries. Conflicts between these users and sport and commercial fishermen are inevitable.

III.9.4.2 Sport Fishing

Total annual sport fishing effort on Albemarle Sound declined between 1977 and 1980 (Table III-29). The annual harvest of most major species also declined during that period (Table III-30). However, the annual harvest of largemouth bass more than doubled from 1977 to 1979 (Table III-30). Sport fishing effort for this species also increased dramatically from approximately 96,000 party-hours in 1977-78 to over

Table III-33. Estimated number and weight of fish caught and harvested by recreational fishermen from inland areas of North Carolina in 1985[1].

Species	Number of Fish Caught: Total	Weight of Fish Harvested (lbs)
Sharks	33,089	4,816
Herrings	24,573	2,713
Toadfishes	53,914	13,186
White perch	129,511	30,245
Striped bass	6,514	9,334
Black sea bass	642,229	49,648
Bluefish	291,558	128,095
Pigfish	1,082,554	162,175
Pinfish	998,900	63,454
Spotted sea trout	112,294	161,838
Weakfish	183,686	192,318
Spot	2,391,667	836,748
Kingfishes	191,098	89,388
Croaker	637,565	174,362
Red drum	13,799	39,580
Mullets	250,852	200,657
Summer flounder	663,072	472,998
Puffers	121,953	10,825
Other species	366,553	39,404
Total	8,195,381	2,651,891

[1]Personal communication, Ronald J. Essig, National Marine Fisheries Service

153,000 party-hours in 1979-80 (Mullis and Guier 1981). This is indicative of the overall increased interest in largemouth bass fishing that is currently being experienced throughout the United States (Van Horn and Birchfield 1981). Van Horn and Birchfield (1981) reported that fishing pressure exerted for largemouth bass in rivers and streams in North Carolina, most of which are tributaries of the Albemarle-Pamlico system, increased from 2,853 angler hours in 1975, to 22,403 angler-hours in 1980. Several bass fishing tournaments are held on major tributaries to Albemarle and Pamlico Sounds on many weekends of the spring, summer, and fall months. Conflicts between bass tournament fishermen and other anglers have become common and are expected to increase.

The harvest of striped bass from Albemarle Sound has declined in recent years to record low levels. This decline is due to the failure of the population to produce a strong year class since 1970 (Rulifson et al. 1986). Extensive research is being conducted to determine the cause(s) of reproductive failures of this population, but the factors leading to the decline have not yet been identified. Stocking of hatchery reared advanced fingerling striped bass is being conducted to bolster the natural populations. The stocked fish and remnants of the naturally produced population are now supporting sport and commercial fisheries in the Albemarle Sound region. Stocking, however, cannot continue indefinitely. If the causes of natural reproductive failures cannot be identified and corrected soon, the fisheries for this species in this area may soon disappear.

Sport fisheries throughout the Albemarle-Pamlico estuarine system are likely to diminish as a result of increasing human development of the area. In addition to the increase in fishing pressure, development also leads to increase in pollution and contaminant inputs, and an overall degradation of the habitat.

III.9.5 Critical Issues

The loss and/or degradation of quality fishery habitat constitute the biggest threat to the fishery resources of this area. Development within this region must be carefully planned and appropriate safeguards taken to avoid extensive damage to the recreational, commercial, and esthetic values.

Conflicts between the various users of the Albemarle-Pamlico estuarine system is a major issue that must be addressed and resolved by the regulatory agencies in the near future. Despite the large size and extensive open-water areas of the system, many areas are becoming increasingly crowded during high use periods, i.e. summer weekends and holidays. Conflicts for space between recreational pleasure boaters (skiers, speed boats, sailboats, etc.) and sport and commercial fishermen are likely to become a major problem. Largemouth bass fishing tournaments are becoming frequent events on the tributaries to the sounds. Conflicts between tournament anglers and other sport fishermen due to congestion of boat launching ramps, competition for fishing space, and excess pressure on the resource are numerous.

Provisions must be made for an anticipated further increase in recreational boating and fishing pressure on the Albemarle-Pamlico system. Additional boat launching ramps will be needed, particularly in popular high-use areas. Boating access in the smaller streams will also need to be improved by removing debris to facilitate boat passage. Consideration should also be given to those anglers who do not fish from boats. Fishing access areas for shorebound anglers can be developed through the construction of fishing piers and clearance of shoreline brush and obstructions.

The fisheries for several important fish species in the Albemarle-Pamlico estuarine system have declined in recent years. Striped bass populations, particularly in Albemarle Sound, have been in a state of decline since the mid 1970's. This decline has necessitated severe restrictions on creel and size limits for this species. Restrictive size limits on flounder and channel bass have been imposed in recent years to prevent overfishing of the populations. More restrictive size limits have also been imposed on largemouth bass. Proper management of the fishery resources and habitat will be necessary to assure high quality sport fisheries for the region in the future.

III.10 Wildlife Resources in the Albemarle-Pamlico Region

III.10.1 Introduction

The Coastal Zone Management Act of 1972 defines an estuary as "that part of a river or stream or other body of water having unimpaired connection with the open sea, where the sea water is measurably diluted with fresh water derived from land drainage." Of the six major sounds in eastern North Carolina (Currituck, Albemarle, Pamlico, Core, Back, and Bogue) the Albemarle and Pamlico are the largest.

These estuaries are of vital importance to resident, transient and wintering wildlife species. Wetlands connected to this system include cypress-gum swamps, pocosins and coastal marsh. These wetland components serve to protect the integrity of estuaries and their tributaries. Therefore, some forestry practices, agriculture, mining, and human habitation have had negative impacts on all components of the total system, thus, an urgent need to protect estuaries from further degradation.

On April 14, 1986, the North Carolina Wildlife Resources Commission adopted a resolution that called for additional protection of the Albemarle-Pamlico estuary, and urged that these waters receive federal designation as an "estuary of national significance." Legislation is presently being considered in the U.S. House of Representatives and Senate that would appropriate funds for the cleanup and protection of the nation's estuaries.

III.10.2 Major Wildlife Resources

The Albemarle-Pamlico system is recognized as the most important component of wintering waterfowl habitat in eastern North Carolina. Mid-winter waterfowl surveys have consistently shown that the majority of wintering Canada geese, snow geese, tundra swans, brant, diving ducks, and sea ducks utilize this estuary system for feeding, loafing and roosting. In addition, it is estimated that approximately 40 percent of all wintering puddle ducks utilize the area.

Mid-winter aerial surveys in recent years have revealed the following numbers of wintering waterfowl in the Albemarle-Pamlico estuarine area: Puddle ducks 50,000-100,000 (approximately 30,000 black ducks and mallards), divers 100,000, Canada geese 25,000, snow geese 20,000, tundra swans 75,000, brant 2,000, and 20,000 sea ducks. The resident black duck population is estimated at 2,000. Webless migratory game birds wintering include rails, gallinules and coots. Surveys have shown coot populations to average 15,000-20,000.

Among waterfowl utilizing the area, there are three identifiable different trophic types included: fisheaters, benthic mollusk eaters (clams, snails, etc.), and herbivores. Mergansers prey almost exclusively upon fish. The scaup, scoters, bufflehead, common goldeneye, and to a lesser degree the ruddy duck, redhead, and black duck feed on benthic invertebrates, preferring clams found in shallow, occasionally intertidal habitats along shorelines. Most other ducks, geese, brant, and swans are largely herbivores. However, in consuming quantities of vegetation, many of these species also ingest benthic invertebrates and should, therefore, be considered omnivorous.

Nongame birds that frequent and are dependent upon the system include various species of raptors, wading birds and shore birds. Raptors include the endangered bald eagle. Presently, there are only two known active nests remaining--one in Washington and the other in Hyde County. Other raptors include the osprey, marsh hawk and a few species of owls. Estuaries provide the food sources (fish, rodents and birds) and habitat needs for these species. Also, the transient peregrine falcon is commonly found during fall migrations. Other categories of nongame birds include diving water birds (grebes, loons and cormorants); waders (herons, egrets, yellowlegs, and ibises); shallow probing and surface searching shore birds (sandpipers, plovers, knots, and oystercatchers); deep probing shore birds (godwits, willets and curlews); and aerial searching birds (terns, gulls, skimmers, pelicans, and kingfishers). Foods sought by these species include small fishes, crustaceans, insects, amphipods and invertebrates.

The estuary system supports an abundant furbearer resource including river otter, raccoon, mink, muskrat, opossum and nutria. Also, the area represents the northern most range of the American alligator which was recently reclassified from "endangered" to "threatened by simularity of appearance."

III.10.3 Public Utilization of Wildlife Resources

Hunting for waterfowl is very popular and is available on public lands, leased private lands and private hunting clubs. Current estimates of statewide duck and goose hunter numbers are 35,000 and 10,000 respectively. In the estuary area, approximately 1,500 acres of managed waterfowl impoundments are made available for public hunting by the North Carolina Wildlife Resources Commission. Current regulations permit hunting on Mondays, Wednesdays, Saturdays, designated holidays and opening and closing days of the season. Hunting is allowed one-half hour before sunrise until 1:00 pm on open days.

Surveys of hunter use and success have indicated an average of 1,000 man-days of recreation provided, with harvest rates of 2.0 birds per hunter per man-day on managed impoundments. In addition, approximately 10 miles of marsh shoreline is available to public hunting on Commission-owned lands.

Individual private impoundments are generally smaller, but in total acres approach 2,000. Hunting pressure is less intensive and subsequently, hunter success is usually greater. Leases on private lands for hunting rights can run as high as $100.00 per acre, and memberships to clubs can cost thousands of dollars per year depending on location.

Very restrictive and regulated waterfowl hunting is available on national wildlife refuges located on Pea Island, Mattamuskeet Lake and Swanquarter Refuge. Wildlife observation, bird watching and other outdoor related activities are becoming more popular each year on state, federal and private lands.

Trapping is very popular in the estuarine area. The intensity of effort and total harvest are highly variable, however, due to a fluctuating fur market.

III.10.4 Current Trends and Critical Issues

Estuaries possess far higher concentrations of nutrients than the sea itself or than the freshwaters running off from land. The high nutrient levels stimulate plant growth resulting in high organic productivity. In particular, nitrogen and phosphorus, the two most important nutrients for plant growth can be found in abundance in estuarine waters. Estuaries are more strongly influenced by association with land than is the marine system.

Since the Albemarle-Pamlico estuarine system represents an abundant food source for many species of resident, transient and wintering birds,it is imperative that the integrity of the system be preserved. Wintering populations of many species are dependent upon reproductive and nesting success in the far north (Canada and Alaska). Therefore, the health of waterfowl and other species is of utmost importance prior to spring migrations to the north. Birds need sufficient fat accumulations to withstand the rigors of migration and to be successful in breeding and rearing young.

Human impacts are having negative effects on the estuary system. Forestry and agricultural practices in pocosins have adversely impacted the system. Drainage through ditching has increased freshwater runoff and sedimentation into estuaries. Chemicals and fertilizers have caused eutrophication and algae blooms. Reduction of marsh has upset the detrital system, thus, reducing an important element in the total food chain. Accelerated urbanization and industrialization has brought about expanded problems of waste disposal. Biodegradable effluents consume oxygen and eliminate animal life. Mining activities for phosphate release chemicals causing further eutrophication.

III.10.5 Future Outlooks and Conclusions

The future will certainly bring with it greater demands for outdoor related recreational opportunities. Wildlife can persist only

in numbers that the environment can support. Life cycles of migrating birds require adequate wintering areas which must provide required foods to sustain and prepare migrating birds for spring return flights and successful breeding. Demands on the resource and costs for already limited opportunities will greatly increase.

The management of any population of wild animals is indeed extremely difficult, and it becomes even more complicated when management must be accomplished coincidentally with that of other resources of the land. The Albemarle-Pamlico estuarine system is threatened by the concentrated development of human society along our coast. Its future existence depends heavily on widespread understanding of the value to man of this natural ecosystem, and on a broader appreciation of the strong ties between its neighbors, the uplands and the ocean.

III.11 Tourism and Recreation in the Albemarle-Pamlico Region

III.11.1 Introduction

Recreational uses of the Albemarle/Pamlico study area include overnight stays and day trips. Visitors engage in a broad range of activities, including swimming, boating, fishing, shellfishing, hunting, camping, and sight-seeing, as well as simple relaxation and aesthetic enjoyment of the area's natural beauty. Oceanfront beaches along the barrier islands forming one boundary of the study area are the dominant attraction of visitors to the area, but many of the activities pursued by people at the beach take place in or along the sounds.

Specific information about hunting, fishing, and second-home/resort development is covered elsewhere in this chapter. This section examines existing sources of data about travel and tourism in the area. Estimates of travel-related expenditures, numbers of overnight travelers, and employment in travel-related industries in the area are presented.

III.11.2 Characterization of Use

Recreation is a significant and growing use of the Albemarle/Pamlico study area. Vacationing on the barrier island beaches is increasingly popular, and recent years have brought accelerated building on the remaining undeveloped, privately owned portions of the Outer Banks and Carteret County beaches. Other recreational activities associated with vacationing at the beaches or along the sounds of the mainland include recreational boating, fishing and hunting, camping or day-trips at federal and state parks and nature preserves, and attendance at other features in the area such as historic sites, outdoor dramas, aquariums, and museums.

Fishing, waterfowl hunting, boating, and swimming are activities obviously related directly to the estuarine system, and are dependent on the water quality of the system to some degree. Regardless of the specific activity attracting people to the area, the visitors have a direct impact on the estuarine system in terms of waste disposal, destruction of wildlife habitat, stormwater runoff pollution from developed areas, and pollution associated with pleasure boats and marinas.

III.11.3 Baseline Data

Each year, the Division of Travel and Tourism (T&T) of the North Carolina Department of Commerce publishes the North Carolina Travel Survey and the accompanying North Carolina Travel Study - Technical Report. The study reports monthly figures for the statewide N.C. Travel Index; attendance and visitation figures for various federal, state and local attractions or services; estimates of travel expenditures, employment, and wages for each county; and special topics which vary from year to year.

Data reported by county can be used in characterizing travel and tourism in the Albemarle-Pamlico study area. Travel expenditures have been reported by county for decades, and thus may be useful for establishing trends in travel in the Albemarle-Pamlico region. Other county data series, such as estimates of person-nights of travel activity, and estimated and secondary effects of travel expenditures, have only been published for the past two or three years.

Table III-34 shows travel expenditures for 1975-1985 for the 20 counties bordering the Albemarle and Pamlico Sounds and their tributaries. Because this information is published each year in current dollars, expenditures have been adjusted to constant (1972) dollars in order to estimate the percentage increase in travel expenditures from year to year that is not accounted for by inflation alone.

Travel expenditures are estimated in the T&T study from total statewide hotel and motel sales. These sales are then distributed among counties on the basis of the county's shares of hotel and motel receipts. This method of estimating travel expenditures may not give an accurate estimation of the absolute value of expenditures in individual counties, particularly in counties in which the small number of accommodations firms has caused nondisclosure of data for many years. A small volume of expenditures in a county also may cause the opening or closing of even a single accommodations enterprise to be reflected as a dramatic percentage change in the travel expenditures of that county. Furthermore, a change in business ownership may lead to a change in the sales tax reporting classification moving the business into or out of the accommodations sector, even though the nature of the business did not actually change.

These estimates of travel expenditures include travel which related to business as well as recreation. Coupling these figures with general knowledge about the major industries in a particular area, such as the resort areas along the beaches of Dare and Carteret counties, is a means of determining trends in recreation-related travel.

Estimates of person-nights of travel activity by county has been reported by the T&T study since 1983. Table III-35 presents these estimates for all 20 counties for 1983, 1984, and 1985. Person-nights are estimated from total travel expenditures using assumptions drawn from the 1977 National Travel Survey, adjusted for individual counties to reflect informed judgement about the anticipated mix of business and pleasure travelers.

The T&T study presents estimates of person-nights with these caveats:

> "The [estimation] method has been developed as a start on making estimates of visitors by county. It does not attempt to account for travel by persons who do not stay overnight, although such travel appears, from the 1977 National Travel Survey, to account for about 13 percent of person-trips in North Carolina. Given the limited data, the results must be considered general and preliminary. Moreover, care must be taken in comparing these figures with visitation figures at sites such as the National Seashores...which base their estimates on different definitions."

TABLE III-34

1975-1985 North Carolina Travel Expenditures[1]

Year	Travel Expenditures[2,3] (Current $)	Travel Expenditures[4] (Constant $)	% Increase From Previous Year (Constant $)
1975	$ 80,405	$ 64,170	--
1976	92,444	70,193	9.4
1977	118,047	84,743	20.7
1978	131,534	88,219	4.1
1979	219,821	135,275	53.3
1980	242,908	135,702	0.3
1981	328,830	169,064	24.6
1982	353,357	171,532	1.5
1983	379,958	177,883	3.7
1984	519,870	235,876	32.6[5]
1985	573,742	252,194	6.9

Average annual increase = 15.7%
Average annual increase excluding 1983-84 = 13.8%

[1]For the following counties: Beaufort, Bertie, Camden, Carteret, Chowan, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Lenoir, Martin, Pamlico, Pasquotank, Perquimans, Pitt, Tyrrell, and Washington.

[2]Source: N.C. Travel Study - Technical Report Annual report by the Division of Travel and Tourism, N.C. Department of Commerce.

[3]Current dollars: Nominal value as reported in Travel Study

[4]Constant (1972) dollars: Nominal value deflated using personal consumption expenditure deflator (1972=100), 1975-1984 (1985 estimated) Source: U.S. Statistical Abstract, 1986.

[5]This figure is artificially large due to the effects of tax law changes in 1983 causing seasonal rental of cottages and condominiums to be included in the accommodations sector.

TABLE III-35

Estimates of Person-Nights of Travel Activity
By County, 1983 - 1985

	Thousands of Person-Nights		
County	1983	1984	1985
Beaufort	214	246	162
Bertie	13	11	11
Camden	5	5	4
Carteret	2213	2539	2845
Chowan	67	94	97
Craven	630	613	681
Currituck	40	38	40
Dare	3725	5844	6431
Gates	8	7	5
Hertford	120	87	89
Hyde	268	282	317
Jones	3	4	4
Lenoir	270	270	276
Martin	163	193	186
Pamlico	2	3	2
Pasquotank	568	597	625
Perquimans	13	12	11
Pitt	770	1132	847
Tyrrell	4	4	4
Washington	22	21	18
TOTAL	9118	12002	12655

Source: N.C Travel Study - Technical Report
Division of Travel and Tourism, North Carolina Department of Commerce (1984 and 1985)

Employment in five travel-related sectors collected by the NC Employment Security Commission is also presented by county since 1983 in the T&T study. Table III-36 shows the number of travel-related employees and percentage of total private sector employment for each of the 20 counties for 1983-1985. (This information can also be obtained for earlier years from the N.C. Employment Security Commission.)

Statewide figures are reported in the T&T study based on employment in seven sectors, the five presented for counties plus bus travel and gasoline stations. Even with the inclusion of these additional sectors, the statewide percentage of employment in travel-related industries was approximately 8% in 1983 and 1984. Comparison of this figure with those in Table 3 shows that seven counties in the Albemarle/Pamlico study area are significantly more dependent on travel-related industries as a source of employment than is the state as a whole.

Although not presented here, attendance figures can be obtained for state parks in the area (including Pettigrew, Merchant's Millpond, Goose Creek, and Jockey's Ridge, as well as others which may be of interest); the state aquarium at Manteo; the Cape Hatteras and Cape Lookout National Seashores; and other attractions of the area such as the Wright Brothers Memorial. These figures incorporate various means of estimation, and there is an obviously wider margin of error in estimating visitation at some places than others. These figures may be of later use, however, in establishing general trends in terms of travel and tourism in the study area.

III.11.4 Significant Trends

The potential sources of error in county-level data discussed previously are less serious in aggregations of counties. After adjusting for inflation, and considering these potential estimation errors, the time series data presented in Table III-34 seem to show a significant increasing trend in travel expenditures in the region over the period 1975-1985.

The average annual increase in travel expenditures over the period is 15.7%. In 1983, the base used for estimating travel expenditures in the T&T study was broadened because rentals of homes, cottages and condominiums to transient users became subject to the state sales and use tax. This had a dramatic impact on the figures for some counties having a large number of such units, such as Dare and Carteret. Even when the percentage increase from 1983 to 1984 is excluded, however, the average annual increase in travel expenditures over the period is 13.8%.

Although county level data is not shown in Table III-34, two counties, Dare and Carteret, account for 75% of 1985 travel expenditures for the 20-county group, up from 60% in 1979.

The data in Table III-35 show that person-nights of travel in the study area increased over the years 1983-85, although some counties showed a decrease over the period. Dare and Carteret counties again account for the largest share of activity, accounting for over half of the

TABLE III-36

Employment in Five Travel-Related Sectors[1] by County, and Percentage of Total County Private Sector Employment, 1983 - 1984

County	Travel Related Employees 1983	Percent of County Total 1983	Travel Related Employees 1984	Percent of County Total 1984
Beaufort	664	5.28	795	6.01
Bertie	56	1.14	59	1.13
Camden	28	7.39	26	7.43
Carteret	1950	19.52	1933	17.85
Chowan	219	6.08	256	6.74
Craven	1835	12.37	1995	12.30
Currituck	104	13.96	106	12.77
Dare	1967	38.27	2122	36.47
Gates	22	2.83	24	3.03
Hertford	545	7.87	592	8.56
Hyde	152	13.02	157	17.70
Jones	14	1.65	13	1.51
Lenoir	1201	6.22	1275	6.34
Martin	449	6.69	438	6.29
Pamlico	80	5.47	72	4.74
Pasquotank	719	10.71	735	10.20
Perquimans	46	5.13	51	5.43
Pitt	3326	13.70	3698	14.06
Tyrrell	8	1.99	8	1.87
Washington	125	6.96	150	7.96
TOTAL	13510		14505	

[1]Air transportation, Restaurants, Accomodations, Amusements, and Museums.

Source: N.C Travel Study - Technical Report

Division of Travel and Tourism, North Carolina Department of Commerce (1984 and 1985)

person-nights of travel in the region in each year. Estimates of person-nights have only been attempted at the county level for three years, and as noted previously, caution must be exercised in making comparisons of these data with other types of travel estimates.

III.11.5 Expected Outcomes

Data presented in this report show an increasing trend in travel expenditures in twenty counties of the Albemarle/Pamlico Study area. This trend is especially strong in the counties containing oceanfront beaches, suggesting an increasing demand for coastal water-related recreational activities.

The general consensus of most recent studies supports the conclusion that demand for recreational activities in coastal areas will rise in the coming years. As recreation related travel into the counties of the Albemarle/Pamlico study region increases, human impacts in terms of waste disposal, destruction of wildlife habitat, stormwater runoff pollution from developed areas, and pollution associated with pleasure boats and marinas will become increasingly significant sources of stress on the estuarine resource.

III.11.6 Critical Issues

Increased recreational travel into the Albemarle-Pamlico study area will lead to a number of critical issues in terms of conflicts with other uses of the area.

A major impact of recreation and tourism is on shellfish beds and fishery nursery areas and feeding grounds, caused by one or more of the following: stormwater runoff from developed land areas; leaking septic tanks; increased waste loads from wastewater treatment plants; water pollution associated with recreational boating, especially at marinas; and conversion of wetlands for development.

Recreation and tourism also have an impact on wildlife resources. Development of resort and recreational areas may alter or destroy wildlife habitat at the site. Recreational activities may further disturb wildlife, even if not directly altering or destroying habitat.

Tourism and recreation leads to demands on sewage disposal systems, which in turn can have a negative effect upon recreational activities. Even when treatment systems are working properly, limited capacity for assimilation of waste may place siting and density restrictions on development.

Recreational fishing and shellfishing may have an impact on the fishery resource, leading to a conflict among all sport and commercial fishing users of the area.

CHAPTER IV

INTERACTIONS AMONG SOCIETAL USES: CONFLICT AND COMPETITION

IV.1 Introduction

All human activities described in the previous chapter interact directly with the Albemarle-Pamlico estuarine system. Interactions in six of those activities (agriculture, commercial forestry, waste disposal, residential and commercial development, mining and industrial development, and national defense directly affect water quality or aquatic resources in the estuaries. The remaining four human activities (commercial fishing, sports fishing, recreation and tourism, and wildlife resources), depend upon those resources and thus are affected by modifications of estuarine water quality. Figure IV-1 shows a conceptualization of the relationship between these predominately affecting and affected societal uses.

Some interactions among societal uses are negative, often resulting in social conflict or competition. Reducing these social interactions through management will require clear and widespread understanding of the environmental processes through which they are manifested. Gaining such understanding is the goal of the Albemarle-Pamlico Estuarine Study.

In this chapter, the negative interactions among various societal uses are characterized. Negative interactions are emphasized as a device to concentrate effort on existing and potential social conflicts. The conflicts, pressures and competitions are identified, and their mechanisms are explored, so that the processes mediating negative interactions can be clearly isolated and management alternatives can be evaluated. Finally, the consequences of these interactions for the estuary are characterized as environmental manifestations of the societal use conflicts. In this way, environmental problems are clearly tied both to causal mechanisms and societally important consequences. Subsequent chapters use this use/interaction/consequence framework to identify possible management strategies available (Chapter V) and to identify management actionable research goals for the study (Chapter VI).

The first step in building causal webs from human activities through environmental consequences to secondary affects on other human uses is to identify those interactions where conflicts occur. Managers of natural resource agencies in North Carolina compiled a preliminary evaluation of the relative magnitudes of these negative interactions, presented as Figure IV-2. These evaluations include only environmentally important negative interactions: competition for space among various land uses are considered to be outside the scope of this study, except where environmentally important consequences result.

The negative interactions considered to be major include waste disposal and commercial fishing, mining and industrial development and commercial fishing, residential and commercial development and commercial fishing, and agriculture and commerical fishing. These conflicts result from the point or nonpoint source pollution of estuarine waters, coupled to destruction of fisheries habitat.

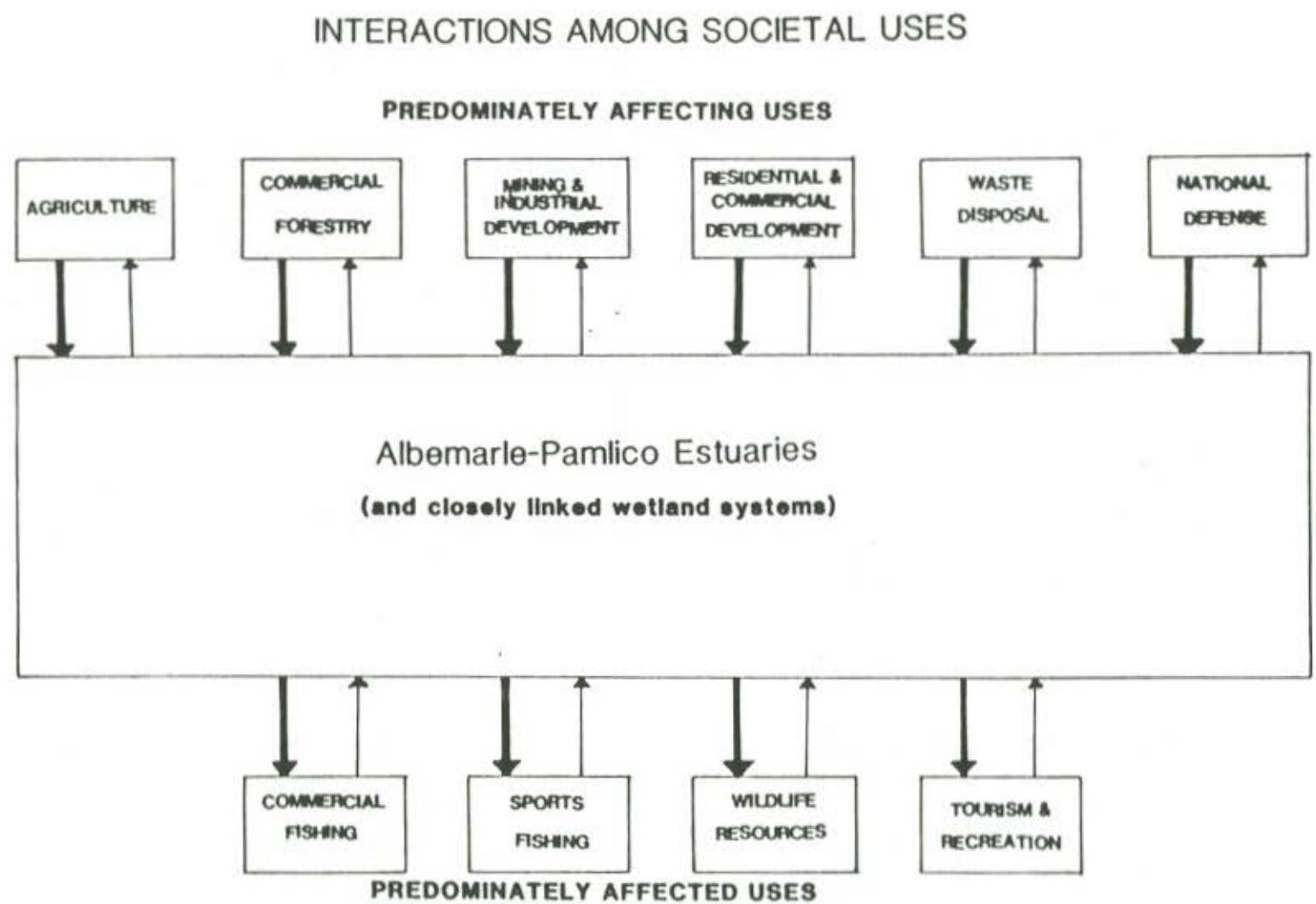
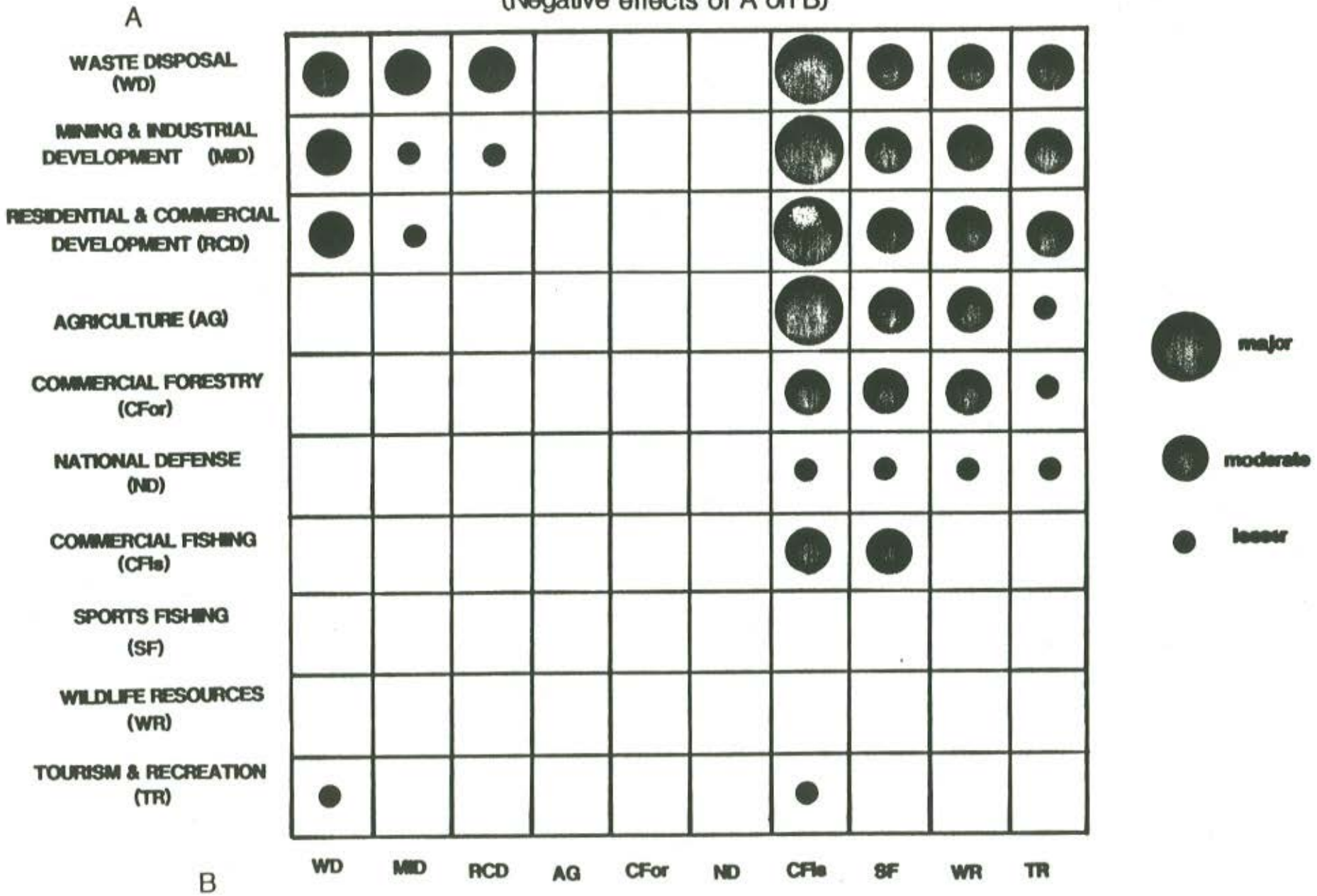


Figure II-4 Conflicts among human uses of the Albemarle-Pamlico estuarine system.

Figure IV-2. Negative interactions among societal uses in the Albemarle-Pamlico region.
(Negative effects of A on B)



Moderate conflicts exist between sports fishing and each of the affecting uses except national defense, between forestry and commercial fishing, and between waste disposal and wildlife resources. These conflicts are similar in nature to those above, only less in severity. Additional moderate conflicts result from habitat-modification effects of agriculture, forestry, mining and industrial development, and residential and commercial development on wildlife resources. Also, limited assimilative capacity in streams results in moderate conflicts between competing generators of waste: mining and industrial development, residential and commercial development and waste disposal. Aesthetic considerations mediate moderate conflicts between tourism and recreation, and residential and commerical development, mining and industrial development and waste disposal. Finally, harvest-related effects are responsible for conflicts between commercial fishing and both fishing uses.

Lesser conflicts exist between national defense and fishing, national defense and wildlife resources, and national defense and tourism/recreation. Tourism and recreation are also impacted by the other land-conversion related activities, agriculture and commercial forestry.

Each of these interactions is explored in the following section in order to identify the processes through which environmentally important modifications affect other uses.

IV.2 Characterization of Interactions

IV.2.1 Major Negative Interactions

IV.2.1.1 Effect of Agriculture on Commercial Fishing (and Sport) Fishing

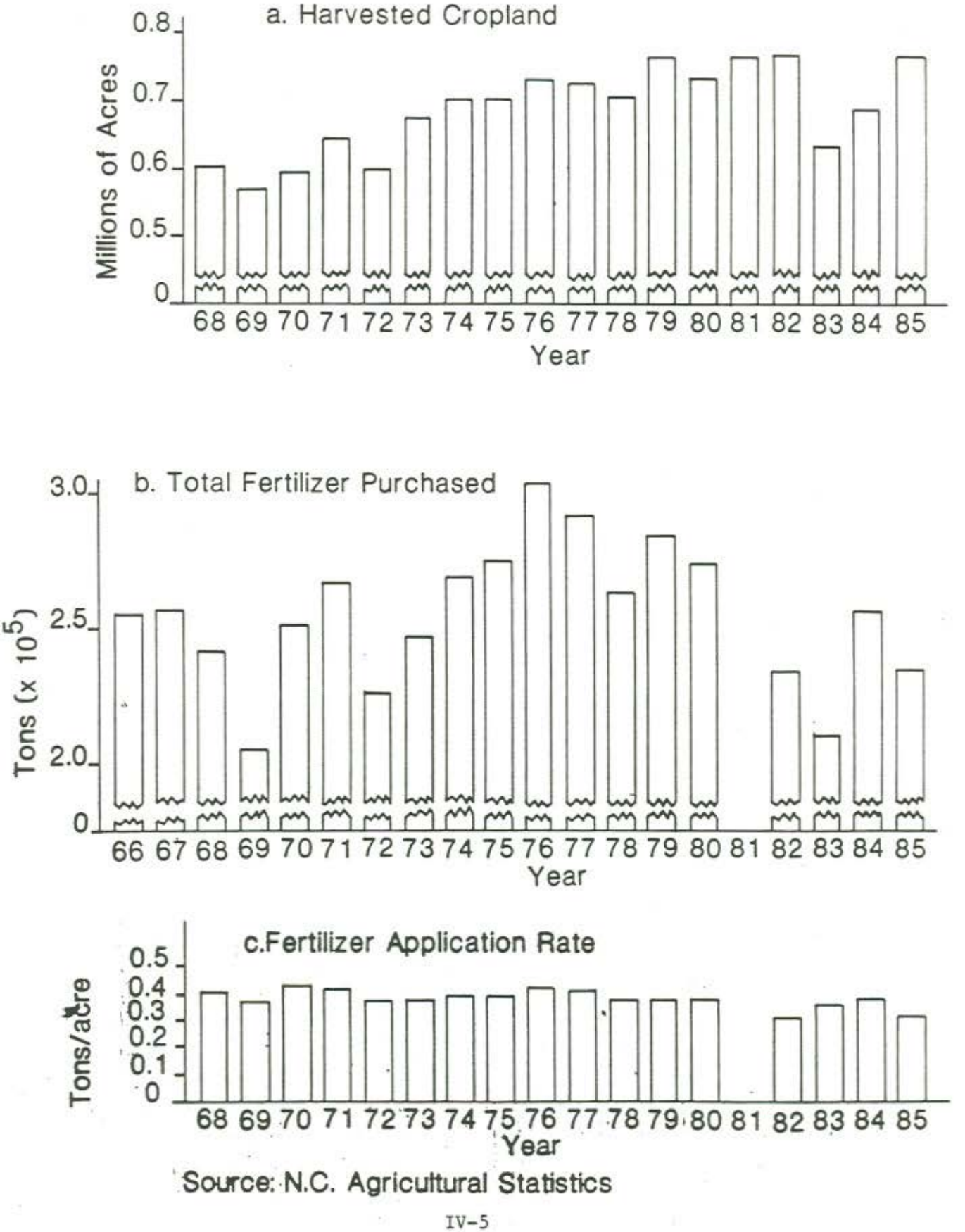
Widespread conversion of low-lying forested wetland areas to agriculture occurred from about 1940-1981 on the Albemarle-Pamlico Peninsula with peak intensity between 1963 and 1981 (Richardson, 1981; McMullan, 1984; McMullan, 1985). In order for this activity to occur, dense drainage networks had to be installed especially in regions with shallow or deep organic soils (Heath, 1975; Daniel, 1978; Skaggs et al., 1980). These drainage networks have greatly modified the hydrology of the peninsula, especially the rate and location of freshwater delivery into shallow enlargements which serve as primary nursery areas for estuarine species. This increase in nonpoint source runoff has carried with it large loads of sediment, nutrients and toxic contaminants tracible to agricultural activities.

Furthermore, agricultural trends in the entire tributary basins have important implications for water-quality mediated effects on fisheries. Although recent economic troubles have negatively affected agriculture in general, total harvested acres are up markedly in the region since 1970 (Figure IV-3). Patterns of concentration of major crops near major tributaries is depicted in Figure IV-4. Also, livestock in the basins is up markedly (Figure IV-5). Even though programs aimed at improvements in nonpoint source pollution due to agriculture have been very successful in some regions, they are just beginning to be implemented in others.

An analysis of the mechanisms driving the conflict between agriculture and both fisheries uses is presented in Figure IV-6. As can be seen, large fluxes

Figure IV-3.

TRENDS IN AGRICULTURAL DEVELOPMENT
IN THE TAR-PAMLICO BASIN



Source: N.C. Agricultural Statistics

Figure IV-4.

AGRICULTURAL CHANGES IN THE TAR-PAMLICO BASIN:
ACRES PLANTED IN MAJOR CROPS

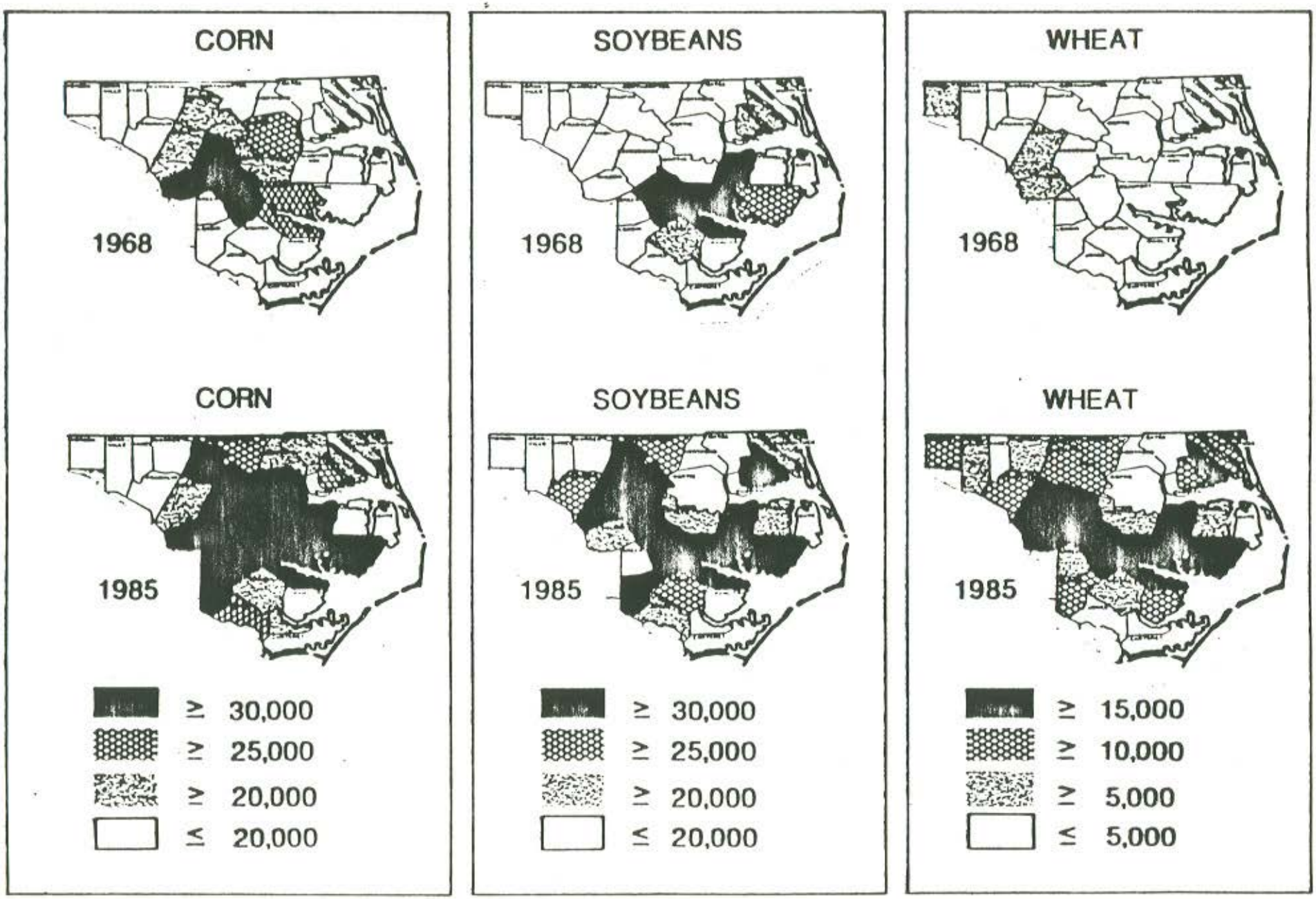
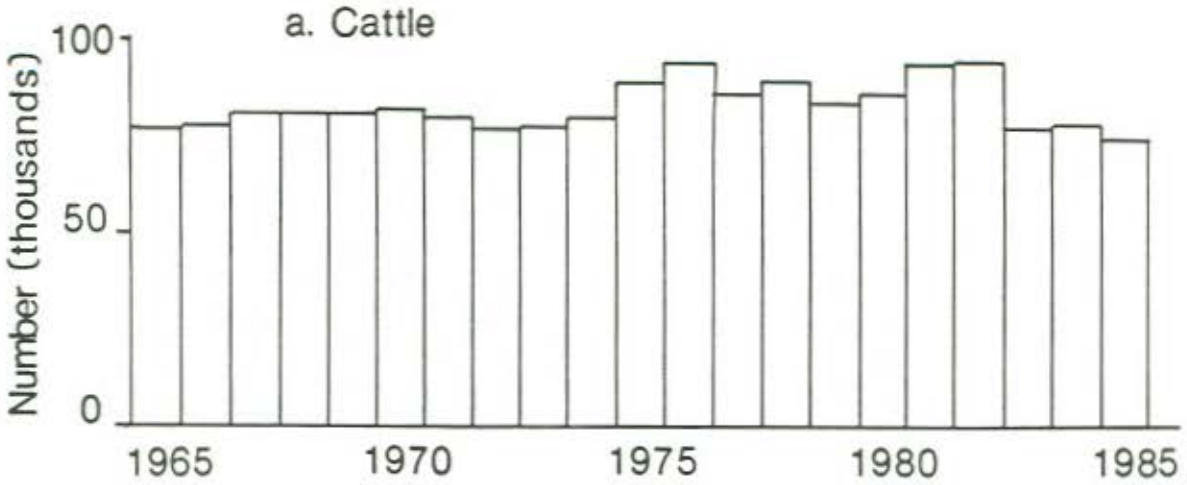
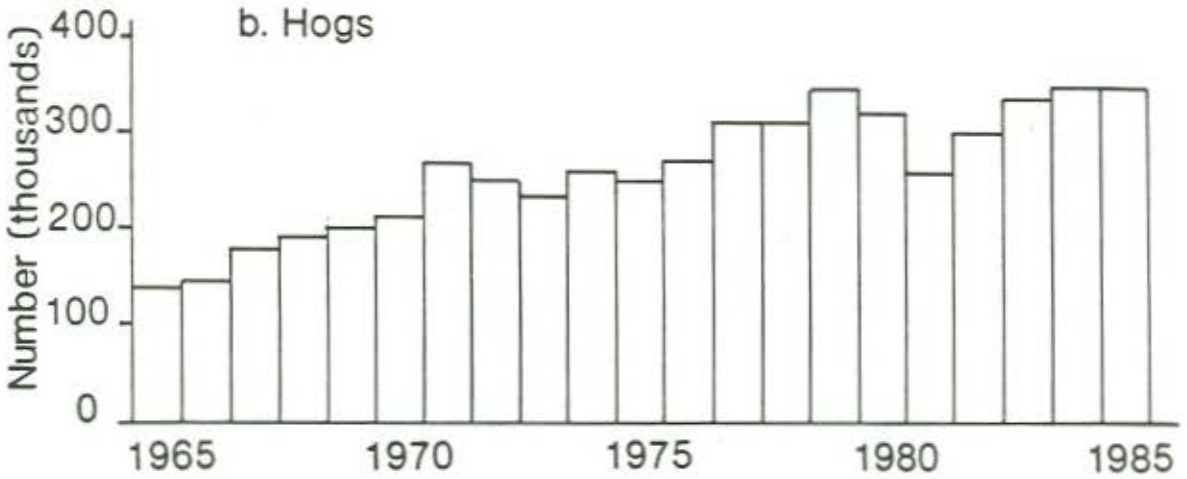
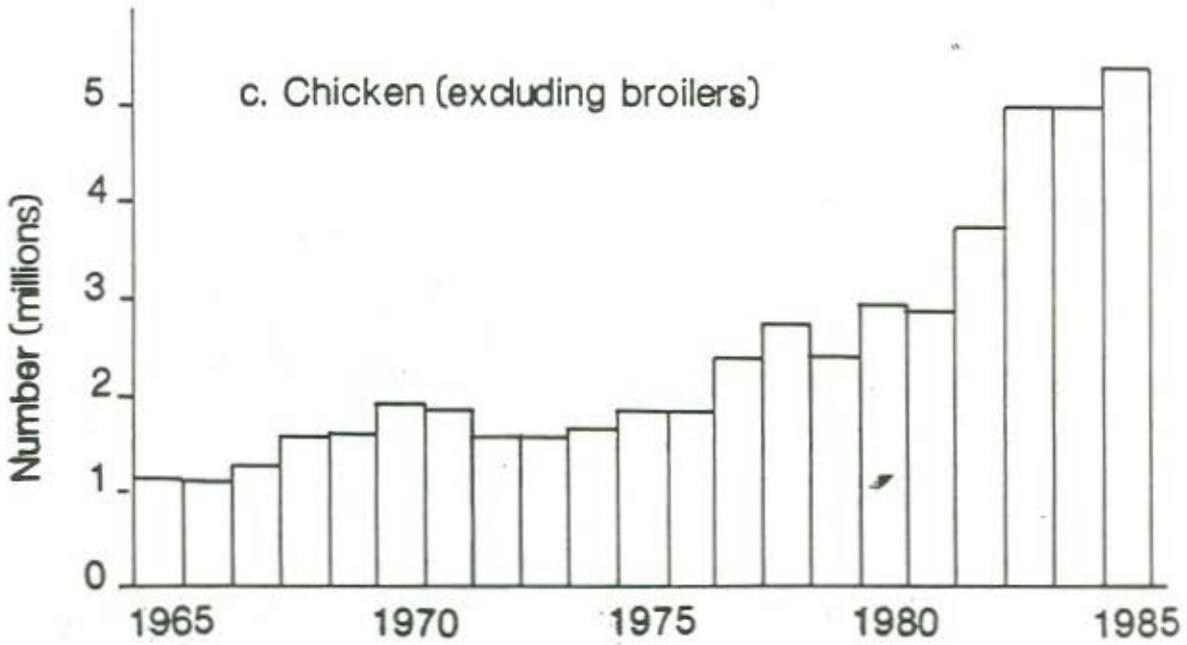


Figure IV-5.

LIVESTOCK IN THE TAR-PAMLICO BASIN







Source: N.C. Agricultural Statistics

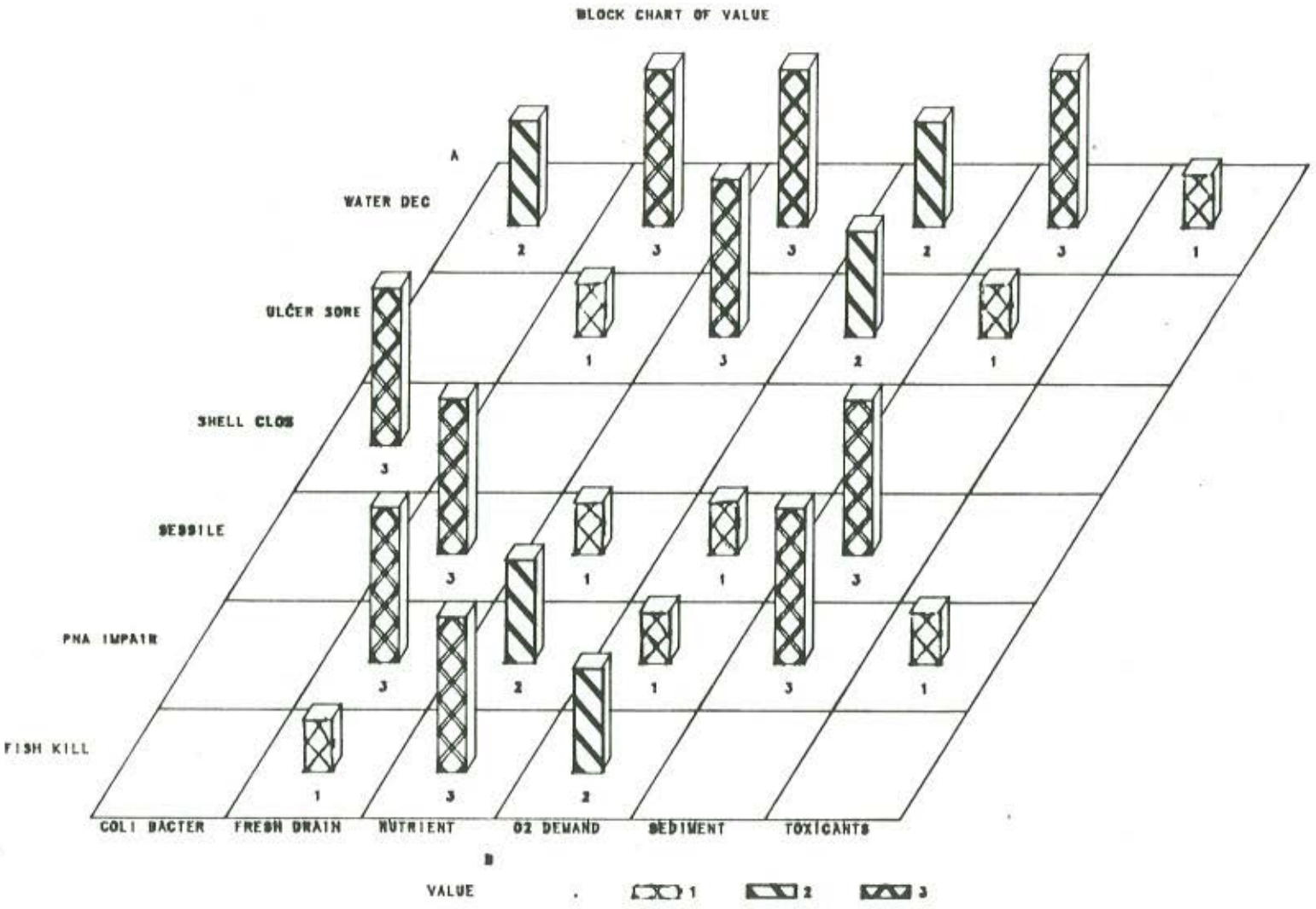


Figure IV-6. Interaction between agriculture and commercial and sports fishing.

of freshwater, sediments, nutrients, and oxygen-demanding substances result from agriculture, which contribute to a variety of fisheries resource effects.

Impairment of nursery function and changes in the distribution and abundance patterns of sessile estuarine organisms like oysters have been related to land-conversion activities (Pate and Jones, 1981; Street and McClees, 1982; DEM, 1985). Dissolved-oxygen-related fish kills in the Pamlico River are becoming more frequent, and are linked to loadings of nutrients and organic substances and changes in local hydrologic regimes (DEM, 1986a). Ulcerative sore disease (ulcerative mycosis) and red sore disease (Aeromonas hydrophila) have both been linked to stress related to a variety of point and nonpoint-derived environmental changes (Esch and Hazen, 1982; Noga and Dykstra, 1986). In addition, agricultural-derived fecal coliform bacteria continue to cause or maintain shellfish closures in the region (DEM, 1986b).

Overall, the specific cause-effect relationships between agricultural loadings due to nonpoint source pollution and these environmental effects have yet to be completely understood, but the causal significance of poorly-planned landuse-conversion activities for estuarine problems is clear.

IV.2.1.2 The Effect of Waste Disposal on Commercial (and Sport) Fishing

Waste from point sources in the Albemarle-Pamlico region is rich in nutrients and oxygen-demanding substances, both of which contribute to eutrophication-related dissolved-oxygen problems. Human populations in the region continue to increase at a constant rate, with concomitant sewage loading changes (see Chapter III). Industrial point sources discharge large volumes in all principal tributaries, up to 85%-90% of total flow in some tributaries at low flow (see Chapter III). Fisheries effects of this point-source loading of nutrients, coupled to that from nonpointsources, include anoxia-related fish kills, eutrophicationdriven food chain disruption and likely contribution to the ulcerative sore disease problems. Toxicants may be contributing to declines in striped bass larval survivorship in similar estuaries, and may be involved in the Albemarle-Pamlico declines (Rulifson, 1986). Finally, fecal coliform discharges and buffer zones around sewage treatment plants are responsible for large closures of shellfish beds (DEM, 1986b).

IV.2.1.3 Effect of Residential and Commerical Development on Commercial (and Sports) Fishing

Nonpoint-source runoff from urbanized areas in close proximity to productive nursery grounds has important environmental ramifications in the AlbemarlePamlico region. Such runoff carries increased loads of sediment, fecal coliform bacteria and trace contaminants (oil, grease, lead, chromium, cadmium, etc.). Septic systems and marinas are particularly notable sources of coliform organisms. Fisheries effects include nursery ground impairment and contamination of shellfish beds. In addition, dredging for boat basins, channels and marinas and filling of marshes and productive bottoms results in the loss of fisheries habitat.

IV.2.1.4 Effect of Mining and Industrial Development on Commercial (and Sports) Fishing

Existing phosphate mining operations and potential mining and processing for of ilmenite and peat may cause significant increases in total loading of phosphorus, sediment, oxygen-demand substances, freshwater and trace contaminants, with potentially serious implications for estuarine organisms. In particular, an existing 60 MGD phosphate operation, a proposed titanium processing plant and 23,000 acres of permitted peat mines all drain into the central part of the Pamlico River. Major pulp mill discharges exist in the Chowan, Roanoke and Neuse Rivers. Other point-source discharges are summarized in Chapter III. Discharge constituents from these various sources undoubtedly contribute to dissolved-oxygen-related fish kills, eutrophication-driven food chain disruption and impairment of nursery function, with obvious consequences for fisheries.

IV.2.2 Moderate Negative Interactions

IV.2.2.1 Effects of Land-Use Conversions on Wildlife Resources

The wetlands and forests of the northeast coastal plain support a wide variety of wildlife. Conversion of that land to agriculture, commercial forestry, residential or commercial development or mining or industrial development can have serious consequences for native organisms. These effects are mediated through direct destruction of the organisms involved and through habitat destruction. On the other hand, land conversion may actually improve habitat for disturbance-compatible species such as doves and deer. Several rare and endangered species are threatened by habitat losses, including black bear, red-cockaded woodpeckers and American alligators. In addition, land-use conversion ofter results in instream modifications which may significantly affect nongame species (e.g. the Tar River spiny mussel, Canthyria steinstansana).

IV.2.2.2 Impact of Commercial Forestry on Commercial (and Sports) Fishing

The same nonpoint processes that mediate the agricultural effect on fisheries occur as a result of commercial forestry operations, but to a much lesser extent. Forestry requires reduced applications of fertilizer and a much reduced disturbance regimen. Nonetheless, the drainage systems put into place to facilitate logging and silvicultural operations result in modified hydrologic regimes in critical estuarine nursery areas, and larger loads of sediment and oxygen-demanding substances into estuarine waters. The effects on fisheries are the same as those due to agriculture, but the overall magnitude is less. Disturbance in forested wetlands often results in increased coliform bacteria concentrations, causing shellfish waters to be closed.

IV.2.2.3 Impacts of Waste Disposal on Wildlife Resources

Waste disposal can have significant implications for aquatic species sensitive to water quality changes, or dependent on sensitive species. Also non-aquatic species such as migratory waterfowl are affected when loadings of nutrients or other contaminants from waste disposal affect their primary food source (i.e. aquatic macrophytes).

IV.2.2.4 Impacts of Waste Disposal, Mining and Industrial Development, and Residential and Commercial Development on Tourism and Recreation

Waste disposal and related activities have important implications for contact recreation (swimming and boating), recreational shellfishing and tourism in general. Because the tourist industry depends strongly on aesthetics, unsightly conditions which can result from waste disposal strongly influences its success. Furthermore, seasonal increases in population in resort areas place additional stress on sewage treatment facilities, with potential feedback effects on growth rates.

Environmentally important consequences of this interaction include closures of shellfish waters, closures of areas to contact recreation, degradation of waste quality during peak season treatment plant failures and impairment of aesthetics by waste disposal or related activities.

IV.2.2.5 Conflicts between Mining and Industrial Development and Waste Disposal

Because assimilative and dilutive capabilities of streams are limited, disposal of waste from industrial sources and from domestic sources represent competing uses. The volume of waste permitted for a proposed facility and the concentrations of contaminants allowed depend on the loading from existing facilities. Streams with low assimilative capabilities or with relatively high existing waste loads can cause severe restriction in new discharge permits and substantial expense in waste treatment, depending on the degree of conservatism required during the wasteload allocation process. In addition, any activity which modifies flow in a stream will directly affect the discharges which can be permitted.

IV.2.2.6 Conflicts between Waste Disposal and Residential and Commercial Development

As above, the limited assimilative capacities of streams result in direct competition between waste loading from businesses, industries, and residential sources. In this case, however, aesthetics and health constraints play major roles in siting of residential and commercial facilities, such that waste disposal can have a direct negative impact on certain potential developments.

IV.2.2.7 Impacts of Commercial Fishing on Sports Fishing and Commercial Fishing

Potentially significant effects of commercial fishing practices on fish stocks or nursery functions have occurred in the past and are likely in the Albemarle-Pamlico region. The magnitude of those effects has not been ascertained.

IV.2.3 Lesser Negative Interactions

IV.2.3.1 Impacts of National Defense on Commercial (and Sports) Fishing

National defense-related activities can have locally significant effects on fisheries, particularly near facilities where toxic substances are handled or where repeated dredging is required. Examples of estuarine areas receiving relatively high impacts from defense facilities include tributaries of the middle Neuse (e.g. Slocum Creek), the upper Neuse River (near Goldsboro) and the Pasquotank River (near Elizabeth City). In addition, the port facilities at Morehead City significantly affect local water quality.

IV.2.3.2 Impacts of National Defense on Wildlife Resources

National defense also has negative impacts on wildlife resources. Noise from aircraft can have significant effects on migratory waterfowl and large mammals. Also, water quality degradation can significantly affect nongame populations on a local basis. Many of these negative effects are mitigated by the habitat preservation which has occurred as a by-product of restrictions on access (e.g. the Dare County Bombing Range).

IV.2.3.3 Impacts of National Defense on Tourism and Recreation

Environmental degradation caused by defense-related activities has caused impairment of recreational opportunities in certain localities in the region (e.g. Slocum Creek). Furthermore, restrictions on other activities (e.g. private aviation limitations, limited access to lands for hunting) have also reduced recreational activities locally.

IV.2.3.4 Impacts of Agriculture and Commercial Forestry on Tourism and Recreation

Because aesthetics strongly affect tourism and recreation, all activities which cause environmental degradation negatively impact tourism and recreation. Similarly, major land-conversion activities reduce recreational opportunities, potentially affecting tourism.

IV.3 Consequences of Use Conflicts: Environmental Manifestations

The negative interactions examined above all result because of environmental modifications caused by the affecting actvities. The consequences of those modifications are often recognized as "environmental problems," when changes impinge on some other use. In this program, research projects are targeted at important processes mediating the effects rather than at the effects themselves. Information gained will allow management of the processes causing the problems rather than the symptoms of those problems.

Definite changes in the health of the Albemarle-Pamlico system have occurred, presumably as a result of human activities. The following sections evaluate the status of the most prominent of those changes, identify causal relationships to human activities and direct research toward critical processes and relationships.

IV.3.1 Declines in Fisheries Productivity

Major declines in commercial fisheries have occurred in the Albemarle-Pamlico region since the late 1970's. Striped bass, shad and river herring landings from Albemarle Sound are greatly depressed from historic levels. In addition, commercial landings of croaker, catfish and flounder have trended downward since 1980 (see Chapter III). Blue crab landings show a similar decrease. The reasons for these declines remain equivocal, but undoubtedly include declining water quality, critical habitat loss and fisheries-related effects. Declines are expected to continue unless causes can be ascertained, and corrective steps taken. Research intended to establish causal relationships between various environmental effects and fisheries declines, and to evaluate

effects of fisheries practices on fisheries stock is crucial to improved management of the valuable fisheries resources.

IV.3.2 Ulcerative Sore Diseases

Recent outbreaks of ulcerative mycosis in commercially important species in the Pamlico River present a major challenge. Up to 85%-90% of menhaden sampled were affected in 1985 (Noga and Dykstra, 1986). Many other commercially important species are affected, including flounder and weakfish. Recent investigations suggest that stress related to water quality degradation is an important factor leading to disease outbreaks, but epidemiological relationships are poorly understood (Noga and Dykstra, 1986). Furthermore, red sore disease in commercially important species in Albemarle Sound reached epidemic proportions during the 1970's, but the causes for the outbreak and the potential for future outbreaks remain ambiguous (Esch and Hazen, 1980). Research on causes of disease outbreaks is sorely needed.

IV.3.3 Anoxia-Related Fish Kills

Recent years have shown a significant increase in fish kills reported in the Pamlico River. Out of kills reported since 1966, 87% occurred in the last half of this interval (DEM, 1986a). High variability in conditions between years and in reliability of reporting makes trend analysis difficult, yet the information available suggest that fish kills are becoming more common. Most of these fish kills are related to oxygen depletion, related to eutrophication, water-column and benthic respiration and salinity stratification, but the causal mechanics are poorly known. Changes in the vertical distribution of oxygen-depleted zones have been recognized as significant anthropic effects on Chesapeake Bay (Stanley, 1985), but we lack the vertical samples required to document similar trends in the Albemarle-Pamlico region. Fisherfolk, however, complain vociferously about the ravages of "dead water," and are convinced that intensity and extent of affected regions have increased (DEM 1986c).

IV.3.4 Changes in Distribution Patterns of Aquatic Sessile Organisms

Historic changes in distribution patterns of important organisms have been dramatic in the Albemarle-Pamlico region. Preliminary studies suggest that viable oyster beds have been displaced downstream roughly 10-15 miles in the Pungo, Pamlico and Neuse Rivers since the late 1940's (Phillips, 1982). The causes for this effect are uncertain, but probably include changes in salinity and sedimentation patterns induced by drainage from agricultural and silvicultural areas as well as cultural harvesting techniques (e.g. removal of shells).

A second guild of organisms which have displayed marked changes in historic distribution patterns are the submerged aquatic plants. Extensive beds of brackish water macrophytes which existed in 1976 (Davis & Brinson, 1976) had almost disappeared by 1985 (Davis *et al.*, 1985). This decline parallels similar declines in the Chesapeake Bay and elsewhere, and represents an environmentally important change in fisheries habitat and waterfowl food. Preliminary research suggests that environmental perturbations were involved, but definite answers await experimental elucidation.

IV.3.5 Impairment of Nursery Area Function

The marshes fringing the lower Pamlico-Neuse Rivers and Pamlico Sound provide essential nursery functions supporting the sound and oceanic fisheries of much of the central Atlantic coast. Most of these areas are bordered by low-lying wetland areas, which must be drained before they can be used for agriculture, silviculture or other dry land uses. This process has resulted in an extensive network of drainage canals, many of which flow directly into the estuarine embayments which serve as primary and secondary nursery areas for commercially important species. The freshwater, sediment and trace contaminants delivered through these drainage systems have negatively affected the function of those nursery areas. Although the exact extent of existing impairment may prove difficult to estimate where historical data is lacking, identification of impaired areas and assessment of restoration/mitigation potential may be easily accomplished.

IV.3.6 Eutrophication

Blooms of phytoplankton in response to cultural enrichment of estuarine waters with nutrients are well documented in the Albemarle-Pamlico system. Spectacular blooms of noxious blue-greens in the Chowan River occurred in 1972, 1978 and 1983 (DEM, 1982 and per. com.). The Neuse River continues to exhibit high-intensity blooms of blue-green algae whenever nutrient loadings are high in spring, and flow rates are low in summer (Paerl, 1986). Many other tributaries display periodic blooms, depending on flow regimen, nutrient loading, salinity and meteorologic conditions. Even the Pamlico River, where salinities are normally high enough to prevent blue-green domination of algal assemblages, displays seasonal blooms of dinoflagellates, which probably contribute to oxygen-depletion phenomena in the river. Modification of algal populations in response to nutrient enrichment also has important ramifications for striped bass in the Roanoke River (Rulifson, 1986). Research on causal relationships of the eutrophication process is important to allow management of its effects.

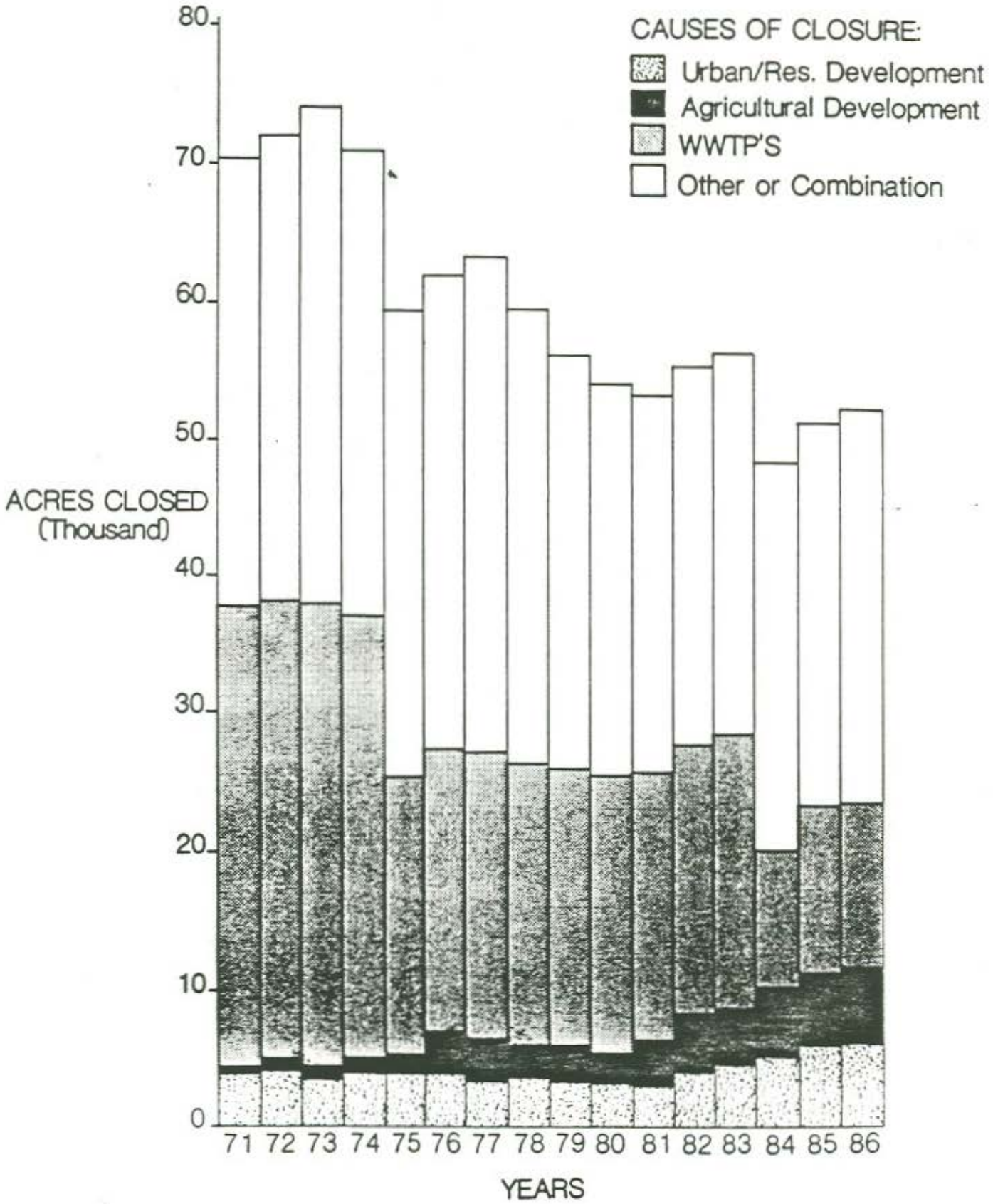
IV.3.7 Habitat Loss

Human activities in the Albemarle-Pamlico region have greatly affected ecosystem functions of estuarine habitats and tightly-linked wetland habitats. Dredging and filling of productive bottoms, marshes and pocosins has modified reproductive, migratory and feeding patterns for a wide variety of aquatic and terrestrial organisms. The relative habitat value of these areas is poorly known, and restoration or mitigation potential for impacted areas has yet to be evaluated.

IV.3.8 Shellfish Closures

The trends in closure of shellfish waters in North Carolina resulting from bacterial contamination due to human activities is shown in Figure IV-7. Relatively few of the total shellfish beds in the state occur within the study area, although Pamlico Sound supports large oyster grounds, Core Sound contains important hard clam areas, and Bogue Sound provides a variety of shellfish resources. Most of the less saline areas (Neuse River, Pamlico River, Albemarle Sound and tributaries) contain species such as Rangia cuneata and Macoma spp. which are not exploited extensively. Aside from Carteret County, the majority of shellfish closures in the study area have resulted from agricultural operations or from residential or commercial developments. Although interesting questions

Figure IV-7. PROHIBITED ACREAGE IN N.C. SHELLFISH WATERS
(46 SALINE AREAS ONLY)



have been posed about the relationship between development and the risk of consuming contaminated shellfish, they probably will be addressed elsewhere.

IV.3.9 Toxicant Effects

Relatively little is known about the effects of toxicants on estuarine organisms in the Albemarle-Pamlico region. Specific locations (e.g. Slocum Creek) have been identified where toxicant problems exist, but large-scale problems have not been documented. Concern remains over potential toxicity of specific constituents of permitted and proposed discharges (e.g. titanium, fluoride, antimony) and the whole effluent toxicity of others (pulp mill effluent), yet the region is relatively toxicant-free (see Chapter III). A systematic baseline evaluation of potentially toxic contaminants has never been conducted.

IV.4 Summary

Negative interactions among human uses of the Albemarle-Pamlico estuarine system demonstrate the enormous complexity of the system and its high degree of interconnectedness. The areas (geographical and logistical) where these conflicts are greatest are those where predominantly affecting uses have sufficient intensity to impinge significantly on predominantly affected uses. These potential stress points should receive the bulk of the effort allocated under this program, both in terms of evaluating management options for the processes invclved and directly addressing environmental manifestations of those conflicts where the causal activities cannot be regulated for societal, political, legal or technical reasons. Chapter V examines the existing regulatory framework pertinent to these major conflicts and the processes mediating them. Chapter VI proposes a series of management-related research projects which will allow more efficient management of these conflicts and the resource limitations they represent.

CHAPTER V

MANAGEMENT PROGRAMS AND OPTIONS

This chapter examines the existing federal, state, and local statutory framework within which environmental problems are currently being managed. Many of the statutes considered in this chapter were designed to cope with or remediate environmental problems. Others have been included because of their general impact on land use. Despite the quantity of statutes that currently exist, it is apparent that these pieces of legislation have not succeeded in resolving the problems of conflict and competition that presently exist in the Albemarle and Pamlico Sounds. This chapter classifies federal and state legislation according to the environmental concerns they address and also includes a description of various tools and techniques available to local jurisdictions for managing development. It is hoped that by categorizing these statutes according to the environmental manifestations they address and then providing brief descriptions of this legislation, it should be possible to produce a refined management system that ensures the integrity and productivity of North Carolina's estuarine system.

In general, there are two types of federal and state legislation that have an affect on environmental problems. The first type involves statutes specifically enacted to address particular environmental problems. Examples of this type of legislation are the federal Endangered Species Act of 1973 and the North Carolina Pollution and Hazardous Substances Control Act. The second type of statute involves those that have an affect on general land use. An example of this type of statute is the Coastal Area Management Act. Taken together, both types of legislation comprise the management system that regulates human activities and land use around Albemarle and Pamlico Sounds.

This chapter describes the existing management system in the Albemarle and Pamlico Sound region by classifying existing federal and state statutes according to the environmental problems they might address. The seven categories of environmental manifestations (aquatic habitat modification, freshwater drainage, oxygen-demanding substances, toxicants, sediment flux, coliform bacteria, and nutrient flux) are those used in Chapter IV to examine conflict and competition among societal uses. For each manifestation, federal legislation with major, minor and marginal impacts are listed as well as those North Carolina statutes which have a major impact. Following this classification is a listing of all federal and state legislation considered part of the existing management system as well as brief descriptions of each federal statute and the North Carolina statutes that have a major impact. The final section of this chapter is a listing of local tools and techniques available for managing development around the Albemarle and Pamlico Sound. This listing is followed by a more detailed description of these various growth management options.

This chapter should provide a comprehensive view of the universe of management tools currently available. It should also provide insight into those statutes, programs, tools and techniques most pertinent to effective management of the Albemarle and Pamlico Sound. By viewing these management tools from the perspective of the most critical environmental conflicts, it is hoped that an assessment can be made of the current management system and the building blocks of a better management system be identified. While it is

apparent that a wide variety of tools, techniques and authority currently exists, it is important to recognize that the current management system appears to suffer from a lack of coordination and from problems of insufficient political, financial and administrative wherewithal.

MANAGEMENT PROGRAMS AND OPTIONS

Aquatic Habitat Modification:
- Federal Legislation with Major Impact
- Federal Legislation with Minor Impact
- Federal Legislation with Marginal or Extremely Minor Impacts
- North Carolina Legislation with a Major Impact

Freshwater Drainage:
- Federal Legislation with Major Impact
- Federal Legislation with Minor Impact
- Federal Legislation with Marginal or Extremely Minor Impacts
- North Carolina Legislation with a Major Impact

Oxygen-Demanding Substances:
- Federal Legislation with Major Impact
- Federal Legislation with Minor Impact
- Federal Legislation with Marginal or Extremely Minor Impacts
- North Carolina Legislation with a Major Impact

Toxicants:
- Federal Legislation with Major Impact
- Federal Legislation with Minor Impact
- Federal Legislation with Marginal or Extremely Minor Impacts
- North Carolina Legislation with a Major Impact

Sediment Flux:
- Federal Legislation with Major Impact
- Federal Legislation with Minor Impact
- Federal Legislation with Marginal or Extremely Minor Impacts
- North Carolina Legislation with a Major Impact

Coliform Bacteria:
- Federal Legislation with Major Impact
- Federal Legislation with Minor Impact
- Federal Legislation with Marginal or Extremely Minor Impacts
- North Carolina Legislation with a Major Impact

Nutrient Flux:
- Federal Legislation with Major Impact
- Federal Legislation with Minor Impact
- Federal Legislation with Marginal or Extremely Minor Impacts
- North Carolina Legislation with a Major Impact

Programs that Affect Development Around the Albemarle and Pamlico Sounds

- Complete Listing of Federal Legislation with a Major Impact
- Complete Listing of Federal Legislation with a Minor Impact
- Complete Listing of Federal Legislation with a Marginal or Extremely Minor Impact
- * Brief Descriptions of Programs That Affect Development Around the Albemarle and Pamlico Sound
  - Federal Legislation with a Major Impact
  - Federal Legislation with a Minor Impact
  - Federal Legislation with Marginal or Extremely Minor Impacts

Complete Listing of North Carolina Legislation with a Major Impact
Complete Listing of North Carolina Legislation with a Minor Impact
Complete Listing of North Carolina Legislation with a Marginal or Extremely Minor Impact
*Brief Descriptions of Programs that Affect Development Around the Albemarle and Pamlico Sound
North Carolina Legislation with a Major Impact

Local Tools and Techniques Available for Managing Development
Complete Listing
Development of Growth Management Systems for North Carolina (descriptions)

*No changes from materials previously distributed (approx. 50 pp.)

AQUATIC HABITAT MODIFICATION

Federal Legislation with Major Impact:

- Anadramous Fish Conservation Act
- Coastal Barrier Resources Act
- Coastal Zone Management Act of 1972
- Department of Transportation Act of 1966
- Disaster Relief Act of 1974
- Endangered Species Act of 1973
- Federal Land Policy and Management Act of 1976
- Federal Water Pollution Control Act Amendments of 1972
- Fish and Wildlife Act of 1956
- Fish and Wildlife Conservation Act of 1980
- Fish and Wildlife Coordination Act of 1934
- Fishery Conservation and Management Act of 1976
- Forest and Rangeland Renewable Resource Planning Act
- Land and Water Conservation Fund Act
- Marine Mammal Protection Act of 1972
- Marine Protection, Research, and Sanctuaries Act of 1972
- Migratory Bird Conservation Act
- Migratory Bird Treaty Act
- Mineral Leasing Act of 1920
- National Environmental Policy Act
- National Flood Insurance Act of 1968
- Rivers and Harbors Act of 1899
- Rivers and Harbors Act of 1917
- Rivers and Harbors Act of 1968
- Water Quality Improvement Act of 1970

Federal Legislation with Minor Impact:

- Airport and Airway Improvement Act of 1982
- Commercial Fisheries Research and Development Act of 1964
- Energy Supply and Environmental Coordination Act of 1974
- Fish Restoration and Management Projects Act of 1950

Federal Legislation with Marginal or Extremely Minor Impacts:

- Deep Seabed Hard Mineral Resource Act of 1980
- Deepwater Port Act of 1974
- Federal Water Power Act of 1920
- Federal Power Act (1935)
- National Ocean Pollution Research and Development and Planning Monitoring Act of 1978
- Natural Gas Policy Act of 1978
- Ocean Thermal Energy Conversion Act of 1980
- Ocean Thermal Energy Research, Development, and Demonstration Act
- Outer Continental Shelf Lands Act
- Public Health Services Act
- Water Bank Act of 1970

North Carolina Legislation with a Major Impact:

- Air and Water Resources Act
- Coastal Area Management Act

Dredge and Fill Act
Emergency Management Act
Environmental Policy Act of 1971
Fisherman's Economic Development Program
Mining Act of 1971
Mosquito Control Districts
Natural and Scenic River System Act of 1971
Oil Pollution and Hazardous Substances Control Act
Small Watershed Projects Act
Soil and Water Conservation Districts Act
Stream Sanitation Act
Watershed Improvement Districts Act
Watershed Improvement Programs Act
Wildlife Resources Law

FRESHWATER DRAINAGE

Federal Legislation with Major Impact:

Coastal Zone Management Act of 1972
Endangered Species Act of 1973
Forest and Rangeland Renewable Resource Planning Act
Land and Water Conservation Fund Act
Marine Protection, Research, and Sanctuaries Act of 1972
Migratory Bird Conservation Act
Migratory Bird Treaty Act
Mineral Leasing Act of 1920
National Environmental Policy Act
National Flood Insurance Act of 1968
Soil Conservation Act
Watershed Protection and Flood Prevention Act

Federal Legislation with Minor Impact:

Airport and Airway Improvement Act of 1982

Federal Legislation with Marginal or Extremely Minor Impacts:

Federal Water Power Act of 1920
Federal Power Act (1935)
Food and Agriculture Act of 1962
Interstate Land Sales Full Disclosure Act of 1969
National Ocean Pollution Research and Development and Planning Monitoring Act of 1978
Water Bank Act of 1970

North Carolina Legislation with a Major Impact:

Agricultural Development Act
Air and Water Resources Act
Coastal Area Management Act
County Service Districts Act
Dredge and Fill Act
Environmental Compact Act

Environmental Policy Act of 1971
Forest Development Act
Mining Act of 1971
Municipal Service Districts Act of 1973
Natural and Scenic River System Act of 1971
Regional Water Supply Planning Act of 1971
Sedimentation Pollution Control Act of 1973
Small Watershed Projects Act
Soil and Water Conservation Districts Act
Stream Sanitation Act
Water Use Act of 1967
Watershed Improvement Districts Act

OXYGEN-DEMANDING SUBSTANCES

Federal Legislation with Major Impact:

Clean Water Act of 1977
Coastal Zone Management Act of 1972
Endangered Species Act of 1973
Federal Water Pollution Control Act Amendments of 1972
Housing and Community Development Act
Land and Water Conservation Fund Act
Marine Protection, Research, and Sanctuaries Act of 1972
Mineral Leasing Act of 1920
National Environmental Policy Act
Solid Waste Disposal Act of 1965
Water Quality Improvement Act of 1970

Federal Legislation with Minor Impact:

Energy Reorganization Act of 1974

Federal Legislation with Marginal or Extremely Minor Impacts:

Federal Water Power Act of 1920
National Ocean Pollution Research and Development and Planning Monitoring Act of 1978
Ocean Thermal Energy Conversion Act of 1980
Ocean Thermal Energy Research, Development, and Demonstration Act
Port and Tanker Safety Act
Water Bank Act of 1970

North Carolina Legislation with a Major Impact:

Air and Water Resources Act
Coastal Area Management Act
County Service Districts Act
Drinking Water Act
Environmental Policy Act of 1971
Industrial and Pollution Control Facilities Financing Act
Industrial and Pollution Control Facilities Financing Authority Act
Metropolitan Sewage District Act

Metropolitan Water Districts Act
Regional Sewage Disposal Planning Act of 1971
Regional Water Supply Planning Act of 1971
Soil Additives Act
Soil and Water Conservation Districts Act
Solid Waste Management Act of 1978
Special Assessments Act
Stream Sanitation Act
Watershed Improvement Districts Act

TOXICANTS

Federal Legislation with Major Impact:

Clean Air Act Amendments of 1967
Clean Air Act Amendments of 1970
Clean Air Act Amendments of 1977
Clean Water Act of 1977
Comprehensive Environmental Response, Compensation and Liability Act of 1980
Endangered Species Act of 1973
Environmental Pesticide Control Act of 1972
Federal Insecticide, Fungicide, and Rodenticide Act
Federal Environmental Pesticide Control Act of 1972
Federal Water Pollution Control Act Amendments of 1972
Housing and Community Development Act
Land and Water Conservation Fund Act
Marine Protection, Research, and Sanctuaries Act of 1972
Mineral Leasing Act of 1920
National Environmental Policy Act
Ports and Waterways Safety Act of 1972
Resource Conservation and Recovery Act of 1976
Rivers and Harbors Act of 1899
Rivers and Harbors Act of 1917
Safe Drinking Water Act of 1974
Surface Mining Control and Reclamation Act of 1977
Toxic Substances Control Act of 1976
Water Quality Improvement Act of 1970

Federal Legislation with Minor Impact:

Commercial Fisheries Research and Development Act of 1964
Energy Supply and Environmental Coordination Act of 1974

Federal Legislation with Marginal or Extremely Minor Impacts:

Deepwater Port Act of 1974
Hazardous Materials Transportation Act
National Ocean Pollution Research and Development and Planning Monitoring Act of 1978
Natural Gas Pipeline Safety Act of 1968
Natural Gas Policy Act of 1978
Occupational Safety and Health Act of 1970
Oil Pollution Act of 1961

Outer Continental Shelf Lands Act
Port and Tanker Safety Act
Public Health Services Act
Water Bank Act of 1970

North Carolina Legislation with a Major Impact:

Air and Water Resources Act
Boating Safety Act
Coastal Area Management Act
County Service Districts Act
Drinking Water Act
Environmental Policy Act of 1971
Fisherman's Economic Development Program
Industrial and Pollution Control Facilities Financing Act
Industrial and Pollution Control Facilities Financing Authority Act
Mining Act of 1971
Mosquito Control Districts
Municipal Service Districts Act of 1973
Oil Pollution and Hazardous Substances Control Act
Pesticide Law of 1971
Regional Sewage Disposal Planning Act of 1971
Regional Water Supply Planning Act of 1971
Soil Additives Act
Soil and Water Conservation Districts Act
Solid Waste Management Act of 1978
Special Assessments Act
Stream Sanitation Act
Structural Pest Control Act
Toxic Substances Act of 1979
Water Use Act of 1967
Watershed Improvement Districts Act
Well Construction Act

SEDIMENT FLUX

Federal Legislation with Major Impact:

Clean Water Act of 1977
Coastal Zone Management Act of 1972
Endangered Species Act of 1973
Federal Water Pollution Control Act Amendments of 1972
Forest and Rangeland Renewable Resource Planning Act
Housing and Community Development Act
Land and Water Conservation Fund Act
Marine Protection, Research, and Sanctuaries Act of 1972
Mineral Leasing Act of 1920
National Environmental Policy Act
Resource Conservation and Recovery Act of 1976
Soil Conservation Act
Solid Waste Disposal Act of 1965
Surface Mining Control and Reclamation Act of 1977
Watershed Protection and Flood Prevention Act

Federal Legislation with Minor Impact:

Commercial Fisheries Research and Development Act of 1964
Fish Restoration and Management Projects Act of 1950

Federal Legislation with Marginal or Extremely Minor Impacts:

Food and Agriculture Act of 1962
National Ocean Pollution Research and Development and Planning Monitoring Act of 1978
Water Bank Act of 1970

North Carolina Legislation with a Major Impact:

Agricultural Development Act
Air and Water Resources Act
Coastal Area Management Act
County Service Districts Act
Dredge and Fill Act
Environmental Compact Act
Environmental Policy Act of 1971
Forest Development Act
Mining Act of 1971
Municipal Service Districts Act of 1973
Sedimentation Pollution Control Act of 1973
Small Watershed Projects Act
Soil and Water Conservation Districts Act
Stream Sanitation Act
Water Use Act of 1967
Watershed Improvement Districts Act

COLIFORM BACTERIA

Federal Legislation with Major Impact:

Clean Water Act of 1977
Coastal Zone Management Act of 1972
Endangered Species Act of 1973
Federal Land Policy and Management Act of 1976
Federal Water Pollution Control Act Amendments of 1972
Forest and Rangeland Renewable Resource Planning Act
Housing and Community Development Act
Land and Water Conservation Fund Act
Migratory Bird Treat Act
Marine Protection, Research, and Sanctuaries Act of 1972
National Environmental Policy Act
Ports and Waterways Safety Act of 1972
Resource Conservation and Recovery Act of 1976
Rivers and Harbors Act of 1899
Rivers and Harbors Act of 1917
Safe Drinking Water Act of 1974
Soil Conservation Act
Solid Waste Disposal Act of 1965

Water Quality Improvement Act of 1970
Watershed Protection and Flood Prevention Act

Federal Legislation with Minor Impact:

Commercial Fisheries Research and Development Act of 1964
Fish Restoration and Management Projects Act of 1950

Federal Legislation with Marginal or Extremely Minor Impacts:

National Ocean Pollution Research and Development and Planning Monitoring Act of 1978
Occupational Safety and Health Act of 1970
Port and Tanker Safety Act
Public Health Services Act
Water Bank Act of 1970

North Carolina Legislation with a Major Impact:

Air and Water Resources Act
Boating Safety Act
Coastal Area Management Act
County Service Districts Act
Drinking Water Act
Environmental Compact Act
Environmental Policy Act of 1971
Fisherman's Economic Development Program
Industrial and Pollution Control Facilities Financing Act
Industrial and Pollution Control Facilities Financing Authority Act
Metropolitan Sewage District Act
Metropolitan Water Districts Act
Municipal Service Districts Act of 1973
Regional Sewage Disposal Planning Act of 1971
Regional Water Supply Planning Act of 1971
Soil and Water Conservation Districts Act
Solid Waste Management Act of 1978
Special Assessments Act
Stream Sanitation Act
Water Use Act of 1967
Watershed Improvement Districts Act
Well Construction Act

NUTRIENT FLUX

Federal Legislation with Major Impact:

Clean Water Act of 1977
Coastal Zone Management Act of 1972
Endangered Species Act of 1973
Federal Land Policy and Management Act of 1976
Federal Water Pollution Control Act Amendments of 1972
Forest and Rangeland Renewable Resource Planning Act
Housing and Community Development Act
Land and Water Conservation Fund Act

Marine Protection, Research, and Sanctuaries Act of 1972
Mineral Leasing Act of 1920
National Environmental Policy Act
Resource Conservation and Recovery Act of 1976
Safe Drinking Water Act of 1974
Soil Conservation Act
Solid Waste Disposal Act of 1965
Water Quality Improvement Act of 1970
Watershed Protection and Flood Prevention Act

Federal Legislation with Minor Impact:

Commercial Fisheries Research and Development Act of 1964
Fish Restoration and Management Projects Act of 1950

Federal Legislation with Marginal or Extremely Minor Impacts:

National Ocean Pollution Research and Development and Planning Monitoring Act of 1978
Water Bank Act of 1970

North Carolina Legislation with a Major Impact:

Agricultural Development Act
Air and Water Resources Act
Coastal Area Management Act
County Service Districts Act
Drinking Water Act
Environmental Compact Act
Environmental Policy Act of 1971
Industrial and Pollution Control Facilities Financing Act
Industrial and Pollution Control Facilities Financing Authority Act
Metropolitan Sewage District Act
Metropolitan Water Districts Act
Municipal Service Districts Act of 1973
Regional Sewage Disposal Planning Act of 1971
Regional Water Supply Planning Act of 1971
Soil Additives Act
Soil and Water Conservation Districts Act
Solid Waste Management Act of 1978
Special Assessments Act
Stream Sanitation Act
Water Use Act of 1967
Watershed Improvement Districts Act
Well Construction Act

PROGRAMS THAT AFFECT DEVELOPMENT
AROUND THE ALBEMARLE AND PAMLICO SOUND
December 14, 1986

Federal Legislation with a Major Impact
(in alphabetical order)

Anadromous Fish Conservation Act
Clean Air Act Amendment of 1967
Clean Air Act Amendments of 1970
Clean Air Act Amendments of 1977
Clean Water Act of 1977
Coastal Barrier Resources Act (1982)
Coastal Zone Management Act of 1972
Comprehensive Environmental Response, Compensation and Liability Act of 1980
Consolidated Farm and Rural Development Act of 1965
Department of Transportation Act of 1966 (bridges)
Disaster Relief Act of 1974
Endangered Species Act of 1973
Federal Insecticide, Fungicide, and Rodenticide Act
Federal Environmental Pesticide Control Act of 1972
Federal Land Policy and Management Act of 1976
Federal Water Pollution Control Act Amendments of 1972 (see CWA)
Fish and Wildlife Act of 1956
Fish and Wildlife Conservation Act of 1980
Fish and Wildlife Coordination Act of 1934
Fishery Conservation and Management Act of 1976
Forest and Rangeland Renewable Resource Planning Act
Highway Beautification Act of 1965
Historic Preservation Act of 1966
Housing and Community Development Act
Land and Water Conservation Fund Act
Marine Mammal Protection Act of 1972
Marine Protection, Research, and Sanctuaries Act of 1972
Migratory Bird Conservation Act
Migratory Bird Treaty Act (1918)
Mineral Leasing Act of 1920
National Environmental Policy Act (1969)
National Flood Insurance Act of 1968
National Forest Service Organic Act (1897)
Ports and Waterways Safety Act of 1972
Resource Conservation and Recovery Act of 1976
Rivers and Harbors Act of 1899
Rivers and Harbors Act of 1917
Rivers and Harbors Act of 1968
Rural Development Act of 1972
Safe Drinking Water Act of 1974
Small Business Act
Soil Conservation Act (1935)
Solid Waste Disposal Act
Surface Mining Control and Reclamation Act
Toxic Substances Control Act of 1976

Water Quality Improvement Act of 1970
Water Resources Planning Act of 1965
Watershed Protection and Flood Prevention Act (WPFPA)

Federal Legislation with a Minor Impact
(in alphabetical order)

Airport and Airway Development Act (1970)
Airport and Airway Improvement Act of 1982
Atomic Energy Act of 1954
Commercial Fisheries Research and Development Act of 1964
Energy Reorganization Act of 1974
Energy Supply and Environmental Coordination Act of 1974
Fish Restoration and Management Projects Act of 1950
Wild and Scenic Rivers System

Federal Legislation with Marginal or Extremely Minor Impacts
(in alphabetical order)

Agriculture and Consumer Protection Act
Deep Seabed Hard Mineral Resource Act of 1980
Deepwater Port Act of 1974 (as amended)
Federal Water Power Act of 1920
Federal Power Act (1935)
Food and Agriculture Act of 1962 (RC&D)
Hazardous Materials Transportation Act
Interstate Land Sales Full Disclosure Act of 1969
National Ocean Pollution Research and Development and Planning Monitoring Act of 1978
National Wilderness Act of 1964
Natural Gas Act of 1938
Natural Gas Pipeline Safety Act of 1968
Natural Gas Policy Act of 1978
Noise Control Act of 1972
Occupational Safety and Health Act of 1970
Ocean Thermal Energy Conversion Act of 1980
Ocean Thermal Energy Research, Development, and Demonstration Act
Oil Pollution Act of 1961
Outer Continental Shelf Lands Act (1953)
Port and Tanker Act of 1978
Public Health Services Act
Shipping Act of 1916
Submerged Lands Act (1953)
Urban Mass Transportation Act (1964)
Water Bank Act of 1970

PROGRAMS THAT AFFECT DEVELOPMENT
AROUND THE ALBEMARLE AND PAMLICO SOUND
December 14, 1986

Legislation in North Carolina with a Major Impact
(in alphabetical order)

Agricultural Development Act
Air and Water Resources Act
Boating Safety Act
Coastal Area Management Act of 1974
Conservation and Historic Preservation Agreements Act
County Service Districts Act
Dredge and Fill Act
Drinking Water Act
Emergency Management Act
Environmental Compact Act
Environmental Policy Act of 1971
Fisherman's Economic Development Program
Forest Development Act
Industrial and Pollution Control Facilities Federal Program Financing Act
Industrial and Pollution Control Facilities Financing Act
Metropolitan Sewerage District Act
Metropolitan Water Districts Act
Mining Act of 1971
Mosquito Control Districts
Municipal Service Districts Act
Municipal Subdivision Control Act
Municipal Zoning Act
Natural and Scenic River System Act
Nature and Historic Preserve Dedication Act
Oil Pollution and Hazardous Substances Control Act
Pesticide Law of 1971
Recreation Enabling Act
Regional Sewage Disposal Planning Act of 1971
Regional Water Supply Planning Act of 1971
Sedimentation Pollution Control Act of 1973
Small Watershed Projects Act
Soil Additives Act
Soil and Water Conservation Districts Act
Solid Waste Management Act of 1978
Special Assessments Act
Stream Sanitation Act
Structural Pest Control Act
Toxic Substances Act of 1979
Water Use Act of 1967
Watershed Improvement Districts Act
Watershed Improvement Programs Act
Well Construction Act (1967)
Wildlife Resources Law

North Carolina Legislation with a Minor Impact
(in alphabetical order)

Condominium Act
Outdoor Advertising Control Act
Park Commission Act
Tax Increment Financing Act
Trails System Act
Water Safety Act

North Carolina Legislation with Marginal or Extremely Minor Impacts
(in alphabetical order)

Advertising Control Act
Air and Water Quality Reporting Act
Airport Development Act
Alien Property Act
Annexation Act
Archives and History Act
Atlantic States Marine Fisheries Compact Act
Balanced Growth Policy Act
Bicycle and Bikeway Act of 1974
Building Contract Act
Carrier Act
Cemetery Act
City-County Consolidation Act
Condemnation Act
Connor Act (registration of conveyances)
Corporations Act
Dam Safety Law of 1967
Energy Policy Act
Engineering and Land Surveying Law
Fiscal Information Act for Local Government
Fraudulent Conveyance Act
Gas Conservation Act
Highway Safety Act
Horizontal Property Act
Housing Authorities Law
Housing Corporation Act
Housing Finance Agency Act
Inheritance Tax Act
Land Contracts Registration Act
Land Policy Act
Land Title Registration Act
Local Government Bond Act
Local Government Budget and Fiscal Control Act
Local Government Fiscal Information Act
Local Improvement Act
Mine Safety and Health Act
Mining Compact
Municipal Corporations Act
Municipal Finance Act
Municipal Fiscal Control Act

Occupational Safety and Health Act of North Carolina
Oil and Gas Conservation Act
Public Building Contracts Act
Public Transportation Authorities Act
Public Utilities Act
Public Utilities Commission Act
Public Works Act
Quarries and Mines Act
Real Estate License Law
Real Property Acquisitions Policies Act
Right of Way Act
Rural Electrification Act
Sales and Use Tax Act
Sinking Fund Act
Southeastern Interstate Forest Fire Protection Compact
Southeastern Interstate Low-level Radioactive Waste Management Compact
Southern Growth Policies Agreement Act
Southern State Energy Compact
Supplemental Local Goverment Sales and Use Tax Act
Transportation Authorities Act
Unmarked Human Burial and Human Skeletal Remains Protection Act
Use Tax Act

NORTH CAROLINA LEGISLATION WITH A MINOR IMPACT
(in alphabetical order)

Condominium Act (Sections 47A-1 to 47A-28)
Outdoor Advertising Control Act (Sections 136-126 to 136-140)
Park Commission Act (Section 143-258)
Tax Increment Financing Act (Section 150-101 to 159-111)
Trails System Act (Section 113A-83 to 113A-94)
Water Safety Act (Section 75A-1 to 75A-26)

NORTH CAROLINA LEGISLATION WITH MARGINAL OR EXTREMELY MINOR IMPACTS
(in alphabetical order)

Advertising Control Act (Sections 136-126 to 136-140)

AIR AND WATER QUALITY REPORTING ACT
-- Division of Environmental Management-NRCD -- This statute authorizes the EMC to require all persons receiving a permit from the Division of Environmental Management to file reports covering the discharge of wastes in state waters and to establish and maintain approved systems for monitoring the quality and quantity of such discharges into the water.

Airport Development Act (Sections 63-65 to 63-72)
Alien Property Act (Sections 64-1 to 64-5)
Annexation Act (Sections 160A-24 to 160A-58.10)

ARCHIVES AND HISTORY ACT
++ Regulates the actions of public and private parties in order to ensure that historical and cultural resources are preserved. Section 121-12(a) requires that state agencies consider the effects of any projects funded, operated, or licensed by the agency on any structure, site or district listed in the National Register of Historic Places.

Atlantic States Marine Fisheries Compact Act (Sections 113-252 to 113-258)
Balanced Growth Policy Act (Sections 143-506.6 to 143-506.14)
Bicycle and Bikeway Act of 1974 (Sections 136-71.6 to 136-71.13)
Building Contract Act (Sections 143-128 to 143-135.4)
Carrier Act (Sections 62-259 to 62-281)
Cemetery Act (Sections 65-46 to 65-73)
City-County Consolidation Act (Sections 160B-1 to 160B-15)
Condemnation Act (Sections 40A-1 to 40A-69)
Connor Act (registration of conveyances) (Section 47-18)
Corporations Act (Sections 55-1 to 55-175)

SAFETY LAW OF 1967
++ Requires the Department of Natural Resources and Community Develop-

ment to grant approval of dams and dikes greater than 15 feet in height and where the impoundment capacity is greater than 10 acre-fee. The statute is to provide dam safety and to ensure the maintenance of minimum stream flows of adequate quantity and quality below dams.

Energy Policy Act (Sections 62-2, 113B-1 to 113B-24)
Engineering and Land Surveying Law (Sections 89C-1 to 89C-28)
Fiscal Information Act for Local Government (Secitons 120-30.41 to 120-30.48)
Fraudulent Conveyance Act (Sections 39.15 to 39.22)
Gas Conservation Act (Sections 113-381 to 113-415)
Highway Safety Act (Sections 20-183.1 to 20-183.8)
Horizontal Property Act (Sections 47A-1 to 47A-28)
Housing Authorities Law (Sections 157-1 to 157-39.8)
Housing Corporation Act (Sections 122A-1 to 122A-23)
Housing Finance Agency Act (Sections 122A-1 to 122A-23)
Inheritance Tax Act --
Land Contracts Registration Act
Land Policy Act
Land Title Registration Act
Local Government Bond Act
Local Government Budget and Fiscal Control Act
Local Government Fiscal Information Act
Local Improvement Act
Mine Safety and Health Act
Mining Compact
Municipal Corporations Act
Municipal Finance Act
Municipal Fiscal Control Act
Occupational Safety and Health Act of North Carolina

OIL AND GAS CONSERVATION ACT
++ This Act authorizes the Dept. of NRCD to regulate oil and gas exploration and production in North Carolina, including submerged lands.

Public Building Contracts Act
Public Transportation Authorities Act
Public Utilities Act
Public Utilities Commission Act
Public Works Act
Quarries and Mines Act
Real Estate License Law
Real Property Acquisitions Policies Act
Right of Way Act
Rural Electrification Act
Sales and Use Tax Act
Sinking Fund Act
Southeastern Interstate Forest Fire Protection Compact
Southeastern Interstate Low-level Radioactive Waste Management Compact
Urban Growth Policies Agreement Act

)uthern State Energy Compact
pplemental Local Goverment Sales and Use Tax Act
-ansportation Authorities Act
Unmarked Human Burial and Human Skeletal Remains Protection Act
Use Tax Act

LOCAL TOOLS AND TECHNIQUES AVAILABLE FOR MANAGING DEVELOPMENT AROUND THE ALBEMARLE AND PAMLICO SOUND

Land Acquisition
- Acquisition of Easements
- Advance Site Acquisition
- Tranfer of Development Rights
- Compensable Regulation
- Inverse Condemnation

Public Spending
- Capital Improvement Program
- Annexation
- Development Timing

Taxation
- Special Assessment
- Preferential Assessment

Development Regulations
- Legal Challenges to the Validity of Development Regulations
  - Constitutional Challenges
  - Ultra Vires Challenges
  - Procedural Challenges

Regulatory Growth Management Tools
- Interim or Temporary Development Regulations
- Conventional Zoning
- Minimum Lot Size Zoning
- Exclusive Agricultural or Nonresidential zoning
- Height Restrictions
- Aesthetics and Land Use Regulation
- Conditional and Contract Zoning
- Special Exception
- Bonus and Incentive Zoning
- Floating Zones
- Performance Zoning
- Planned Unit Development and Cluster or Average Density Zoning
- Subdivision Regulations
- Subdivision Regulations Relating to Off-Site Facilities
- Population Caps
- Official Mapping
- Maximum Lot Size
- Building Inspection
- Annual Permit Limits
- Regulation of Mobile Homes
- Local Environmental Impact Ordinances

** For more information on these local tools and techniques, see the attached appendix, "Development of Growth Management Systems for North Carolina".

CHAPTER VI

RESEARCH AND INFORMATION NEEDS

The characterization of conflicts between societal uses of the estuarine system (Chapter IV) and the examination of existing management systems (Chapter V) provided the focus/catalyst for the definition of research and information needs for this project. State and federal resource managers identified the specific management-related information which would allow maximum resolution of existing and potential conflicts and enable effective management of the valuable estuarine resources to occur through the long term. A list of participants is included as Appendix VI-1. A prioritized, edited listing of these management-actionable topics was presented to ten groups of expert researchers for evaluation of status and technical and fiscal feasibility, and translation into researchable, actionable statements. The ten groups included:

a. Fisheries Habitat
b. Shellfish Habitat
c. Fisheries Stock Assessment
d. Land/Water Interface
e. Significant Natural Areas, Wetlands and Endangered Species
f. Eutrophication
g. Physical Processes
h. Aquatic Vegetative Habitats
i. Toxicants, Bacterial Contamination and Fish Diseases
j. Human Environment

A list of participants is included in Appendix VI-2. The evaluations and translations received, framed within the context of management of conflicts between societal uses and limited to direct actionability, form the basis for this chapter.

The topics presented below have been reorganized and combined for efficient presentation. Each section incorporates three main processes: characterization, evaluation and management. Characterization includes scoping studies, information gathering processes, and examination of trends to identify areas of fruitful concentration. Evaluation includes scientific research and other assessments required to understand processes mediating environmental interactions adequately to allow effective management. Management includes informational studies and feasibility evaluations of potential management alternatives for specific problems, processes and interactions, as well as attitudinal studies of the affected or regulated populations. In all cases, the direct management utility for each area is given. Where specific projects were recommended, they are listed with appropriate costs (Appendix VI-3).

All projects are assumed to result in digitization of information developed in the geographic information system designated for the program. These projects do not represent an exhaustive list of projects which should be funded by the program, but are instead examples of technically feasible research projects with direct management relevance suggested both by resource managers and researchers.

I. RESOURCE CRITICAL AREAS: IDENTIFICATON AND MANAGEMENT

TOPIC AREA: FISHERIES HABITAT (SEE ALSO "AQUATIC VEGETATIVE HABITAT")

General Justification

The Albemarle-Pamlico system is unique in the degree of dependence of its fisheries resources on specific estuarine habitats, many of which are impaired or threatened by human activities. Productivity of those fisheries resources is therefore strongly dependent on accurate characterization and efficient management of those habitats. Mitigation of losses caused by nursery ground deterioration presents an effective potential mechanism to lessen the conflict between land-use conversion activities and fishing activities.

Characterization

1. Compile and analyze all existing data on Primary Nursery Areas, Secondary Nursery Areas, Inland Nursery Areas, and Anadromous Spawning and Nursery Areas to determine adequacy of designations, to establish baselines and to identify impaired or impacted areas.

   Management Utility: Consolidation of information on this important issue will allow more efficient management both across-the-board and on a case-by-case basis. Documentation of nursery importance will strengthen the case for protection. Identification of impaired areas will allow pilot mitigation or restoration projects. Correlative secondary studies based on this information will help identify or evaluate causal relationships to human activities (see #1 in Evaluation, below).

Evaluation

1. Conduct correlative studies to relate accumulated nursery information to environmental factors and to human-use-related factors (e.g. land-use conversions, drainage).

   Management Utility: Comprehensive scoping work on existing data should be used to frame hypotheses about causal connections between nursery productivity and anthropic change. Knowledge of these processes is essential to effective management and successful mitigation.

2. Design and conduct experimental studies based on #1 above to identify ecological factors necessary for major nursery habitats to function, and to assess the relative importance of those factors.

   Management Utility: Experimental explication will probably be required to separate "noise" from "signal," to predict the sensitivity of a nursery system to changes related to either development or mitigation.

3. Determine the relative contributions of major habitat types (including submerged vegetation, nursery habitats and other river and sound habitats) to overall juvenile populations for major species.

   Management Utility: Management and mitigation efforts can be concentrated on those species or habitats most receptive to change or most deserving of attention.

4. Use existing information on striped bass reproductive patterns to design and conduct experimental evaluations of the loss in reproductive success in the Roanoke River.

   Management Utility: Although extensive work has been conducted and proposed on this serious situation, diverse hypotheses still exist on the causes for the decline (toxicity, thermal changes, food chain disruption, etc.). Consolidation of existing information should allow framing of testable hypotheses. The design of mitigation efforts is premature until causal relationships are understood.

Management

1. Document all obstructions to anadromous fish migration and evaluate the potential for mitigation.

   Management Utility: Obstructions to migration probably have a very serious impact on anadromous fish such as herring and shad which have shown marked declines in the past decade, especially in tributaries to Albemarle Sound. Identification and evaluation of such obstacles must precede an active mitigation program, if runs of those fish are to be returned to former status.

2. Evaluate the potential for mitigation or restoration of impaired Primary Nursery Areas, including design of a pilot project for such an area. This design should include features intended to document the importance of the factors identified in "Evaluation" #1 and #2 above.

   Management Utility: Various structural strategies have been proposed to mitigate human impacts on critical nursery habitats. Once adequate information is available, the costs and likely effectiveness of such efforts needs to be ascertained.

3. Evaluate regulatory options, in light of information gathered above, to protect critical nursery habitats. Both technical and economic feasibility should be considered.

   Management Utility: Previous efforts at regulation for Primary Nursery Areas have broken down in the absence of adequate technical information. Once the suggested studies are completed, adequate information should be available to allow the design of an efficient, effective management program.

TOPIC AREA: AQUATIC VEGETATIVE HABITAT

General Justification

Aquatic vegetative habitats (both submerged and emergent) perform a wide variety of important ecosystem functions, including fisheries nursery capacity, current baffling and sediment consolidation, primary production and refuge predators for prey species. The relative value of each type of vegetation is poorly known. In addition, some of these organisms are very sensitive to environmental perturbations, and have shown dramatic changes in the study area in the last ten years.

Characterization

1. Document the current distribution and composition of emergent and submergent wetland habitat types, in the format of the National Wetlands Inventory.

   Management Utility: Precise knowledge of locations of sensitive vegetative habitats would be invaluable in existing regulatory programs in the evaluation of proposed development projects and mitigation efforts. Furthermore, this effort would provide a baseline for trend analysis intended to identify threatened habitat types and to enable management program design.

2. Document historic trends in location, abundance and composition of submerged aquatic vegetation (SAV) beds.

   Management Utility: Characterization of trends allows the identification of high-priority areas and species for management efforts, so that evaluative studies and management assessments are applied most efficiently. Restoration pilot studies should be conducted in historic beds, once technical and economic feasibility are established.

Evaluation

1. Examine the current suitability of the Pamlico River for SAV growth, and evaluate the potential for reestablishment of historic SAV beds in that region.

   Management Utility: The dramatic recent declines in SAV in the Pamlico River have probably had serious implications for fish and waterfowl populations in that area. Preliminary work suggests that restoration should be possible, but experimental work is required before full-scale restoration should proceed.

2. Evaluate the effects of turbidity variation due to different sources on SAV in Pamlico Sound and Currituck Sound (this is best done in conjunction with #1 above).

   Management Utility: Modification of turbidity due to algal growth and erosion (i.e. biological and geological) has been

shown to significantly affect SAV in Chesapeake Bay. Long-time Pamlico residents describe changes in turbidity as one major difference in the river, and major increases in total sediment load in the river have been documented (Phillips, 1986). Effects of chronic changes in suspended sediment are poorly known. Successful reintroduction of SAV will depend on the suitability of environmental conditions (e.g. turbidity) at the sites selected.

3. Assess the available data base on fringe wooded swamps, evaluate their functional role and interpret the extent and ramifications of impacts to these systems.

   Management Utility: Programs exist to regulate development in wooded swamps, but the functional role of those areas, their significance as aquatic nursery habitats and the impacts of piecemeal development are poorly known. Rational management decisions relevant to wooded swamps can only be made based on an understanding of functional relationships.

4. Characterize the ecosystem function of Juncus roemerianus marshes, especially as nursery habitats.

   Management Utility: Irregularly flooded marshes covered with black needlerush cover extensive areas in portions of the study area, but the significance of those habitats and the consequences of their modification are uncertain. Permit decisions should be based on reasonable prediction of such consequences.

Management

1. Design a pilot reintroduction program for SAV in the Pamlico River based on information developed above.

   Management Utility: Once causal relationships have been evaluated, the expected benefits of such a program can be predicted, and its design optimized.

2. Develop a protocol for monitoring critical areas (Pamlico River, Currituck Sound, Core Sound) for SAV on a 5-10 year return period.

   Management Utility: The disappearance in the Pamlico River was evaluated after the fact. Early detection of similar problems would greatly increase the likelihood that causal relationships could be established and that effective management strategies could be developed.

TOPIC AREA: SIGNIFICANT NATURAL AREAS, WETLANDS AND ENDANGERED SPECIES HABITATS

General Justification

A major effect of land-use conversion and associated nonpoint impacts on streams in the Albemarle-Pamlico region is the loss of wetland habitats crucial to the survival of both aquatic and terrestrial organisms. Information on the extent of these losses is sparse, yet can be obtained generally at relatively low costs. The identification component of such a process can be linked to other proposed projects to yield enormous amounts of critical information at a relatively low cost. Afterwards, rational management strategies can be derived for these important areas preserving their tight linkages to the aquatic systems in the Sounds.

Characterization

1. Complete the identification and characterization of natural areas of high significance in the region.

   Management Utility: Land-use conversion in the past has occurred largely in ignorance of what was being altered or of consequences for the estuaries. General scoping studies were conducted under the CEIP program for some areas, but many critical areas are largely unknown. The high correlation between remaining natural areas and wetland areas suggests that natural areas and wetland areas could be mapped at the same time, with relatively low additional costs.

2. Complete the National Wetlands Inventory in the Project Area.

   Management Utility: Many regulations, both federal and state, apply to the development of wetland areas. Wetlands in the Albemarle-Pamlico region are usually tightly connected to adjacent estuarine waters through hydrologic relationships and nutrient cycling. Knowledge of existing wetland areas can help avoid conflicts between land-conversion and fisheries interests, and be beneficial in site-selection activities, evaluation of proposed projects, evaluation of pre-project conditions in violations cases and even estimation of timber volumes. All watershed planning activities would be greatly facilitated by the availability of accurate wetlands mapping. Many of the other projects proposed here could be completed in conjunction with the National Wetlands Inventory process.

3. Identify endangered species habitats within the study area.

   Management Utility: Specific federal regulations pertain to endangered species and critical habitats for endangered species. In the Albemarle-Pamlico region, most of these occur in the same wetland areas described above. Preliminary habitat scoping could be done in direct conjunction with the National Wetlands Inventory.

4. Identify altered wetlands in the Albemarle-Pamlico region, especially those in close proximity to estuarine waters, and evaluate the potential for restoration or mitigation.

Management Utility: The potential is great for restoration of some impacted wetland areas to decrease negative effects on nursery areas. An evaluation of alternative strategies, likely success and probable costs should precede any restoration efforts. The potential for water management plans, or even rerouting of drainage away from nursery areas, may be even greater.

Management

1. After initial characterizational work is complete, survey highest priority natural areas in detail and construct management plans.

   Management Utility: Where preservation is intended, simple isolation may be neither possible, desirable or effective. Individual site characteristics must be considered.

2. After initial survey work, prepare detailed management plans for particular species of special concern.

   Management Utility: Management plans are essential if this endeavor is to succeed, especially where large areas are involved.

3. Evaluate alternative strategies for wetland protection in the Albemarle-Pamlico region.

   Management Utility: Although many regulations exist which affect conversion of wetland areas, no comprehensive state management strategy has been adopted. If water-related resources are to be managed effectively, a comprehensive, rational wetlands management package must be formulated.

II. WATER QUALITY AND ESTUARINE RELATIONSHIPS

TOPIC AREA: NONPOINT SOURCE POLLUTION: LAND-USE CONVERSION AND ITS EFFECTS ON ESTUARINE WATERS

General Justification

Much of the Albemarle-Pamlico region is rural, and land-use conversion represents the source of most contaminants of estuarine waters (sediment, nutrients, trace contaminants). In addition, the low profile of most of the lands east of the Suffolk Scarp requires that extensive drainage networks be installed before effective farming or silviculture can be accomplished. These activities represent a constantly changing mosaic of interactions between land and water which strongly influence instream productivity. Relatively little is known of these processes in some areas, and much of what is known is out of date.

Characterization

1. Construct a detailed, up-to-date land-use map for counties immediately adjacent to estuarine areas, including all drainage networks and water-control structures, and indicating concentrations of high-pollutant-yield land uses.

   Management Utility: No accurate assessments of the contribution of nonpoint sources to instream problems can occur without up-to-date information on land-use. Similarly, planning for water management, land-use modification or impact mitigation depends on accurate drainage network assessment.

2. Complete soil surveys in the region (specifically Hyde County).

   Management Utility: Estimation of pollutant yields for a given use depends strongly on soil characteristics. Digitization of soil surveys makes a wide variety of management evaluations possible, from siting studies for septic systems, to evaluation of sites for specific development purposes, to identification of areas where existing population densities exceed the assimilative capacity of the soils. Furthermore, soil surveys provide a wealth of practical information which could be provided to the public through a cooperative federal/state/local venture.

3. Establish historical trends in land use and drainage, updated from existing information.

   Management Utility: Assessment of the time course of land-conversion activities should allow examination of long-term and short-term effects in receiving streams, and probably enable correlative studies to be done on nursery area effects.

Evaluation

1. Consolidate all available information on the effects of land-use conversion on estuarine water quality and ecology, to identify information gaps and frame hypotheses about causal relationships between human activities and instream effects.

   Management Utility: All management decisions related to land use are predicated upon the understanding of the effects of those activities on the estuarines. Although much work has been done, large amounts of it are not generally available, and no synthesis has been attempted. This initial scoping work must precede any specific management evaluations, and should include correlative studies to relate existing land use and drainage to estuarine nursery function.

2. Construct a large-watershed-level model for hydrology and water quality in tidewater areas, to include evaluation of land-use changes and drainage system changes on salinity patterns, sediment loading and nutrient loading.

Management Utility: All predictions of land-use conversion must depend on reasonable understanding of processes mediating the effects. Models seem the most expeditious vehicle for this endeavor, and would be essential in the following tasks.

3. Develop cumulative impacts methodology in assessing land-conversion effects and drainage effects.

   Management Utility: The major impediment to limiting nonpoint effects in sensitive drainages has been the inability of regulatory agencies to relate piecemeal changes to instream effects. Modeling probably could do this if a waste-load-allocation style approach were used, assuming maximum tolerable loads of constituents could be determined.

4. Develop user-oriented versions of all such models.

   Management Utility: A major problem in the past has been the inability of regulatory personnel to obtain predictive models which they could use which were capable of answering the questions they needed answered. Agency personnel should work directly with academicians to develop user-friendly models adapted to answer questions posed by existing regulatory requirements.

5. Evaluate the risk of development on different mineral and organic soils in terms of pollutant loadings.

   Management Utility: Preliminary studies suggest that fluxes of contaminants from different kinds of soils in different hydrologic contexts (e.g. pocosin peats versus floodplain peats versus marsh mucks) are very different. Soil maps and land-use maps could be used to identify areas with greatest development risk and least development cost.

6. Evaluate the effects of channelization on water flow rates, constituent concentrations and fisheries utilization of streams in the coastal zone.

   Management Utility: Channelization has occurred in large numbers of coastal streams, with unknown effects on physical, chemical and biological characteristics of those waters. Any management plan for the region should include a basic understanding of the effects of channelization.

Management

1. Evaluate the performance of various Best Management Practices (BMPs) in coastal situations, using a mixture of field and modeling techniques.

   Management Utility: Application of BMPs is currently well-intended, but probably results in excessive expenditures in some areas and inadequate expenditures in others.

2. Recommend BMP packages for different coastal soils, hydrologic situations and land-uses, based on the above studies.

   Management Utility: Optimal application of practical management techniques for a given situation benefits everyone involved. Specific practices should be tailored to the unique situations found in the study area.

3. Design optimal water management strategies for various coastal situations, and evaluate the potential for mitigation of existing water management problems.

   Management Utility: Water management is increasingly recognized as a vital component of the coexistence of agriculture and silviculture and fisheries interests. Optimization would serve all these interests.

TOPIC AREA: POINT SOURCE POLLUTION I: EUTROPHICATION AND DISSOLVED OXYGEN

General Justification

Nutrients and other contaminants derived from point and nonpoint sources have significant effects on water quality in the Albemarle-Pamlico region. Serious algal bloom conditions have occurred and continue to occur when conditions are right in several main tributaries of Albemarle and Pamlico Sounds. These blooms not only are unsightly and have negative impacts on the aesthetics of the region, but also have serious ramifications for estuarine organisms. Clear understanding of the processes at work and the development of a predictive tool are necessary for effective management to be possible.

Characterization

1. Assemble pertinent water quality data and explore them statistically to identify important relationships and historical trends.

   Management Utility: Existing data is sparse and fragmented, and has never been examined in a comprehensive fashion to document instream effects of anthropic activities. Scoping studies are required to frame hypotheses about causal relationships, to identify problem areas and information gaps, and to provide first approximation information to resource managers for ongoing regulatory programs.

2. Assemble comprehensive N/P budgets for the Albemarle-Pamlico Sound Complex.

   Management Utility: Effective management of cultural eutrophication depends on accurate assessment of the relative contributions of source activities. Estimation of expected

efficacy of a particular management strategy requires not only cost estimates but also realistic benefit projections.

Evaluations

1. Establish historical trends in cultural nutrient enrichment using sedimentation/coring techniques, including assessment of "background" levels of nutrients.

   Management Utility: Assessing the impacts of anthropic nutrient augmentation requires estimation of pre-impact conditions for which data are not readily available. In certain circumstances (e.g. constant deposition), certain bloom organisms may even leave remains that could testify to the presence or absence of blooms in the past.

2. Develop a user-oriented model capable of evaluating the effectiveness of nutrient control strategies, and validate for one watershed. The model must allow evaluation of:

   a. upstream versus coastal inputs,

   b. relative importance of N and P as limiting nutrients,

   c. physical limitations to primary productivity, including flow and salinity, and

   d. differential bioavailability of nutrients from different sources.

   Management Utility: Existing models are grossly inadequate for non-conservative substances like nutrients. Wasteload allocations are based on such models. The uncertainity involved in permitting is especially severe in saline portions of estuarine tributaries. Development of a model tailored to the needs of permit-decision-makers would allow much more rational decisions.

3. Delineate conditions under which blooms of noxious algae are expected to occur.

   Management Utility: Prediction of algal blooms from readily available information would allow variable discharge permitting, so that restrictions are tightest when they need to be. If the process of bloom formation were understood, a wide variety of possible mitigational measures could be evaluated (e.g. flow regulation, discharge restrictions, land-use zoning, BMPs).

4. Evaluate the significance of sediment/water column interactions in wooded swamps for nutrient-related water quality concerns.

   Management Utility: Assimilation of nutrients serves to reduce instream concentration, but under certain conditions recycling from the sediments can dominate nutrient dynamics, a process

poorly understood. Wooded swamps not only fringe much of the study area, but are also being proposed as treatment systems for effluents rich in nutrients. Rational decisions on the suitability of such areas depend on knowledge of recycling interactions which is currently sparse.

5. Relate human-activity-driven eutrophication to deoxygenation events in bottom waters and tributaries.

   Management Utility: Active management of point-source discharges is limited by the ability of the regulatory agencies to relate anoxia to causal processes. Until that relationship is demonstrated, little effective management of dissolved-oxygen-related fish kills can be expected.

Management

1. Once nutrient dynamics are better known, evaluate the cost and relative effectiveness of various point and nonpoint source control strategies.

   Management Utility: Accurate prediction of the effectiveness of various strategies depends on knowledge of instream processes.

TOPIC AREA: POINT-SOURCE POLLUTION II: TOXICANTS AND BACTERIAL CONTAMINATION

General Justification

Although the absolute levels of contamination of estuarine waters in the Albemarle-Pamlico region with toxicants are not nearly as high as many more industrialized estuaries, significant toxicants issues remain. As new and increased industrial discharges are permitted, new standards are necessary in saline reaches of streams not required before. Identification of particular potential trouble spots before they become critical will allow more careful management.

Evaluation

1. Evaluate the estuarine toxicity of particular compounds (F, Ti).

   Management Utility: Specific discharges of these compounds exist or are proposed. No water quality standards for these substances exist, and research is necessary to support such standards.

2. Develop effluent bioassays for saltwater.

   Management Utility: As additional discharge permits are requested, the need for a protocol for saltwater bioassays becomes more severe.

3. Conduct sampling of biota to establish baselines for toxic contaminants.

Management Utility: Little is known about the distribution of toxic constituents in organisms or sediments in the study area. Complex cycling of many elements may result in unrecognized problems without scoping studies such as these.

4. Evaluate the chronic effects of suspended sediment in estuarine areas.

   Management Utility: Changes in sediment load due to human activities have been dramatic in many tributary basins, yet the effects are poorly understood for estuarine systems. Many proposed projects result in increased sediment concentrations, yet no sensible control or mitigation efforts can be defended without reasonable knowledge of expected effects.

5. Conduct a scoping study of the relationships between human activities and contamination of shellfish by toxicants.

   Management Utility: Although reasonable efforts have been directed at bacterial contamination, relatively little work exists on toxicant contamination of shellfish in the Albemarle-Pamlico region. Researchers have suggested that bacteria may not be the only reason for limiting shellfish harvest in closed areas.

Management

1. Evaluate management alternatives to current fecal contamination procedures.

   Management Utility: A crucial concern is how well coliform bacteria indicate the presence of disease-causing organisms in estuarine areas. Alternative viral and bacterial indicators have been proposed, but the risks, costs and benefits are not well known. The presence of high levels of coliform organisms in drainage from disturbed natural areas is especially problematic --does a real risk exist from this source? A formal risk assessment of viruses and pathogens in shellfish and in primary recreation areas would be very useful in interpreting the significance of the human activities for shellfish and contact recreation.

TOPIC AREA: PHYSICAL PROCESSES

General Justification

Many of the processes addressed in this study are related to the dispersal or distribution of anthropogenic contaminants. Local or small-scale phenomena are difficult to understand, and even more difficult to predict without a general knowledge of how basic physical processes affect flow patterns in this complex, estuarine system. All of the models suggested above depend on linkage to more general models to be fully effective.

Evaluation

1. Demonstrate the need for and the management relevance of estuarine hydrodynamic and water-quality models. Educate managers on the utility and applicablity of these tools.

   Management Utility: The breadth of possible management utilization of models is great, but would be greatly reduced if clear management goals were not targeted before model development. Therefore, a general scoping study of model applicabiilty and availability should be conducted at the outset.

2. Once modeling needs and utility are documented, implement the most cost-effective, management-actionable program available.

   Management Utility: Once specific management issues and target areas are identified, effective modeling efforts can be designed. All models developed must be user-oriented, such that resource managers can answer specific questions as needed.

3. Evaluate available information on sediment dynamics in the Albemarle-Pamlico system to identify management-related information needs and recommend evaluative research.

   Management Utility: Significant historical changes have been observed in sediment loading into these streams, with potentially serious consequences for organisms. This is particularly true since sediment dynamics are strongly linked to water quality.

III. FISHERIES DYNAMICS: STOCK ASSESSMENT AND DISEASES

TOPIC AREA: FISHERIES STOCKS

General Justification

Crucial concerns in the Albemarle-Pamlico project include the status of fish and shellfish stocks, and the causes of apparent declines in landings for many species. This section addresses current status and documentation of historical fisheries trends.

Characterization

1. Identify and evaluate data elements both necessary and sufficient to assess status of important fisheries stocks and to identify stock declines due to fisheries practices, water quality or natural causes.

   Management Utility: Existing information on fisheries is linked to landings, which are dependent on many interrelated variables. Assessment of actual population levels (and effects of particular human activities) requires much more intensive information. Scoping work on information requirements is,

therefore, essential to evaluate the success of management activities.

2. Identify and characterize existing shellfish beds.

   Management Utility: Currently, use attainability studies must be done "from scratch" whenever classification changes are requested. Knowledge of existing shellfish beds is fragmentary.

Evaluation

1. Identify and evaluate the factors responsible for dramatic variation in blue crab year classes.

   Management Utility: Recently, blue crab landings have become highly variable. Understanding this process is required before possible management strategies can be evaluated.

2. Evaluate the effects of fishing practices on water quality and fish stocks.

   Management Utility: As intensity of fishing effort increases and stocks decrease, the effects of fishing on stocks and on water quality are likely to become more and more significant. Very little information on this subject exists from the study area. Identification of specific effects would allow effective management action.

3. Evaluate the relative importance of water quality in nursery areas and circulative transport of larvae in limiting fish stocks.

   Mangement Utility: The degree of effort and funding which should be allocated towards nursery growth restoration should depend on a clear definition of their importance in the maintenance of fish stocks.

4. Evaluate the conditions required for establishment of viable shellfish beds and evaluate the potential for reestablishment in historic areas.

   Management Utility: Large areas of historic beds are now barren. Reestablishment programs should await demonstration of probable bed survival under existing conditions.

Management

1. Evaluate the costs and benefits of requiring excluder devices to reduce bycatch on Sound shrimp boats.

   Management Utility: Technology exists to reduce bycatch of scrap fish, but the reduction in catch efficiency of targeted species has not been evaluated fully. These devices may be required in some portions of the study area (e.g. where sea

turtles are present). Regulations should be designed with the effects on the fishermen in mind.

TOPIC AREA: FISH DISEASES

General Justification

One of the most obvious environmental problems in the Pamlico region is the recent outbreak of ulcerative sore disease on a variety of commercially important fish species. To date, only preliminary epidemiological and pathological work has been completed.

Characterization

1. Consolidate existing information on incidences of ulcerative sore diseases in Albemarle-Pamlico populations and design a sampling program to evaluate human-impacted and less-impacted areas.

   Management Utility: Extensive management programs should be dependent upon a demonstration that the outbreaks described are anthropogenic and not simply cyclical. Scoping work to define the extent and nature of the problem should be used to generate initial hypotheses for experimental work.

2. Characterize other important disease problems affecting estuarine fishes in the Albemarle-Pamlico region.

   Management Utility: Other fish diseases have historically assumed local or short-term significance. If general water quality deterioration continues, then higher incidences would be expected. A baseline survey would allow recognition of an incipient problem before outbreak status is attained.

Evaluation

1. Evaluate the relationship between environmental factors and infectability for a target species (menhaden).

   Management Utility: Any program designed to reduce incidence of outbreaks must address the processes involved. If causal relationships cannot be demonstrated, effective management cannot occur.

2. Relate fungal presence to pathogenicity in effected species.

   Management Utility: Clear definition of the target problem is essential to effective management.

3. Once scoping work is accomplished, conduct water quality analyses to determine the role of various environmental contaminants in the diseases.

Management Utility: Water quality survey work is very costly and should await clearer definition of causal relationships. Initial work suggests that stress due to water quality degradation is a major contributing factor, and management will probably ultimately depend on water quality improvements.

IV. THE HUMAN ENVIRONMENT

TOPIC AREA: SOCIO-CULTURAL STUDIES

General Justification

Essential to effective management of the Albemarle-Pamlico region is a general framework of understanding of social, economic, and institutional systems. Resource managers are faced with a range of options for managing the area to achieve a desired outcome. The analytic tools of the social sciences are required to suggest and evaluate potential management strategies before implementation so that the most promising strategy is chosen.

Of equal importance is monitoring and re-evaluation of a management strategy once it has been implemented. Conditions in existence when the management strategy was chosen may change, or the policy may have unforseen effects, with the result that the policy fails to achieve its stated objective.

A fairly comprehensive base of certain types of data, such as permanent resident population information, is available but may need to be made accessible in a more useful manner. Other data, such as seasonal population information, is not currently available and needs to be collected.

Characterization

1. Compile baseline data on demographic trends, including population size, composition, geographic distribution and the relative contribution of permanent and seasonal components.

   Management Utility: Planning for the future depends strongly on expectations for population parameters and clear knowledge of existing patterns. The shift from less dense resident populations towards denser seasonal populations is significant environmentally and socially.

2. Evaluate the peoples' knowledge and attitudes about natural resources and regulation designed to protect those resources.

   Management Utility: Popular receptivity is vital to the long-term success of this project. All proposed regulation changes must be framed in the context of the regulated population to be effective.

TOPIC AREA: ECONOMIC STUDIES

General Justification

Economic analysis is frequently overlooked as an aid to management of a resource such as the Albemarle-Pamlico estuarine system. Economics can provide vital information not obtained through other types of analysis, including estimates of the market and non-market values provided by the estuarine system.

The tools of economic analysis can also be used to study the incentives facing users of the estuary and adjacent lands for engaging in various alternative activities. Incentives are provided by markets for goods and services, and by government policies such as subsidies, taxes, or regulations.

Evaluation

1. Estimate economic incentives to landowners adjacent to the estuaries for competing land-use alternatives:

   a. agriculture, forestry and peat mining,
   b. resort development and preservation.

   Management Utility: Understanding economic incentives will enable management strategies to shift land-use conversion patterns toward desired ends.

2. Estimate economic incentives created by specific government policies designed to influence land-use (e.g. swapbuster).

   Management Utility: Comparison of stated goals with actual economic incentives will give much needed information on the true effects of regulation and document the level of effectiveness of a regulation in meeting its stated goal.

3. Estimate the value of a "non-market" good or sevice (such as hunting, recreational fishing, or aesthetic values) for a specified geographic area.

   Management Utility: Studies of this kind are rarely undertaken, but are vital to understand economics of land-use patterns, and should allow more precise evaluation of costs and benefits for particular kinds of regulation.

4. Conduct a case study (real or fictional) of a recent development to evaluate the private and public benefits and costs of the proposed development.

   Management Utility: Normally, balanced evaluations of the economic effects of development are elusive: increases in tax base are obvious, while costs may be less so. A study of this kind would allow better informed decisions by local governments addressing zoning issues and other land-use limitations.

TOPIC AREA: INSTITUTIONAL STUDIES

General Justification

In order to effectively manage the Albemarle-Pamlico system, it will be necessary to understand all of the important systems (natural, social, economic, political, etc.) and how they function in the larger system of which they are a part. For example, one cannot hope to manage the natural resources of the region without understanding the politics of the area.

Characterization

1. Characterize political and governmental systems and relationships within the study area.

   Management Utility: Effective management of natural resources in the region is strongly dependent on voluntary cooperation of local governments.

2. Evaluate the role of science in policy determinations, and design tools to allow effective integration where appropriate.

   Management Utility: Studies such as the APES usually result in highly technical determinations of relatively low utility to managers, because basic issues and assumptions differ between these groups. A mechanism to facilitate communication and coordination between such disparate disciplines is essential in this effort.

3. Characterize existing management systems in terms of efficiency in attaining stated goals, including geographic framework, policy substance, enforcement capabilities and flexibility to societal change.

   Management Utility: Identification of areas where stated management goals are not being met will allow targeting of funds to provide information or technical support for those programs.

4. Characterize and evaluate alternative management frameworks for problem areas identified in #3 above.

   Management Utility: Studies of costs and benefits of available alternatives for programs which need refinement should allow better management, while maintaining the basic structure of the existing programs.

TOPIC AREA: INTERDISCIPLINARY CASE STUDY

An interdisciplinary study (biological, economic, social, and institutional) of an estuarine area should be conducted to determine its value in terms of its various uses and products. Procedures should include collection and analysis of information concerning trends in: (1) demography, (2) land use, (3) water quality, (4) infrastructure, (5) institutional structure, (6) regulatory regime and implementation status, (7) fish and wildlife production, and (8)

economic activity. Results should be used to analyze the value of the selected estuary relative to types and degrees of potential development.

A pilot project should be done initially, to develop the conceptual framework for the comprehensive study. The pilot project would also determine the feasibility of studying various specific sites.

APPENDIX VI-1: MANAGEMENT OF RESOURCES IN THE ALBEMARLE-PAMLICO REGION
LIST OF PARTICIPANTS, NOVEMBER 17 AND DECEMBER 16, 1986

	Agency	Name	Title	Phone	Location
State					
	NRCD	Lynn Muchmore	Assistant Secretary for Natural Resources	733-4984	Raleigh
		Doug Rader	Project Coordinator, APES	733-5083	Raleigh
	Environmental Management	R.Paul Wiles	Director	733-7015	Raleigh
		Jim Mulligan	Regional Supervisor, Washington NRCD Office	946-6481	Washington
	Coastal Management	Dave Owens	Director	733-2293	Raleigh
		John Crew	Chief, Planning and Resource Evaluation	946-6481	Washington
	Marine Fisheries	Bill Hogarth	Director	726-7021	Morehead City
		Terry Sholar	District Manager, Central	946-6481	Washington
		Harrel Johnson	District Manager, Northern	338-0225	Elizabeth City
	Land Resources	Steve Conrad	Director	733-3833	Raleigh
		Charles Gardner	Chief, Land Quality Section	733-4574	Raleigh
	Soil and Water Conservation	Bill Austin	Director	733-2302	Raleigh
		Carroll Pierce	Chief, Watershed Protection Section	733-2302	Raleigh
	Forest Resources	Harry Lawson	Director	733-2162	Raleigh
		Fred White	Chief, Technical Development and Planning	733-2162	Raleigh
	Water Resources	John Morris	Director	733-4064	Raleigh
		John Sutherland	Chief, Water Resources Planning Section	733-4064	Raleigh
	Planning and Assessment	Bill Flournoy	Chief, Environmental Assessment Section	733-6378	Raleigh
		Katherine Foote	Chief, Economic Assessment Section	733-6378	Raleigh
	Wildlife Resources	Debbie Paul	Chief, Nongame Wildlife Section	733-3391	Raleigh
		Dick Hamilton	Assistant Director	733-3391	Raleigh
	Parks and Recreation	Chuck Roe	Coordinator, Natural Heritage Program	733-7087	Raleigh
		Julie Moore	Protection Specialist, N.H.P.	733-7087	Raleigh
Federal					
	Fish and Wildlife Serv.	Mike Gantt	Field Supervisor, Div. of Ecol. Services	856-4520	Raleigh
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		Kate Bennett	Contaminants Specialist	856-4520	Raleigh
	Nat. Marine Fisheries Ser.	Bud Cross	Director	728-8734	Beaufort
		Randy Cheek	Area Coordinator	728-2576	Beaufort
	U.S. Geological Survey	Jim Turner	District Chief, Water Resources Division	856-4510	Raleigh
		Jerad Bales	Project Chief	856-4520	Raleigh
		Ed Simpkins	Chief, Hydrol. Records Section	856-4510	Raleigh
	U.S. Army Corps of Engineers	Wayne Wright	Chief, Enforcement Section	343-4481	Wilmington
		Larry Belcher	Chief, Planning Branch	343-4503	Wilmington
		Tom Meehan	Study Manager, NE NC Area Task Force	343-4502	Wilmington
	U.S. Environmental Prot. Ag.	Howard Marshall	Ecologist	404-347-3866	Atlanta
		Ed Laws	Nonpoint Coordinator	404-347-3791	Atlanta

APPENDIX VI-2: RESEARCHER MEETINGS, JANUARY 5-7, 1986
LIST OF PARTICIPANTS

GROUP	NAME	AFFILIATION	PHONE
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	Roman Cruz	U.S. Environmental Protection Agency	919-541-2126
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	Carroll Pierce	NRCD, Soil & Water Conservation	919-733-2302
	Melissa McCullough	NRCD, Coastal Management	919-733-2293
Significant Natural Areas, Wetlands, and Endangered Species	Chuck Roe	NRCD, Natural Heritage Program	919-733-7701
	Mike Gantt	US Fish & Wildlife Service	919-856-4520
	Gail Cannon	Duke University Marine Laboratory	919-728-2111
	Steve Leonard	NRCD, Soil & Water Conservation	919-733-2302
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	Don Stanley	ECU	919-757-6792
	Harrell Johnson	NRCD, Marine Fisheries	919-338-2351
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	John Fisher	NCSU	919-737-2331
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	Mark Brinson	ECU, Dept. of Biology	[illegible]
	Ernie Seneca	NCSU, Dept. of Botany	[illegible]
	Harrell Johnson	NRCD, Marine Fisheries	[illegible]
	Terry Sholar	NRCD, Marine Fisheries	[illegible]
Toxicants, Pathogens, Fish Diseases	John Dorney	NRCD, Environmental Management	[illegible]
	Mark Sobsey	UNC, Dept. of Environmental Science	[illegible]
	Robert W. Benton	DHR, DHS, Shellfish Sanitation	[illegible]
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	John Maiolo	ECU, Dept. of Sociology & Anthropology	919-757-6883
	Leon Danielson	NCSU, Dept. of Economics & Business	919-737-2256
	David J. Brower	Center of Urban & Regional Planning	919-962-3074
	Jim Waters	NMFS, NOAA	919-728-8710

APPENDIX VI-3: APPROXIMATE PROJECTED COSTS

	COST ($1000's) *
I. RESOURCE CRITICAL AREAS	
A. FISHERIES HABITAT	
C1. PNA/SNA surveys	10-15 K
E1. PNA/SNA correlations	20-25 K
E2. PNA/SNA controlling factors	75-100 K
E3. Major habitat types	60-80 K
E4. Striped bass reproduction	60-80 K
M1. Anadromous obstructions	5-10 K
M2. Mitigation of impaired nurseries	30-50 K
M3. Nursery regulatory options	15-20 K
B. AQUATIC VEGETATIVE HABITAT	
C1. Current distribution patterns	75-125 K
C2. Historical trends	120-150 K
E1. Pamlico River suitability	60-75 K
E2. Turbidity effects and origins	80-120 K
E3. Role of wooded swamps	10-15 K
E4. Role of Juncus marshes	50-75 K
M1. Pilot restoration SAV	?
M2. Monitoring protocol	5 K
C. SIGNIFICANT NATURAL AREAS, WETLANDS AND ENDANGERED SPECIES HABITATS	
C1. Natural area identification	28-100 K
C2. NWI completion	70 K
C3. Endangered species habitats	2-100 + K
C4. Altered wetlands	30 K
M1. High priority area surveys	50 K
M2. Management plans, high priority areas	50 K
M3. Wetland protection strategies	50 K
II. WATER QUALITY AND ESTUARINE RELATIONSHIPS	
A. NONPOINT SOURCE POLLUTION	
C1. Land-use mapping	100-150 K
C2. Soil survey	30 K
C3. Trends in land use	35-50 K
E1. Land-use conversion effects	100-120 K
E2. Large-watershed models	500-1000 K
E3. Cumulative impacts methodology	30-50 K
E4. User-oriented models	30-50 K
E5. Suitability of development of soils	30-50 K
E6. Channelization effects	10-20 K
M1. BMP performance	30-50 K
M2. BMP packages	10-20 K
M3. Optimal water management practices	20-30 K

B. POINT SOURCE POLLUTION I: EUTROPHICATION

C1.	Data massage	50-100 K
C2.	Comprehensive N/P budgets	20-50 K
E1.	Historical trends	50-100 K
E2.	User-oriented models	100-500 K
E3.	Bloom formation	100 K
E4.	Sediment/water interactions	50-75 K
E5.	Eutrophication and deoxygenation	?
M1.	Cost effectiveness of management	20

C. POINT SOURCE POLLUTION II: TOXICANTS AND BACTERIA

E1.	Toxicity of F, Ti	40 K
E2.	Saltwater bioassays	10-50 K
E3.	Toxicant baselines	200 K
E4.	Chronic effects of suspended sediment	++
E5.	Shellfish toxicants	?
M1.	Alternatives to fecal coliforms	?

D. PHYSICAL PROCESSES

E1.	Model utility	10-20 K
E2.	Model development	?
E3.	Sediment dynamics	?

III. FISHERIES DYNAMICS

A. FISHERIES STOCKS

C1.	Data evaluation	50 K
C2.	Shellfish beds	250 K++
E1.	Blue crab variation	?
E2.	Fishing practices	?
E3.	Nursery areas and larval transport	?
E4.	Shellfish bed viability	40-60 K
M1.	Excluder effects	20-40 K

B. FISH DISEASES

C1.	Ulcerative sore incidence	25 K
C2.	Other disease incidence	19 K
E1.	Environmental factors	68 K
E2.	Fungal pathogenicity	15 K
E3.	Water quality effects	++

IV. HUMAN ENVIRONMENT

A. SOCIO-CULTURAL STUDIES

C1.	Demographic trends	35 K
C2.	Attitudes about resource management	32-64 K

B. ECONOMIC STUDIES

E1.	Land-use incentives	10-30 K
E2.	Economics of policies	10 K
E3.	Value of "non-market" goods	50 K+
E4.	Development case study	25-50 K
C.	INSTITUTIONAL STUDIES	
C1.	Political/governmental systems	10 K
C2.	Role of science in policy	10 K
C3.	Efficiency of existing systems	25-60 K
C4.	Alternative management systems	25-60 K
D.	INTERDISCIPLINARY CASE STUDY	100-120 K

* PRELIMINARY ESTIMATES ONLY

CHAPTER VI: ADDENDUM

Relevance to Major Conflicts: Agriculture and Commercial Fishing

Conflict resolution depends on three factors: understanding the processes mediating the interaction well enough to predict the effects of management actions, understanding the consequences and costs of management strategies themselves, and understanding the governmental and cultural systems well enough to make control programs effective. The Albemarle-Pamlico Estuarine Study should provide copious information relevant to these areas. The conflict between agriculture and commercial fishing is based on two linked land/water interface processes (drainage to reduce water table levels, and nonpoint source runoff) and a number of instream processes (e.g. eutrophication, food-chain effects, deoxygenation, ulcerative sore initiation), many of which are poorly understood. Furthermore, the costs and benefits of potential management strategies are not well known at present. Therefore, an effective implementation plan must be based on knowledge of critical processes, their human contexts and alternative management strategies designed to integrate anthropic and natural systems.

The following sections present the proposed research and schedule for that research which should contribute toward effective management of continuing land-based activities to allow maintenance of aquatic productivity.

I. UNDERSTANDING THE PROCESSES INVOLVED

A. Land-Use Conversion, Nonpoint Effects

PROJECT	COST	SCHEDULE
1. Land-use updates	120K **	1987 1987-1988
2. Soil survey, Hyde Co.	30K *	1987-1988 1988-1989
3. Scoping work on process	30K	1987
4. Experimental work	70-90K	1987-1988 1988-1989
5. Large-watershed model	500-1000K	1987-1988 1988-1989 1989-1990 1990-1991
6. Risk of development of different soils	30-50K	1987-1988 1988-1989

B. Nonpoint Drainage, Effects on Nursery Areas

PROJECT	COST	SCHEDULE
1. PNA/SNA surveys	10-15K	1987
2. PNA scoping studies	20-25K	1987-1988
3. PNA experimental work	75-100K	1988-1989
		1989-1990
		1990-1991

C. Nonpoint, Pollution, Effects on Finfish Declines

PROJECT	COST	SCHEDULE
1. Experiemental work on striped bass reproductive problems	50-70K	1987-1988
		1988-1989
2. Experimental work on relevant value of habitats and impairment losses	60-80K	1988-1989
		1989-1990

D. Nonpoint Pollution, Effects on Submerged Macrophytes

PROJECT	COST	SCHEDULE
1. Current distribution	75-125K	1987-1988
		1988-1989
		1989-1990
2. Causes of Pamlico River loss and present suitability	60-75K	1987-1988
		1988-1989

II. UNDERSTANDING MANAGEMENT EFFECTS

A. Nursery Area Restoration and Protection

PROJECT	COST	SCHEDULE
1. PNA restoration pilot	30-50K	1990-1991
		1991-1992
2. PNA protection regulation	15-20K	1990-1991

B. SAV Reintroduction

PROJECT	COST	SCHEDULE
1. Pilot reintrocution	50-75K	1989-1990
		1990-1991
2. Monitoring protocol	5K	1987-1988

C. BMP Performance

PROJECT	COST	SCHEDULE
1. BMP effectiveness	30-50K	1987-1988 1988-1989
2. BMP package design	10-20K	1989-1990
3. Optimal water management	20-30K	1989-1990 1990-1991

SUMMARY TABLE

	1987	1987-1988	1988-1989	1989-1990	1990-1991	1991-1992
Land-use effects	(100K)	20K				
		15K	15K			
	30K					
		35K	35K			
		125K	125K	125K	125K	
		15K	5K			
Nursery Areas	10K					
		20K				
			25K	25K	25K	
Finfish Declines		25K	25K			
			30K	30K		
SAV		25K	25K	25K		
		30K	30K			
Management					15K	15K
					15K	
				25K	25K	
		5K				
		15K	15K			
				10K		
				10K	10K	
-						
	40K	330K	340K	250K	215K	15K

[ΣΣ- $1190 K in 6 years)

Relevance to Major Conflicts: Waste Disposal vs Commercial Fishing

The conflict between waste disposal and commercial fishing results from a variety of instream processes, including eutrophication, deoxygenation, rerelease of contaminants in sediments, initiation of ulcerative sore diseases, etc. The nature of these processes and the consequences and effectiveness of management alternatives are poorly known.

The following sections present research needed to understand these processes well enough to manage the system effectively.

I. UNDERSTANDING THE PROCESSES INVOLVED

A. Point Source Pollution: Eutroph, D.O. and H_{20} quality

PROJECT	COST	SCHEDULE
1. Data Massage	50-100K *	1987 1987-1988 1988-1989
2. Budgets	20-50K	1988-1989 1989-1990
3. Trends in Nut./Eutroph.	50-100K	1987-1988 1988-1989
4. Eutroph. Model	100-500K	1987-1988 1988-1989 1989-1990 1990-1991
5. Bloom Formation	100K	1987-1988 1988-1989 1989-1990
6. Sediment/H_{20} Interaction	50-75K	1987-1988 1988-1989

B. Point Source Pollution: Toxicants

PROJECT	COST	SCHEDULE
1. Contaminants baseline	(180K)	1987-1988 1988-1989
2. Chronic suspended sediment	100K?	1987-1988 1988-1989 1989-1990
3. Shellfish contaminants by toxicants	50K?	1989-1990 1990-1991

II. UNDERSTANDING MANAGEMENT STRATEGIES

A. Euthrophication-Related Strategies

PROJECT	COST	SCHEDULE
1. Management costs	20K	1989-1990

B. Toxicants Control Stratgies

1. Estuarine toxicity	40K	1987-1988 1988-1989
2. Saltwater bioassays	10-50K	1988-1989
3. Alternatives to fecal contamination	50K	1989-1990 1990-1991

SUMMARY TABLE

PROJECT	1987	1987-88	1988-89	1989-90	1990-1991	1991-92
Eutroph.	33K	33K	33K			
			10K	10K		
		25K	25K			
		25K	25K	25K	25K	
		33K	33K	33K		
		25K	25K			
		33K	33K	33K		
				25K	25K	
				20K		
		20K	20K			
			10K			
				25K	25K	
	33K	195K	215K	172K	75K	

[ee = 690K]

Relevance to Major Conflicts: Land-Use Conversion & Wildlife Resources

Although conflicts between individual land uses and wildlife resources are commonly perceived to be moderate, taken together the conflict is of major importance. The main process mediating this conflict is habitat destruction, but the tigh linkage between wetland systems and instream processes make a fine understanding of these relationships essential.

I. UNDERSTANDING PROCESSES (HABITAT LOSS, VALUE OF HABITAT)

PROJECT	COST	SCHEDULE
1. NWI	70K	1987 1987-1988 1988-1989
2. Natural area identified	28-100K	1987-1988 1988-1989 1989-1990
3. Endangered species habitat	2-100K	1987-1988 1988-1989 1989-1990
4. Fringe wooded swamps	10-15K	1987-1988
5. Juncus marshes	50-75K	1988-1989 1989-1990

II. MANAGEMENT OF PROCESS

PROJECT	COST	SCHEDULE
1. Management plans, natural areas	50K	1990-1991 1991-1992
2. Management plans, wildlife	50K	1990-1991 1991-1992
3. Wetland protection regs.	50K	1990-1991 1991-1992
4. Altered wetland restoration	30K	1990-1991

SUMMARY TABLE

Project	1987	1987-88	1988-89	1989-90	1990-91	1991-92
Land Use	20K	30K	20K			
		28K	28K			
	10K	30K	20K			
		10K				
			25K		25K	
Management					25K	25K
					25K	25K
					25K	25K
						30K
	30K	98K	93K		100K	105K

Other Processes Relevant to Conflict Amelioration

I. FISHERIES ISSUES

A. Fisheries Stock Assessement

PROJECT	COST	SCHEDULE
1. Stock declines scoping work	50K	1987-1988 1988-1989
2. Shellfish beds	(250K++)	1987-1988 1988-1989 1989-1990 1990-1991 1991-1992
3. Blue crab declines	?	?
4. Fishing effect of fishing	?	?
5. Water quality/transport effects on laval pop.	?	?

B. Fisheries Stock Management

PROJECT	COST	SCHEDULE
1. Anadromous obstacle study	5-10K	1987-1988
2. Reestablishment of shellfish beds	40-60K	1988-1989 1989-1990
3. Bycatch reduction	20-40K	1987-1988

C. Ulcerative Sore Diseases

PROJECT	COST	SCHEDULE
1. Scoping work on red sore	25K	1987-1988
2. Scoping work on others	19K	1987-1988
3. Infectability and environmental factors	68K	1988-1989 1989-1990
4. Fungal presence disease	15K	1988-1989
5. H_2O quality work	?	1990-1991 1991-1992

SUMMARY: OTHER PROCESSES

Project	1987	1987-88	1988-89	1989-90	1990-91	1991-92
Fisheries		25K	25K			
		5K				
			20K	20K		
		20K				
		25K				
		19K				
			40K	28K		
			15K			
	(+)	94K(+)	100K(+)	48K(+)	(+)	(+)
Human Envir.		35K				
		16K	16K			
		10K	10K			
		10K				
		25K	25K			
			15K	10K		
		10K				
		10K				
		25K				
			15K	10K		
		25K	25K	25K	25K	
		166K	106K	45K	25K	

II. HUMAN ENVIRONMENT

PROJECT	COST	SCHEDULE
1. Demographics	5K	1987-1988
2. Attitudinal studies	32-64K	1987-1988 1988-1989
3. Economic incentives	10-30K	1987-1988 1988-1989
4. Specific incentives (policies)	10K	1987-1988
5. "Non-market" goods	50K	1987-1988 1988-1989
6. Case study	25-50K	1988-1989 1989-1990
7. Political/govern. system	10K	1987-1988
8. Science and Policy	10K	1987-1988
9. Management systems	25-60K	1987-1988
10. Alternative management	25-60K	1988-1989 1989-1990
11. Interdisciplinary study	100-120K	1987-1988 1988-1989 1989-1990 1990-1991

OVERALL SUMMARY

ITEM	1987	1987-88	1988-89	1989-90	1990-91	1991-92	
Ag - Fish	40K	330K	340K	250K	215K	15K	
Wd - Fish	33K	195K	215K	172K	75K	-	-
Land use - Wildlife	30K	98K	93K	100K	105K	-	
Fisheries	+	94K(+)	100K(+)	48K(+)	+	+	
Human Envir.		166K	106K	45K	25K	-	
SUMMARY	103K	883K	854K	615K	420K	15K	

CHAPTER VII

DATA MANAGEMENT

The purpose of the Albemarle Pamlico Estuarine Study, as stated in Chapter I, is to enable resource managers to better preserve the productivity of the estuarine area by expanding relevant knowledge about the impact of human uses upon its physical, biological, and social systems. Chapter VI identifies specific researchable, actionable themes that must be pursued to improve management capabilities in the area.

In striving to fulfill the purpose of the Albemarle Pamlico Estuarine Study, the importance of adequate data and of having data in a form that can be readily utilized by managers cannot be overemphasized. To achieve the goal of developing a viable, long term management strategy for the region, managers and researchers have identified research and information needs.

A considerable amount of information about the area already exists. The information is in the form of literature, tabular data, and geographic or mapped data. Additional information will need to be compiled to enable researchers to accomplish the research goals set forth in Chapter VI and to meet the needs of managers. The project will need to bring together the disparate data about the region, including both existing and new data.

The overall objective of the data management efforts of Albemarle Pamlico Estuarine Study will be to provide users with access to data that will aid in addressing the issues outlined in Chapter VI. The ability to effectively manage the data will be critical to the success of the project. This chapter describes the data to be managed and the computer system to be used for managing the data for the Albemarle Pamlico Estuarine Study.

DESCRIPTION OF DATA

The following section describes the data collection objectives of the Albemarle Pamlico Estuarine Study. In developing these objectives, three important issues were identified. First, a database for the study, while it may be very large, must be limited to data that is relevant to the research topics that have been identified by the resource managers and researchers and that will be useful in practical estuarine management applications. A careful evaluation of existing databases and of data that need to be compiled must be completed for the Albemarle Pamlico Estuarine Study.

Second, the data must be of good quality. Existing databases will be evaluated according to an established set of procedures, and future data collection efforts must meet these standards. Finally, the data must be put in a form that will be useable by managers and scientists.

Data Identification

The process of data identification has already begun. In Chapter VI, a wide variety of research and information needs has been identified. State and federal managers (see Appendix VI-1) identified management related information that will facilitate effective management of estuarine resources. In a separate effort, ten groups of researchers (see Appendix VI-2) have identified the specific information requirements necessary to address the research topics set forth in Chapter VI.

It is difficult at the onset of the Albemarle Pamlico Estuarine Study to anticipate all of the project's long-term research and information needs. As research projects are completed, new information needs will be identified. Data identification will be an on-going task.

Data Standards

Working groups established by the Data Sub-Group of the Albemarle Pamlico Estuarine Study Technical Committee are developing data assessment procedures and criteria. These data standards will form the basis for quality control of data.

Information Types

Information about the region exists in two primary forms: literature and data.

1) Literature

Researchers and resources managers must have access to the results and conclusions of prior research efforts on the Albemarle Pamlico region and on the research topics in general. References to the literature, including bibliography and abstracts, will be stored for each of the primary topic areas. The literature will be cross-referenced to related databases.

2) Data

The strategy behind the data management efforts will be to use geography, whenever possible, as a framework for relating the data about the area. In almost every case, the data can be referenced to the earth's surface, whether it be to land use, shoreline, hydrography, political boundaries,

soils, or coordinate locations for monitoring stations, water supply intake locations, point source dischargers, etc.

Accurate and up-to-date data will be critical to accomplishing the characterization and evaluation of the key research topics set forth in Chapter VI. The Albemarle Pamlico Estuarine Study's data collection efforts will concentrate on building a database of four key layers of data.

a) Base map data

Detailed hydrography, shoreline, transportation networks, and political boundaries from U.S. Geological Survey (USGS) 7.5 minute quadrangles will form the foundation of the geographic database. USGS is currently compiling the data in a computer compatible format called Digital Line Graphs.

Access to these base map data will be vital in identifying and managing resource critical areas, assessing water quality, defining estuarine relationships, and studying fisheries dynamics.

b) Land use/land cover

A detailed, up-to-date land use/land cover inventory and a historical land use/land cover inventory will form another important data layer. With these data, researchers can locate and generate areal measurements of farmland, forestland, peatland, wetlands and other land use classifications and examine their relationship to critical estuarine habitats.

The evaluation of land use development trends and the effect of land use conversion on critical areas, natural processes, and human activities will be critical to resolving existing and potential conflicts and developing viable estuarine management strategies.

c) Soils

Soil surveys form a third major data layer. The location and areal measurement of specific soil types, their proximity to drainage networks, and the distribution of soil types by land use will provide researchers with a source of pollution loading yields for water quality and runoff models.

d) Census

The fourth data layer will consist of political boundaries and census data. Economic analysis and the identification of demographic trends will be essential to developing an overall management strategy for the region.

These four basic data layers cut across all of the research topics discussed in Chapter VI. Access to these data in a management useable form will permit researchers and

resource managers to characterize and evaluate the key resource topics.

Additional data will be important to specific research topics. These would include Primary and Secondary Nursery Areas, Inland Nursery Areas, Anadromous Fish Spawning and Nursery Areas, Submerged Aquatic Vegetation Beds, endangered species habitat, natural areas, and watershed boundaries. These data may be compiled through specific research projects.

The tabular data will include: large, active, established databases such as the Environmental Protection Agency's Storet or USGS's National Water Information System; smaller, less widely used databases that may exist now only on micro-computers at scattered locations; databases that have not yet been computerized; and databases that will be compiled through project research applications.

COMPUTER SYSTEM

Given the research concerns and data management objectives outlined above and in Chapter VI, a computer system for managing data has been designed to serve the needs of the Albemarle Pamlico Estuarine Study.

System Design Objectives

In designing a system for the study, a number of system design objectives were identified.

1. The system must limit the duplication of both systems and data. Duplicating systems will add enormous costs to the project. Duplicating major, dynamic databases is not only redundant, but can pose potential data integrity and inconsistency problems if updates to the databases are not strongly coordinated.

2. The system should permit and accomodate use by managers, technicians, and scientists.

3. The system must provide remote access to a variety of users. Managers and researchers from many different government agencies and universities, both within and outside the project area, must be able to use the data management system.

4. The active utility of the system must be capable of extending beyond the lifetime of the Albemarle Pamlico Estuarine Study. Because a major goal of the study is to develop long-term management strategies for the region, system design must ensure continued database maintenance and access so that the system can be self-supporting beyond the scope of this study.

5. The capability for compiling, storing and analyzing geograpic data must be an integral part of the system. Geographic data will be a critical component of the research efforts to develop management strategies and to employ management activities that are adopted.

6. Flexibility is an important design objective. It is difficult at the onset of the Albemarle Pamlico Estuarine Study to anticipate every question or research direction. The system must be flexible enough to manage both new and existing data, to permit ad hoc queries, and to facilitate system design adaptations to handle technological developments or new management strategies.

7. The system must incorporate an effective interface with existing systems. Without this feature, many of the design criteria described above, including system and data duplication, long-term maintenance of the system, and the flexibility to adapt to changing situations and goals, will be impossible to accomplish.

System Description

The system will consist of a primary computer system with central control which will be connected through a communications network both to existing systems and to remote users (see Figure 1, Albemarle Pamlico Estuarine Study Computer Systems Diagram). The system will be used for data management, geographic data analysis, statistical analysis, and literature searches.

The system will provide access to data of good quality, data that is relevant to the key issues and in a form that managers can use. The system will permit geographic data analysis, through access to a geographic information system (GIS). Computer systems that store, retrieve, and analyze data according to either their geographic location or their attribute values are called geographic information systems. A GIS provides the capability to convert maps of geographic information to a digital format. The primary purpose of a GIS is to generate information, in the form of either maps or measurements, for use in research or management applications.

The GIS can be used to display the data on graphic terminals, plot the data at various scales, generate areal or linear measurements, aggregate the data to produce interpretive maps, and to overlay separate layers of geographic data where the relationship of those layers is important.

The system will not duplicate the ability to do sophisticated statistical analysis. Rather, the system will enable users to access data for statistical analysis on existing systems such as the Triangle Univeristies Computer

Albemarle-Pamlico Estuarine Study
Computer Systems Diagram

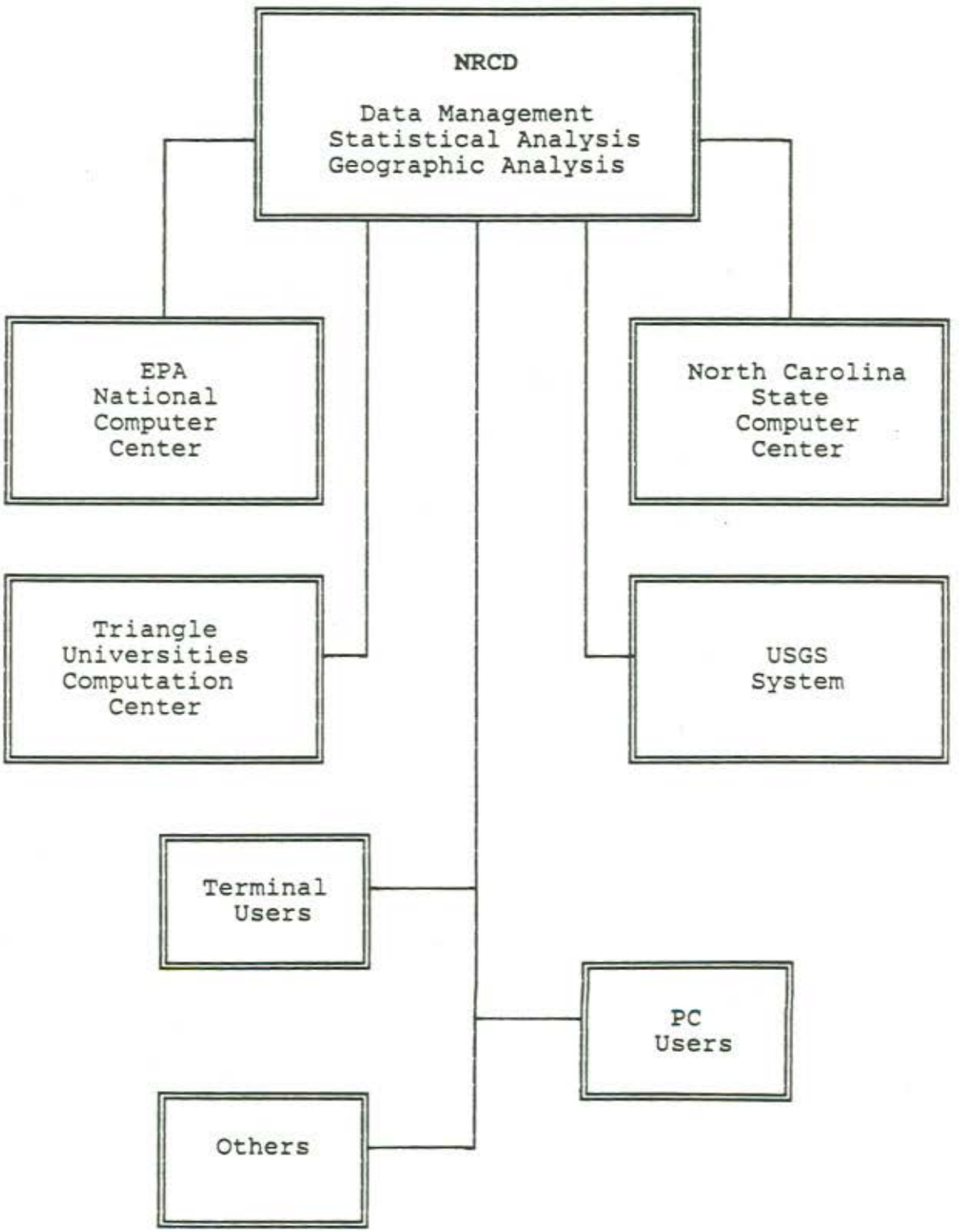

Figure 1

Center. The system will enable users to integrate the results of statistical analysis in practical applications and in conjunction with other data.

Land Resources Information Service

The computer system at Land Resources Information System (LRIS), an agency of the Department of Natural Resources and Community Development, will be used as the primary computer system.

The Albemarle Pamlico Estuarine Study will realize several benefits from this arrangement, and a number of system design objectives will be met by establishing LRIS as the primary system. LRIS has an established computer system management "infrastructure" i.e. staff, facilities, procedures, etc. By utilizing an existing computer system as the primary system, the Albemarle Pamlico Estuarine Study will avoid the enormous costs of establishing a new system.

The basic computer hardware to run the system is already on line at LRIS. LRIS also has most of the communications hardware and software for connecting to standard, existing data communications networks, including the State Data Communications Network. The availability of an experienced staff using established procedures will eliminate the expense, the time, and the inefficiency inherent in developing an entirely new system.

LRIS is a service agency and, as such, has no program committment that would supersede the Albemarle Pamlico program requirements. That would not be the case with most existing computer systems.

LRIS already has a large database of geographic data for the Albemarle Pamlico study area.

Several of these factors relate directly to the system design objectives, including minimal duplication of equipment and data, long-term maintenance of both the system and the data, and the interface with existing systems.

Another system design objective is the capability for dealing with geographic data. LRIS has operated a GIS for ten years and has considerable experience in this technology and its application to natural and cultural resource management. The GIS will be an invaluable tool to researchers and resource managers for gathering information, identifying trends, and evaluating management alternatives.

Components

The components of the computer system include:

1) Hardware

The primary system is a Data General MV8000-II super mini-computer which currently has six megabytes of memory, approximately one gigabyte of disk storage, 16 asynchronous data ports, and a 1600/800 b.p.i. tape drive. Two other systems are utilized to support the geographic data capture process at LRIS. System peripherals include color graphics terminals, four digitizing tables, a drum/beltbed plotter, two line printers, and several alphanumeric terminals.

The system will be expanded as necessary to effectively support the Albemarle Pamlico Estuarine Study's data management requirements at a constant level of support. The system upgrade will include additional disk storage, asynchronous ports, memory and CPU capabilities to support additional processing.

2) Software

All systems storing data for the study will employ a relational data base management system (DBMS) to facilitate data sharing and integration. The DBMS utilized for the study will be INFO, a relational DBMS and fourth generation language marketed by Henco Software, Inc. INFO has been installed at LRIS by the state at North Carolina. Several cooperating federal agencies either currently support or plan to acquire INFO, including the U.S. Geological Survey, the Environmental Protection Agency (EPA), the Corps of Engineers, and the U.S. Fish and Wildlife Service.

ARC/INFO, a widely used GIS from Environmental Systems Research Institute, will be adopted as the standard GIS for the project. ARC/INFO software was recently installed by the State of North Carolina on the LRIS system and is also being used by USGS and EPA.

SAS (Statistical Analysis System) will be installed on the primary system to support low level statistical analysis requirements and to facilitate data sharing.

A text management software package will also be installed on the primary system. The text management system will enable users to do literature searches. The bibliographic database will also include pointers that will identify the research data in the tabular database that derive from that literature.

Communications

The primary system will be networked and integrated with both the end users and other computer installations supporting major databases relevant to the project.

1) Host Computer Communications

Specialized communications hardware and software will be utilized for physically connecting the primary system at LRIS to other host computers.

2) Remote User Network

An established data communications network will be used to link remote users to the primary system. The system will utilize either a commercial network or the existing North Carolina State Data Communications Network.

A "front-end" software package will be developed to simplify access to the system so that the network will be perceived by end users as an integrated system. The front-end system will provide a management oriented interface to the data and will pre-process and integrate disparate data into INFO and ARC/INFO compatible formats.

The physical communications network and the front-end software will enable the primary system to fulfill the system design objective to promote use by managers, technicians, and scientists and to provide remote access.

The overall system design, by permitting access to major existing, dynamic databases, will avoid costly duplication of these databases and ensure that users have access to consistent, updated data.

LEAD AGENCY

The North Carolina Department of Natural Resources and Community Development will be assigned management responsibility for the Albemarle Pamlico data and systems. The long-term estuarine management policies that evolve from the Albemarle Pamlico Estuarine Study will become the responsibility of the State of North Carolina at the conclusion of the five year study.

As the state agency with primary management responsibility for the region, the Department of Natural Resources and Community Development is most suited for continued operation of the system and maintenance of the database. Under this arrangement, the data and the system to manage and utilize the data will be centrally located in the agency with long-term management responsibilities. The lead agency responsibilities will include:

1) Staffing

2) Traditional operations management
   data backup and archival
   security enforcement
   equipment maintenance
   software maintenance
   system performance monitoring
   system tuning

3) Database design

4) Design of computer programs

5) Coding of computer programs

6) Procurement
   development of RFB's or specifications
   installations
   acceptance testing

7) Vendor liaison
   problem determination and resolution
   preventive maintenance
   contractual arrangements

8) Liaison with users

9) Training

10) Documentation

11) System use/cost accounting

COSTS

The estimated costs associated with data management for the Albemarle Pamlico Estuarine Study are summarized in the table in Figure 2. A description of each cost item follows.

Hardware

The computer system at LRIS will be upgraded to accomodate the increased workload anticipated from the Albemarle Pamlico Estuarine Study. The hardware will include additional data ports, modems, memory, disk, and a possible upgrade to the central processing unit. The hardware and software for processing satellite imagery will also be installed for developing a land use/land cover inventory.

Albemarle Pamlico Estuarine Study
Data Management Budget

ITEM	FY-86/87	FY-87/88	FY-88/89	FY-89/90	FY-90/91
Hardware	$56,300	$30,000	$30,000	$30,000	$30,000
Software	$ 4,500	$30,000	$10,000	$10,000	$10,000
Maintenance	$ 5,600	$21,000	$22,000	$23,000	$24,000
Communications Fixed Costs	$ 2,200	$20,000	$20,000	$20,000	$20,000
Communications Variable Costs	0	$15,000	$20,000	$25,000	$25,000
Design/Programming	$40,000	$50,000	0	0	0
Data Entry and Analysis	$50,000	$50,000	$50,000	$50,000	$50,000
Supplies	$22,500	$ 2,000	$ 2,000	$ 2,000	$ 2,000
Staff	$ 7,500	$30,000	$30,000	$30,000	$30,000
TOTAL	$188,600	$248,000	$184,000	$190,000	$191,000

Figure 2

Software

Commercial software products that will be acquired for use specifically in the Albemarle Pamlico Estuarine Study include SAS and a text management system for managing bibliographic text. ARC/INFO, the geographic information system and data base management system that will be used in the study, is already installed on the LRIS system.

Maintenance

These estimates cover the costs of maintenance contracts with vendors of the hardware and software described above.

Communications-Fixed Costs

The fixed costs for data communications fall into two categories. First, there are costs for hardware and software to establish communications between the primary system at LRIS and other host computers storing data relevant to the study. Fortunately, it appears that LRIS already has the hardware and software to communicate with the host systems that have been identified thus far (see Figure 1).

The second group of fixed communication costs are those required to establish LRIS as a node on an established data network so that it can be accessed by remote terminal or PC users. These estimates were based on the costs to utilize TYMNET, a large commercial data communications network, and include installation and operation charges. The software required by TYMNET is already installed at LRIS. It is possible that the network costs can be reduced significantly if the State Data Communications Network is upgraded to support the required communications protocol.

Communications-Variable Costs

TYMNET, or any data communications network, will charge fees that vary according to the hours of use and the number of bytes transmitted. These estimates were based on TYMNET rates and a moderate level of network utilization.

Design/Programming

These funds will be used to design the database for the Albemarle Pamlico Estuarine Study. The design will identify data elements that will be incorporated in the system; the relationships that exist between data elements; how data will be represented in the system; and provisions for revising the database design. The funds will also be used to design and develop the front-end software for handling user interface to the data and communications between other host computers and the primary system.

Data Entry and Analysis

These funds will be used to implement the database design and enter basic data into the system that are relevant to the issues described in Chapter VI. Funds will also be used for maintaining and updating data. In addition, analysis and interpretation of the data will be covered by these funds, at the discretion of the Albemarle Pamlico Estuarine Study Project Coordinator.

Supplies

These funds will be used to purchase mylar copies of all of the USGS 7.5 minute quadrangles covering the study area, and to acquire Landsat data tapes for the area.

Staff

These costs cover salary and fringes for a data coordinator for the project. The coordinator will be hired July, 1987 and continue employment through the duration of the study.

Other Costs

Any other costs associated with entering or accessing data in the system will be charged according to the established LRIS rate structure in effect at the time. The current rate schedule is shown in Appendix VII-1.

SCHEDULE

The schedule for installing and implementing the data management system is outlined in the Gantt chart in Figure 3.

Installation

Installation of hardware and software will begin in FY-86/87 and be completed during the second year. Because the primary system will be established at LRIS, much of the system is already operational. GIS capabilities will be available to researchers and resource managers immediately, and geographic data collection can commence during the first year of the project.

A system upgrade will be initiated immediately and completed during the first year. Additional upgrades will continue over the course of the study to meet the project's data management requirements.

The host computer communications will also be installed during the first year. The remote user communications network will be installed during the second year. In the meantime,

Albemarle Pamlico Estuarine Study
Data Management System
Installation and Operation Schedule

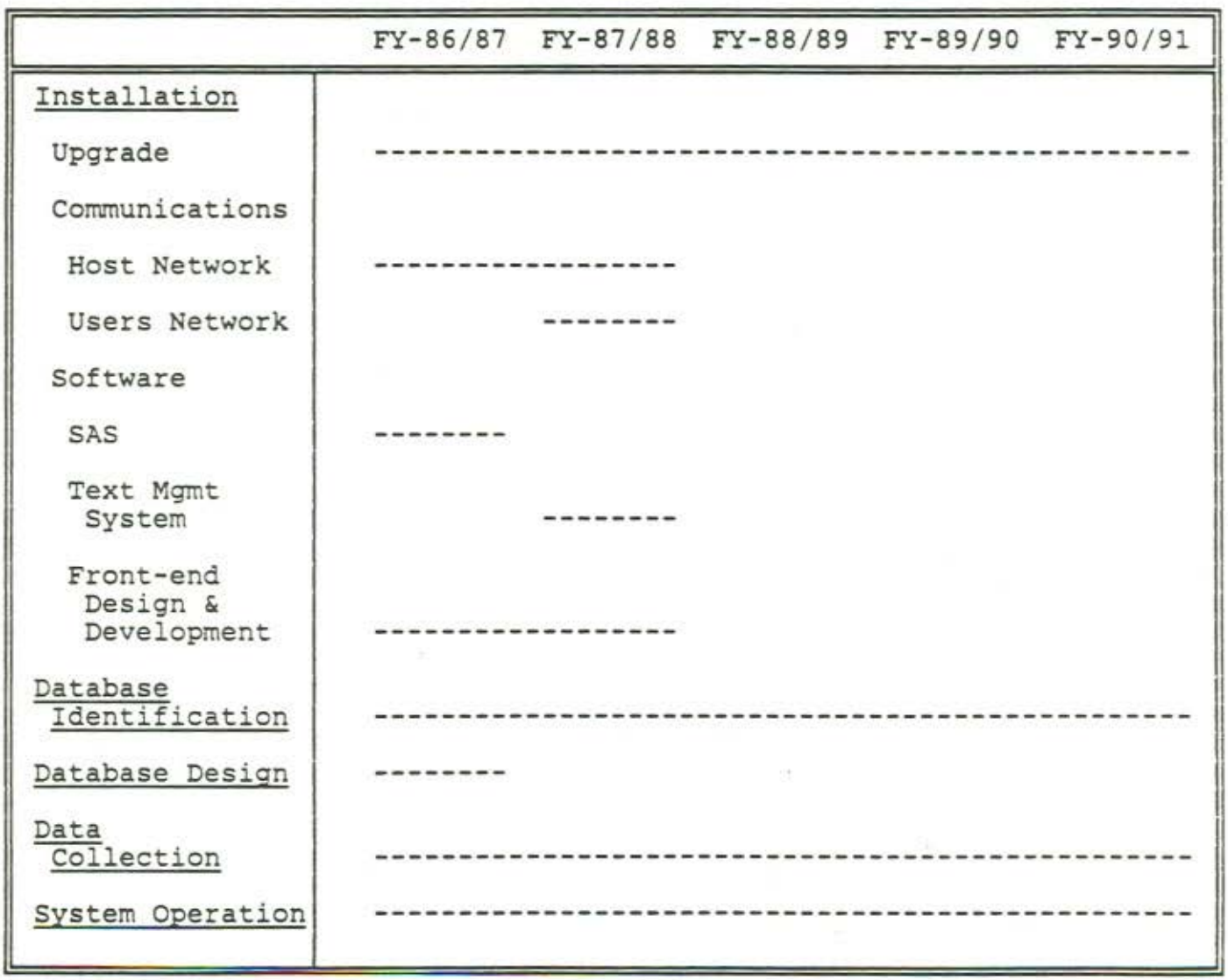

Figure 3

users may access the system in dial-up fashion, but not through a network.

The GIS software and DBMS are already on line at LRIS. The SAS package will be installed during the first year. A text management system will be added during the second year.

The front-end system design will begin immediately and be completed during the second year.

Database Design

Database design will be initiated during the first year and will be complete by the second year. Some database design refinements may occur throughout the course of the project.

Database Identification

Database identification has already begun and will continue over the course of the study as new research and information needs are identified.

Data Collection

Data collection will begin immediately and continue over the course of the study. Many important tabular databases already exist. Large databases relevant to the research issues will be networked to the system through the communications network.

A great deal of geographic data for the Albemarle Pamlico region already exists on the geographic information system at LRIS. Through a variety of on-going projects, additional geographic data is continually being incorporated into the GIS. These data will be available for use immediately.

Operation

With the existing capabilities at LRIS, data management activities will begin during the first year of the study. Full scale operation and utilization by remote users will not begin until the second year. Operation will continue throughout the five year life of the study. At the conclusion of the Albemarle Pamlico Estuarine Study, the Department of Natural Resources and Community Development will continue to manage the data and utilize the system for estuarine management applications.

LAND RESOURCES INFORMATION SERVICE
512 N. Salisbury Street, Room 1193
Raleigh, North Carolina 27611

(Effective April 1, 1984)

Rate Schedule

STAFF SERVICES:

Production activities:

$40/hr . . . . .Console/connect time

$15/hr . . . . .Preparation items (labeling, map preparation, verifying, etc.)

Programming:

$40/hr . . . . .For all program activities

CLIENT RATES:

Prime time:

$30/hr . . . . .7:30 a.m. - 6:00 p.m., Monday - Friday

Non-prime time:

$15/hr . . . . .6:00 p.m. - 7:30 a.m., Monday - Friday

$15/hr . . . . .6:00 p.m. - 7:30 a.m., Friday - Monday (weekends)

MISCELLANEOUS SERVICES:

Modem/Batch:

$15/hr . . . . .All modem charges/connect time for batch jobs

Copies of Existing Map Products:

$10 each

Copies of Existing Analytical Reports:

$2 each

Special Plotting Media:

Mylar $2.50/running foot above normal cost

Vellum $1.25/running foot above normal cost

Glossy .75¢/running foot above normal cost

Liquid ink pens used with mylar and vellum will require 1 hour @ $15/hour for set-up

CHAPTER VIII

PUBLIC PARTICIPATION IN THE ALBEMARLE-PAMLICO ESTUARINE STUDY

The complex yet fragmented structure of the existing management system for natural resources in the Albemarle-Pamlico region requires cooperation among institutions and individuals for the management goals of this project to be attained. The tight connection between land-use patterns and water-quality-mediated biological problems in this system underlines the need for strong positive relationships with diverse segments of the user population. This need will be addressed by an active public participation/public awareness program, intended to facilitate communication between the public and program administrators, to marshall support from local governments and regional institutions, and to allow dissemination of information gathered through this study.

Public Participation Programs

The mechanisms for public participation in the Albemarle-Pamlico Estuarine Study are both formal and informal. The pathways for citizen input include Citizens Advisory Committees (CACs), announced public meetings and conferences, the public review of all public documents, and the placement of a public liaison person in the region (proposed). Additional mechanisms include legislative/governmental liaison, informational presentations to technical groups, and general availability of administrative staff and receptivity to informational and philosophical queries.

Citizens Advisory Committees (CACs)

The Policy Committee for the Albemarle-Pamlico Estuarine Study requested that regional Citizens Advisory Committees be established, representing a broad cross-section of interests and occupations. In response, the Technical Committee established a Subcommittee on Public Participation, chaired by Dr. Mike Orbach (East Carolina University). After much discussion and revision, the Technical Committee approved a recommendation from that Subcommittee that two regional CACs be convened, representing the Albemarle region and the Pamlico region. The recommended makeup of those committees is shown in Table VII-1. Procedures were established for nomination by Technical Committee members or by citizens. Specific Technical Committee members were asked to provide nominations in specific categories such that every category had some nominations.

Table VII-1: Citizens Advisory Committees for the Albemarle-Pamlico Estuarine Study

There shall be one committee representing the Albemarle Sound region and one committee representing the Pamlico Sound region. Each committee shall be composed of representatives as follows:

1. Public Officials (2)
2. Educator
3. Tourism
4. Developer
5. Sport Fishing Interest
6. Commercial Fishing Industry
7. Agriculture
8. Industry
9. Environmental Group
10. Coastal Engineer/Surveyor
11. Private Citizen (4)

Following an appropriate interval, nominations and supporting materials were considered by the Technical Committee. A consensus was reached, and slates of recommended CAC members were approved by the Technical Committee. These slates were transmitted to the Policy Committee. The structures of the committees and individual members were approved and appointed by the Policy Committee on February 13, 1987, at a meeting held in Beaufort County.

The goals and purposes of these CACs were laid out in a Policy Committee directive, originally issued in August 15, 1986, and approved in modified form on February 13, 1987. The charge to these committees states:

The general charge to the Citizens Advisory Committees shall be:

1. to provide a mechanism for structured citizens' input into the Albemarle-Pamlico Estuarine Study from their respective regions; and

2. to assist in the dissemination of information relevant to or developed by the Albemarle-Pamlico Estuarine Study in their respective regions.

More specifically, the Citizens Advisory Committees shall:

1. Elect a Chairperson for their respective committee. The two Chairpersons shall be member of the Technical Committee.

2. Report at each meeting of the Technical Committee (TC), through their respective Chairperson.

3. Review all documents and materials produced by the Albemarel-Pamlico Estuarine Study. They shall include the results of such review in the Chair's reports to the Technical Committee.

4. Take such initiatives as are necessary and appropriate, in conjunction with the other activities of the Albemarle-Pamlico Estuarine Study, to ensure adequate citizen input from affected and interested constituencies in their regions.

5. Meet at their own discretion, but at least twice yearly, in locations convenient to the citizenry of their regions.

An important feature of this process was the election of chairpersons of those CACs, who also serve as voting members of the Technical Committee for the study. Those representatives are from the Albemarle CAC and from the Pamlico CAC. A list of CAC members appears as Table VII-2.

Table VII-2: Citizens Advisory Committees for the Albemarle-Pamlico Estuarine Study

Albemarle Region	Pamlico Region
Mr. Lloyd Ballance	Mr. Alton Ballance
Mr. Ralph Calfee	Mr. Steve Barnes
Dr. Mike Corcoran	Ms. Grace Bonner
Mr. Fred Fox	Mr. Ralph Buxton
Ms. Mary Harrell	Mr. Ernie Larkin
Captain Alfred Howard	Mr. Dick Leach
Dr. Jimmy Jenkins	Mr. Neal Lewis
Mr. William McGeorge, Jr. (ex officio)	Mr. Rann Carpenter
Mr. Eddie Meekins	Mr. Todd Miller
Mr. Murry Nixon	Mr. Willy Phillips
Mr. Terry Pratt	Dr. Thomas Quay
Mr. John Stallings	Dr. Clark Rodman
Ms. Eve Trow	Mr. John Spagnola
Mr. C. W. Witherspoon	Mr. Garland Strickland
Ms. Winnie Wood	Mr. Buddy Swain
Mr. Glen Wood, Jr.	

Announced Public Meetings and Conferences

The second formal public involvement mechanism is announced public meetings of all kinds. A current list of all such meetings held appears as Table VII-3. Of these, the most important was the conference held at Beaufort County Community College on February 14, 1987.

Table VII-3. Public Meetings Held to Date

Group	Date	Place
Tar-Pamlico River Foundation	September 23, 1986	Washington, NC
Neuse River Foundation	November 10, 1986	New Bern, NC
Back Bay Restoration Foundation	November, 1986	Knotts Island, NC
Regional Conservation District & SCS	February 10,1987	Williamston, NC
Public Conference	February 14, 1987	Washington, NC

The goals of this conference included presentation of the workplan to the general public and exploration of additional public involvement vehicles by comparison to other National Estuaries Program projects. Speakers included Rep. Walter B. Jones, Secretary S. Thomas Rhodes (NRCD), Jack Ravan (US EPA), John Costlow (Duke University Marine Laboratory), Douglas N. Rader (Program Coordinator) and a number of representatives of other programs. Afternoon workshops examined information goals of the project, the role of science in public policy and the role of citizens in estuarine programs.

Additional regional meetings are planned to present information on the workplan for the study to the public and to receive public input on the goals and direction of the study.

Public Liaison Staff (Proposed)

The importance of the public involvement effort to this project, the spatial displacement of key administrative personnel from the effected region, and the diversity of duties necessary under the program suggest that a satellite office in the region would greatly expand the effectiveness of this effort. The office should be located at the Washington Regional Office or the Morehead City Marine Fisheries center, and should involve regular travel between northern, central, and southern locations. Proposed duties of the staff member would include response to public inquiries, dissemination of information and public education, promotion of public awareness of issues of major concern and preparation of a project newsletter. Close communication between central program staff and regional staff will be maintained at all times.

Legislative/Governmental Liaison

Maintenance of effective communications between the Albemarle-Pamlico Estuarine Study and governmental units on all levels is vital to the success of the project, both in terms of financial support and effective implementation of recommendations developed during the course of the project. NC Representative Walter B. Jones was instrumental in the procurement of federal moneys for this study and has been vitally involved in its formation. Contacts are being made in the offices of all legislators, state and federal, with interests in the region. The Program Coordinator has made a formal presentation of program information to the Interstate Chowan River Water Quality Task Force, comprising state senators, representatives, and delegates from Virginia and North Carolina. General information about the purpose and goals of the study is being prepared for the entire Legislature.

Local government offices are being contacted with the help of the Washington Regional Office Manager, Ms. Lorraine Shinn, and with regional councils of governments. A series of meetings will be held with those governmental bodies to provide information and garner support for the project. Local governments will be vital to the successful implementation of project results.

Relations with the Press

The Office of the Program Coordinator and regional staff are constantly available for informational requests from the press. The Coordinator has provided information on the project to several newspapers. A NRCD radio interview was taped with Mr. Lowell Shumaker on program goals and functions. An article on the project is in the planning stages for Wildlife in North Carolina, for spring or summer release.

Informational Presentations to Technical Meetings

Information about the program and results derived from the projects funded under the program is actively disseminated through technical meetings and publications. A list of such meetings appears on Table VII-4.

Table VII-4. Technical Information Presentation

Group	Date	Place
District Meeting, USGS	December 10, 1986	Winston-Salem, NC
American Fisheries Assn.	January 30, 1987	Gloucester Point, VA
Ocean '87	May 26-29, 1987	Seattle, WA

Summary

Positive relationships with all segments of the effected population are vital to the success of this endeavor. Now that initial project planning is nearing completion, liaison with the private citizens, local interest groups, local governmental units, and state and federal agencies and legislators will be a major focus of project administration.

CHAPTER IX

ADMINISTRATIVE PROCEDURES

Administrative Structure

As a joint venture between state and federal agencies with interests in northeast North Carolina, the Albemarle-Pamlico Estuarine Study is administered by two cooperative management committees: the Policy Committee and the Technical Committee. The roles and duties of these committees are described below. Day-to-day administration is conducted by the state project officer/program coordinator, Dr. Douglas N. Rader, and the North Carolina Department of Natural Resources and Community Development.

The Policy Committee

The Policy Committee for the Albemarle-Pamlico Estuarine Study was appointed to establish general policies and goals for the program; to execute ultimate authority in program administration; to review and approve all substantial expenditures of funds under the project; to structure, appoint, and replace members of the Technical and Citizen's Advisory Committees; to approve and appoint program staff; to approve the workplan for the study; to evaluate progress of the study towards established goals; and to provide broad-based support for the project in policy and political matters. Seven members were appointed in June, 1986, including the Regional Administration of EPA Region IV and the Secretary of the NC Department of Natural Resources and Community Development (Table IX-1). The Co-chairmen may appoint designees to serve in their absence, and will alternate chairing committee meetings. Meetings will be held at least twice annually at various locations including in the Albemarle-Pamlico study area.

Table IX-1: Policy Committee

Mr. Dan Ashe	Dr. Dirk Frankenburg	Mr. S. Thomas Rhodes*
Dr. John Costlow	Ms. L. K. Gantt	
Dr. Ford Cross	Mr. Jack Ravan*	

(*Co-chairmen)

Policy Committee Procedures

Voting Procedure

All decisions of the Policy Committee shall be made by majority vote of persons present. Only duly appointed members may vote. Votes taken by telephone poll or written inquiry may be conducted when the need is determined by the program coordinator or any Policy Committee member, provided the results of such votes are presented to the entire committee at its next meeting. All roll-call votes shall be noted in meeting minutes. All members shall receive reasonable notice of all scheduled meetings.

Required Action

Policy Committee approval is required for the following actions:

- Policy Committee member replacement
- Technical Committee member appointment
- Technical Committee member replacement
- Citizen's Advisory Committee appointment
- Citizen's Advisory Committee replacement
- Workplan submission to EPA
- Award of funds under contracted services over $1,000
- Budget modifications when amounts moved exceed $1,000
- Appointment or replacement of program coordinator
- Annual Report release
- Final Report release
- Project termination

The Policy Committee may identify other specific actions which require approval.

Other Procedures

Travel funds for Policy Committees members shall not be provided from program monies except under exceptional circumstances. This policy may be modified by specific committee action.

When possible, Technical Committee Co-chairmen should attend Policy Committee meetings. At least one Policy Committee member should attend Technical Committee meetings.

Agendas for meetings should be approved by Policy Committee Co-chairmen. Agenda items should be forwarded to the Program Coordinator.

The Technical Committee

The Technical Committee for the Albemarle-Pamlico Estuarine Study was initially convened in Washington, North Carolina, on August 15, 1986. The Co-chairmen of the committee are the Deputy Secretary of the NC Department of Natural Resources and Community Development and the Director of the EPA Region IV Water Management Division. Co-chairmen may appoint designees to serve in their absence, and will alternate chairing sessions. Co-chairmen will call meetings. Table IX-2 lists current Technical Committee members.

Table IX-2: Technical Committee

Mr. William Austin	Mr. Charles Fullwood, Jr.	Mr. David Owens
Mr. Bruce Barrett*	Ms. Michelle Hiller	Mr. Larry Saunders
Mr. Keith Buttleman	Dr. William Hogarth	Ms. Sharon Shutler
Dr. Ernest Carl*	Mr. Harry Layman	Dr. James Stewart
Dr. B. J. Copeland	Dr. Alvin Morris	Mr. James Turner, Jr.
Mr. Tom Ellis	Dr. Michael Orbach	Mr. R. P. Wilms

(*Co-chairmen)

The Technical Committee's major duty is to provide technical support to program staff during the planning phase of the study, to review draft documents and make recommendations to the Policy Committee on document technical merit, to help design and evaluate effective information management and public participation programs, to review draft requests for proposals, to aid in the review of proposals received, and to make recommendations on projects to be funded to the Policy Committee. Additional duties may be assigned at the direction of the Policy Committee.

Voting Procedures

All decisions and recommendations of the Technical Committee shall be made by majority vote of duly appointed members present. Votes may be taken by telephone poll or by written inquiry when circumstances warrant, at the discretion of either co-chairman or the Program Coordinator, provided the results of such votes are presented at subsequent meetings. All members shall receive reasonable notice of all meetings.

Required Action

Technical Committee action is required on:

- Recommendation to Policy Committee on public participation program
- Recommendation to Policy Committee on Citizen's Advisory Committee members
- Review of draft documents (workplans included)
- Review of Requests for Proposals (RFPs)
- Review of submitted proposals
- Recommendation to Policy Committee on grant awards

The Policy Committee may direct other action be taken at its discretion.

Other Procedures

Travel funds for Technical Committee members shall not be reimbursed from program funds unless specific action to that effect is requested by the Policy Committee.

Replacement of Technical Committee members will require Policy Committee approval.

The Program Office

The Program Office was established on November 1, 1986, in Raleigh, North Carolina. The program coordinator appointed at that time is Dr. Douglas N. Rader. Duties of the coordinator include:

- o Preparation of all program documents
- o Preparation of all RFPs issued under the program
- o Coordination of the review of all submitted proposals
- o Administration of all grants awarded by the program
- o Supervision of all staff employed by the project
- o Administration of day-to-day program functions
- o Staff support for all announced meetings of the Policy Committee and the Technical Committee
- o Staff support to Citizen's Advisory Committee, as necessary
- o Preparation of all general information documents from the program
- o Oversight of all technical documents released by the program
- o Other duties as assigned by the Policy Committee or NRCD.

The Program Coordinator shall meet all deadlines established by the Policy Committee and the Cooperative Agreement except when specific release is obtained from the Policy Committee.

Research Administration

Project Planning

Project planning will occur as dictated by the Cooperative Agreement, with NRCD and the Program Coordinator holding primary responsibility for workplan assembly. The Technical Committee will provide technical and editorial expertise to allow accurate evaluations of environmental concerns and appropriately targeted research to address those concerns. The Technical Committee will review the draft workplan and make recommendations to the Policy Committee concerning appropriateness of contents. The Policy Committee will review the draft workplan and approve the final version before it becomes official.

Evaluations of progress will be conducted to establish new goals on an annual basis, and progress reports will be issued. Each new annual workplan will receive full review from the Policy and Technical Committees.

Requests for Proposals

Once initial planning is complete, appropriate requests for proposals (RFPs) will be designed by the program office to cover each project area

recommended for funding. These RFPs will be reviewed by the Technical Committee to ensure that results from project execution will provide information needed for management purposes. Each RFP will include a clear specific statement of information to be gathered, hypotheses to be tested and deliverables expected by specified deadlines. Requests issued will include projects covered by short-term, Fiscal Year 1986-1987 funds for planning and scoping studies and projects covered by projected Fiscal Year 1987-1988 funds to be active in October, 1987. Planning-related RFPs will be issued about March 1, 1987, and Fiscal Year 1987-1988 RFPs will be issued about April 1, 1987.

All RFPs will receive broad distribution within and outside the State of North Carolina to attract the best research talent available. The submission period will be open for four weeks from date of issuance of RFPs for short-term studies and six weeks for 1987-1988 RFPs. All deadlines are firm. RFPs in subsequent project years will be treated accordingly.

Eligibility and Conflict of Interest

All potential purveyors of services are eligible for funding under the project, as allowed by state and federal law and regulation. State and federal agencies, state and private universities and private interests will be allowed to submit proposals as allowed by governing regulations. No member of the Policy Committee or Technical Committee may serve as a Principle Investigator on any proposal. If an investigator from a Committee member's institution or agency submits a proposal, that Committee member shall not comment, endorse, or vote on that proposal.

Review of Proposals

Proposals submitted will receive broad, confidential and impartial review. A Proposal Review Subcommittee shall be formed of two members of the Policy Committee and three members of the Technical Committee, appointed by their respective Co-chairmen. This committee will be responsible for coordinating internal and external reviews, and ranking proposals based on technical merit in relation to specific RFPs. Technical merit will be determined based upon at least three external reviews by respected scientists not resident in North Carolina. (The possibility of exchange of review services with other estuarine programs is being examined.) Recommendations for project funding will be submitted to the Technical Committee for their endorsement and then submitted to the Policy Committee for final approval. Initial short-term planning related studies may receive abbreviated review, but the process must be approved by the Policy Committee.

Final Selection and Notification

All grantees selected for funding will be notified by registered mail as soon as possible after the selection process is complete. The Program Coordinator will meet with each grantee to ensure that clear understandings exist of the nature of deliverables expected and deadlines. Awards will be announced to the press after initial notifications are complete.

Project Administration

Grant funds will be dispensed on a negotiated basis for projects, according to normal state procedures for grant administration. Deliverables will be expected on a timely basis, including initial scoping reports, progress reports and final reports. All data evolved under this program must be formatted to be compatible with the data management system, and must be delivered to the Program Office. All models constructed must be developed for manager use and must be delivered in user-friendly form, along with adequate documentation to allow effective use. Grants may extend for more than one year where multiple year information is required to test hypotheses. Renewal grant proposals will follow the same procedures as newly submitted proposals.

Project Time Schedule

The time schedule for the research proposal evaluation process is shown in Table IX-3.

Table IX-3: Time Schedule for Research Activities Under the Albemarle-Pamlico Estuarine Study

Process	Short-Term	Fiscal Year 1987-1988
Planning Complete	February 1	February 1
RFPs Issued	March 1	April 1
Submission Deadline	April 1	May 15
Office Transmission to Reviewers	April 7	May 22
Review Ends	April 28	July 1
Selection	May 1	July 7
EPA Review	-----	July 7 - August 22
Award Notification	May 1	August 22
Grant Active	May 1 - October 1	Oct. 1-Sept. 30, 1988